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The Canadian Academy of Sport Medicine (CASM) is an organization of physicians committed to excellence in the practice of medicine as it applies to all aspects of physical activity. Our mission is to be a leader in advancing the art and science of sport medicine, including health promotion and disease prevention, for the benefit of all Canadians through programs of education, research and service.

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New Concussion Management Guidelines:
Concussion Question and Answer Document For Physicians

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on behalf of the
ThinkFirst-SportSmart Concussion Education and Awareness Committee

Members of the College of Family Physicians of Canada may claim Mainpro-M2 credits for this unaccredited educational program.
1. **What is a concussion?**

Of course, the most important key to managing any condition is to know exactly what you are dealing with. Through the years, a number of definitions of concussion have been proposed, often leading to confusion. In their “Summary and Agreement Statement of the First International Symposium on Concussion in Sport, Vienna 2001,” the Concussion In Sport Group (an international group of physicians and neuropsychologists with concussion expertise) define concussion as “a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces”(this statement was reiterated in the Summary and Agreement Statement of the Second International Conference on Concussion in Sport). Several common features that incorporate clinical, pathological, and biomechanical injury constructs that may be used in defining the nature of a concussive head injury include the following:

1. Concussion may be caused by either 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.
3. Concussion may result in neuro pathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.
4. Concussion results in a graded set of clinical syndromes that may or may not involve a loss of consciousness. Resolution of the clinical and cognitive symptoms typically follow a sequential course.
5. Concussions are typically associated with grossly normal structural neuro imaging studies.

2. **Do you have to lose consciousness to have a concussion?**

Perhaps the most important mistake made when trying to define a concussion is that it involves a loss of consciousness (LOC). In fact, most concussions occur without LOC. LOC is just one symptom of concussion, and, in fact, recent research has suggested that a brief (less than one minute) LOC is not necessarily as significant an indicator of concussion severity as once thought. It is important to realize that many people will report a loss of consciousness because they cannot recall events before, during or after their concussion. Unless this is witnessed as a true loss of consciousness, it may be that the person is experiencing amnesia, which is an important post-concussive symptom. It is also important to note that concussion is not simply caused by a direct blow to the head. Blows to the face and to the jaw (which result in a force being transmitted to the brain) are also common causes of concussion. Even a significant blow elsewhere in the body (for example a hard tackle in football or rugby, being body checked in hockey) can cause concussive symptoms through a rapid movement of the soft brain inside the hard case of the skull. In some head injuries, there may be a structural injury to the brain, such as a bleed. Obviously this is critical to rule out and does affect early head injury management. However, the more typical sport related concussion does not result in any structural injury, but rather a functional injury to the brain cells. A helpful way to explain this to patients is to imagine the brain as a computer. If the computer is clearly damaged (for example, an axe through the CPU or monitor!) then this would define a structural injury. Obviously the computer would not work well due to this damage. In a concussion, the computer looks normal but is not working well, for instance, not processing programs as quickly as possible, running at a slower speed, etc. In other words... operating more like an old 486 computer rather than a Pentium IV! This is the same situation as in a concussion. Unfortunately, what exactly happens to cause this functional disturbance is not completely known. Given the lack
of structural injury, neuroimaging studies will be negative.

3. **Who gets a concussion?**

The majority of concussions that a family physician will see are sport or activity related. Sports which involve contact or collision (example, hockey, football, rugby) are among the most common sports where concussion is seen. However, other sports, such as soccer and basketball, often involve contact and a higher concussion risk. A concussion can occur in virtually any activity, including non-sporting activity where a blow to the head, face or jaw, or other force to the head occurs. You should ask about potential concussion when you have a patient who notes a history of a whiplash injury, or an injury around the neck and shoulder area. For example, someone who fell directly on the shoulder may report mainly shoulder pain at the time, but may also have post concussive symptoms which are critical to deal with.

4. **What are the signs and symptoms?**

Post concussive symptoms can be physical, cognitive and emotional.

- **Physical symptoms** include: headache, dizziness, nausea, feeling unsteady, feeling “dinged” or “stunned” or “dazed”, feeling like their “bell was rung”, seeing stars or other visual disturbances, ringing in the ears, double vision, simply “not feeling right”.
- **Cognitive symptoms** include: confusion, amnesia, disorientation, poor concentration, and memory disturbance.
- **Emotional symptoms** include: feeling of depression or moodiness.
- **Physical signs** of concussion include: loss of consciousness or impaired consciousness, poor coordination or balance, easy distractibility and poor concentration, slowness answering questions and following directions, vomiting, looking “glassy eyed”, photophobia, slurred speech, personality or behavior changes (including inappropriate playing behavior such as skating or running in the wrong direction) and significantly decreased performance or playing ability.

It is important to note that not all concussions will include all of these features. If any one of the aforementioned symptoms (or other similar symptoms) is present concussion should be suspected. Keep in mind that symptoms and signs may be more pronounced later or the next day after the injury. *Again, it is critical to remember that a person does not have to have lost consciousness to have sustained a concussion.*

5. **What exactly causes the symptoms?**

The pathology behind concussion and its resultant symptoms is, as yet, poorly understood. This is obviously a significant limiting factor in our assessment and management, in that there is no simple “test” which will give all the answers about diagnosis and resolution of the problem. It is, therefore, critical to be aware of the multiple post concussive signs and symptoms, and of appropriate management, which will be described further below.

6. **How do I make a diagnosis? What about grading systems?**

If any of the above symptoms or signs is noted in a setting of potential head injury (and don’t forget that head injury can occur in association with neck, shoulder and upper body injuries), the diagnosis
of concussion should be considered. If there are no other obvious reasons for the symptoms, then it should be firmly diagnosed as a concussion.

Through the years, a number of “grading systems” have been proposed for concussion assessment and management. Unfortunately, all these symptoms are anecdotal, based on the experience of their authors, with no scientific evidence to support them. The Concussion In Sport (CIS) Group concluded, “The CIS Group recognizes the strength and weaknesses of several existing concussion grading scales that attempt to characterize injury severity, but no single system was endorsed. It was the recommendation of the group that combined measures of recovery should be used to assess injury severity (and/or prognosis) and hence individually guide return to play decisions.” These “combined measures of recovery” will be discussed in more detail below. Comparing the existing grading systems will show that one system’s “second degree” concussion is another system’s “third degree”. The proposed management and return to play advice is also different. Many of these use loss of consciousness as a significant indicator of severity, and, as previously noted, this may not be the case. As a result, it may be possible to draw inappropriate conclusions. While it would be very nice and easy to have a system that one could plug into as a “cookbook”, unfortunately this is not the case at this time.

At the Prague Concussion Conference in November of 2004, the concept of “simple” versus “complex” concussion was introduced. A “simple concussion” was defined as one which resolves within 10 days (with appropriate post-concussion rehab, as described later in question 10), whereas a “complex concussion” has longer-lasting symptoms, or recurrence of symptoms with exertion. This does not change the assessment and management guidelines given below (questions 7-12), but “complex concussions” should be assessed by a physician with expertise in concussion assessment and management.

7. I’m at the rink or the field and I suspect someone has sustained a concussion. How do I deal with this?

As with any injury, it is critical to assess airway, breathing and circulation first! If the player is unconscious, it is critical to understand that a cervical spine injury could also have occurred and the athlete must be dealt with accordingly, using full cervical spine precautions and management techniques. If the player is conscious, but clearly confused and unable to provide a reasonable history (such as noting neck pain, feeling an extremity, etc.), then it is better to err on the side of caution and also treat this as a potential cervical spine injury. More typically, the player will exhibit typical symptoms and signs as discussed in question 3 above. It is critical to understand that the symptoms may not seem that significant initially, but may continue to evolve and become more severe with time. Thus, any player that you suspect to have had a concussion, should be removed from the game or practice and not allowed to return. No medication should be given, and the signs and symptoms should be monitored for increasing severity. Signs of a structural brain injury could include: increasingly severe headaches, decreasing level of consciousness, increasing tiredness and confusion, any lateralizing weakness, seizure temporally remote from the injury, persistent vomiting. Anyone with these symptoms needs immediate emergency assessment. If you, as a physician, are dealing with a concussion at the rink or the field, it is important to do only what you feel comfortable within your level of expertise. If you have extensive experience dealing with concussion, the player may not need further medical assessment. If not, the player should be referred for further assessment, whether in the emergency department acutely, or to another physician with more concussion expertise as soon as possible. All concussed individuals should be seen by a physician, though.
In many cases, you may be asked to discuss concussion assessment and management with parents, coaches, and trainers. The previously mentioned principles apply. When a concussed athlete is being assessed by a non-physician, it is important that the athlete be assessed by a physician as soon as possible after the injury.

**8. A concussed athlete comes into my office for assessment. How do I do this?**

As with all medical problems, a thorough history, and physical examination are the key to diagnosis and management. It is most helpful if the concussed athlete comes to the office with a friend, parent, etc. who can often provide some of the history that may be difficult for the concussed person. Start by asking about the injury: What happened? Was there a loss of consciousness, and if so for how long? (Remember, a more prolonged loss of consciousness is significant). Is there any amnesia for the event? What are the symptoms? What is the clinical course of the symptoms (improving, worsening)? It is also extremely important to ask about a past history of concussions, and to get specific details regarding these. It has been found that there is an increased risk of sustaining subsequent concussive injuries after a first concussion, although the reasons for this are somewhat controversial and unclear as yet. Thus, the athlete with multiple concussions may be at significantly more risk. The athlete who is becoming concussed more and more easily, and frequently, with more severe and longer lasting symptoms, is of significant concern. When asking about previous concussions it is important to not just ask about documented concussions, but about any episodes where the person had any post concussive symptoms. Many will not make the connection between the symptoms and the fact that they may have been concussions. For example “having your bell rung” or “seeing stars” are often not perceived as a concussion by many, but are in fact consistent with post concussive symptoms even if only transient.

Following the history, an appropriate physical examination should be performed. This should look at the head, the neck (it is very common in the setting of a blow to the head or the face that neck pain can result, and can contribute to such things as headaches), eyes, ear, nose and throat, and structures about the face. A neurologic assessment looking at cranial nerves, power, balance, and coordination is also important. Testing such as heel/toe walking, and Romberg test often reveals poor coordination or balance. In addition to physical tests, cognitive tests must be done. The standard mini mental status exam is not adequate. Tests of orientation, memory and concentration should be performed. Tests of orientation are usually more useful right after the injury, and can include: Who are you playing? Where are we now? What is the score? etc. Memory testing can be done by giving the patient five words to remember, and asking them to repeat them right away (immediate memory) and five minutes later (short term memory). Concentration tests include reciting the months of the year backwards, reciting strings of digits backwards, or performing serial subtraction tests such as “Serial 7”. It is the experience of many dealing with concussion that poorly performed Serial 7’s are often the result of poor arithmetic skills rather than post concussive problems, and so this test isn’t used much! It is important to note that, without doing any “baseline” testing in the same test prior to concussion, it is often hard to tell whether or not an impairment exists. However, if the athlete is obviously significantly impaired in memory and concentration relevant to their age or academic standing, then these tests will bring this out fairly clearly. Their performance in the test can also be used to track improvement as they are reassessed. If you are looking after a team where there is a risk of concussion, a good idea is to perform baseline testing in some of these areas first, so that you will have something to compare to should there be an injury later.
Tools such as the Sport Concussion Assessment Tool (SCAT) can greatly assist your assessment. These tools are referenced at the end of this document and with permission, will be downloadable from the ThinkFirst Canada website (www.thinkfirst.ca) in the near future.

9. Do I need to order any imaging?

As noted previously, concussion is a functional injury not a structural injury, and thus, imaging studies will not be useful. If there is any suspicion of a structural injury, such as a bleed (for example increasingly severe headaches), then imaging with an MRI or CT may be indicated. If there is any concern about associated injuries, such as facial fractures, injuries to the neck, etc, then appropriate imaging should be ordered.

10. How can I manage this player? What sort of treatment options do I have? You said that grading systems are not useful, so how do I know when to allow them back to sport?

This is certainly where things appear to get tough. However, by following a few simple management guidelines, you can successfully, and safely, guide the injured athlete through their post concussive phase and re-introduce them to activity.

As was previously discussed, when a player shows any signs or symptoms of concussion, they should not be allowed to return to play in the current game or practice. They should not be left alone; regular monitoring for deterioration is essential given that symptoms can progress. It is clear that physical activity increases post concussive symptom severity and prolongs their course. Thus, the most important initial management feature for concussion is rest. In someone with severe symptoms, this may need to be fairly significant rest, such as staying in bed, staying seated, etc. However, most are able to carry on with very light daily activities(excluding exercise, weight training, sport participation, and other exertional activities). If their symptoms are worsened, they should reduce their level of activity. It is very important to make this clear to the player, friends and family, as the lack of rest early on can often be a significant cause for prolonged symptoms. Once the person is completely asymptomatic at rest, a graduated increase in activities should be undertaken. Being “asymptomatic” refers to physical, cognitive, and emotional manifestations of concussion. It is helpful to compare this step-wise process to a “dimmer switch” for lights. The brightness should be turned up very gradually, with adjustments downward as necessary if there are symptoms. This contrasts to the “on - off switch” approach that many use, where they go from no activity to full activity. The lack of this graduated, step wise increase is a chief cause of very prolonged post concussive courses in many. (Another way to explain it to your patients is that it is a series of single steps forward rather than two or three steps forward, then six steps back).

A typical return to play or activity protocol is as following. Please note that each level is a step, not a day, so that it may take more than one day to proceed between each step. However, each step should take a minimum of one day:

1. No activity, only complete rest. Proceed to step two only when symptoms are gone.

2. Light aerobic exercise such as walking or stationary cycling. Monitor for symptoms and signs. No resistance training or weight lifting.

3. Sport - specific activities and training (eg. skating in hockey). No contact or risk of contact.
4. Drills without body contact. May add light resistance training at step 3 or 4 and then progress to heavy weights.

The time needed to progress from non-contact to contact exercise will vary with the severity of the concussion and player.

5. Begin drills with body contact.

6. Game play.

_The key to this approach is that the athlete should only continue to the next level if asymptomatic at the current level._ If any post concussive symptoms occur then they should drop back to the previous asymptomatic level and then try to progress again after a day or so. As you can appreciate, this protocol means that it will take a minimum of one week following complete resolution of symptoms before an athlete can return to play. However, it is critical to note that the athlete may not be able to progress from one step to another on a daily basis. So, when asked “How long will I be out?” by the athlete, parent or coach, it is clear that it is impossible to give a specific answer. Sport-specific post-concussion rehab programs are being developed by concussion experts, but follow the guidelines given above.

To summarize this important management information, remember that the athlete should rest until completely symptomatic, and then progress to a step-wise return to play protocol such as suggested above.

**Critical Points:**

*It is always unsafe to return to play while symptomatic* (higher risk of a new concussion, higher risk of more severe post concussive symptoms, higher risk of other injury), and *too rapid of progression while still symptomatic will often prolong the post concussive course.*

**11. When should I provide clearance to return to play if I am asked to do so?**

The concussed athlete should be managed as described above. Once you are certain that the athlete is completely asymptomatic, and has proceeded through a graduated return to play type protocol, then you can more confidently indicate that the player is fit to return to play. Just always remember, a player should never return to play while symptomatic! And, “when in doubt, sit them out!”

**12. What about somebody who has had multiple concussions? When should I be telling them it is not a good idea to return to contact or collision sports?**

This is always a very difficult question to deal with, as we still do not completely know the pathophysiology behind concussion. It has certainly been observed that once one has had one concussion, there is an increased risk of subsequent concussive injuries. However, there are multiple factors which come into play, including possibly genetics. Thus, it is not possible to give a “cookbook” type answer to this. If you have an athlete who has had numerous concussions, it is wise to be very careful, and to seek further opinion from a physician with expertise in dealing with concussion. Three concerning scenarios are:

1. the athlete who has had numerous concussions, with each concussion seemingly more easily obtained, and with symptoms which are more severe and longer lasting;
2. any athlete who has residual neurocognitive problems after other symptoms have all resolved (eg. memory or concentration impairment); and

3. protracted, prolonged symptoms. These are people potentially at risk for significant long term problems and would best be advised to give up any contact or collision activities which put them at risk. However, it would be best to involve the advice of a concussion expert in this regard where possible.

13. **Are children managed differently?**

It is the consensus of concussion experts that the Vienna Guidelines work for children (defined as ages 5-18 at the Prague Conference). However, it is extremely important to be conservative, and always err on the side of caution. The concept of “cognitive exertion” is very important in children; this refers to school, home computer use, video games, etc. These may exacerbate post-concussion symptoms. Thus, it is necessary to rest from these activities as well, until asymptomatic, then gradually re-introduce.

14. **Is there anything I can do to try to prevent concussion?**

Absolutely! A physician is in an excellent position to educate and encourage the athletes, parents, coaches/trainers about ways to recognize the injury, and to reduce the risk of concussion. Recognition of the injury is of primary importance, since appropriate management can begin. Protective equipment is the area most often thought of in this regard, but not the only one. When assessing a patient for concussion, it is important to ask about protective equipment, such as helmets. It is important to try to determine if the helmet is in good condition, whether it is being worn properly or sitting correctly. If you are unsure about this yourself, try to consult someone in your community who may be more expert in this regard (a sporting good manufacturer, hockey trainer, etc.). A helmet that is not worn properly or done up properly will not protect the head. In addition, any helmet that has sustained structural damage will also not protect the head. Helmet liners, whether made of foam, or polystyrene, will deteriorate with time, even though they may look normal. Perfumes, shampoos, and hair gels will contribute to this. There is no definite consensus, but it is often felt that hockey helmets, for example, should be replaced every year or two in someone who plays on a regular basis. Helmets should be encouraged in other sports such as skiing, snowboarding, in line skating and cycling. Newer types of head gear are now being seen in soccer, although, to date, there is really no scientific evidence of their efficacy.

Mouthguards are a controversial area. To date, there is no good scientific evidence that a mouthguard will definitely reduce the risk of concussion. But, theoretically, it is very possible that they will, when a blow comes to the jaw area. Scientific evidence is clear that mouth guards will help to prevent against dental injury, so should be worn for this reason in many sports anyway.

Strengthening of the neck muscles may be helpful in reducing concussion risk as well, particularly in sports where significant collisions occur, and with heading in soccer. Discussing the concepts of fair and clean play with your patient, as well as encouraging them to improve playing style and technique (for example learning how to go into the boards appropriately in hockey) are also very important. Advocating for enforcement of rules and rule changes to make games safer is also very important and the physician plays a significant role in this regard as a community expert. Try to be aware of educational resources available.
15. What does the future hold? Is there research going on?

There are still significant gaps in our knowledge about concussion. Extensive research is going on throughout the world to try to answer some of these very important questions. Work is being done in diagnostic modalities and imaging techniques, as well as in concussion evaluation. Neuropsychological testing has been found to be a very useful way to assess concussion severity and subsequent resolution. More recently, shorter, computer based neuropsych tests make these more available to people and are found to be a very useful adjunct.

It is our hope that the answers to the above questions will help to make physicians more comfortable and confident in dealing with concussion. There are certainly things that are still not known about concussion, and significant controversy in some areas. The use of grading systems, while convenient, is discouraged due to lack of scientific evidence. The key points to remember, though, are:

1. Concussion is a functional injury to the brain. You do not have to be knocked out to have sustained a concussion.

2. It is always unsafe to return to play while symptomatic.

3. Initial concussion management begins with injury recognition, and rest until the patient is asymptomatic. Once asymptomatic, a gradual, step-wise return to activity should be followed.

4. “When in doubt, sit them out”.

5. If you are not sure, seek the help of a physician with concussion expertise where possible.

6. Prevention is critical!

References


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ThinkFirst-SportSmart Concussion Education and Awareness Program

Concussion Information for Athletes

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and the

ThinkFirst-SportSmart Concussion Education and Awareness Committee

Members of the College of Family Physicians of Canada may claim Mainpro-M2 credits for this unaccredited educational program.
1. What is a Concussion?

A concussion is the most common form of head injury suffered by athletes. A concussion can be caused by a direct or indirect hit to the head or body (for example, a hard tackle or check). This causes a change in brain function which results in a variety of symptoms (see below). With a concussion there is no visible injury to the structure of the brain, meaning that tests like MRI or CT scans appear normal.

2. What actually happens?

When an athlete suffers a concussion, the brain suddenly shifts or shakes inside the skull and can knock against the skull's bony surface. A hard hit to the body can result in an acceleration-deceleration injury when the brain brushes against bony protuberances inside the skull. Such forces can also result in a rotational injury in which the brain twists, potentially causing shearing of the brain nerve fibres.

In the minutes to days following a concussion, brain cells remain in a vulnerable state. New research emphasizes that the problem may not be the structure of the brain tissue itself but the abnormality causes functional damage of the brain cells, i.e. how they work. The exact length of this period is unclear, but the brain temporarily does not function normally and during this time it is more vulnerable to a second head injury.

3. How do concussions occur?

Most concussions occur as a result of a collision with another object while the person is moving at a high rate of speed. When the person comes into sudden contact with arena glass or boards, opponent, stick or the ground direct trauma may result. Forces such as these (and others) can result in deceleration and rotational concussive injuries.

4. Who to tell?

It is extremely important to seek medical advice after any blow to the head or body in which you suffer signs and symptoms of a concussion. Often, concussions in athletes can go untreated (and even unnoticed by others) because few symptoms are visible to casual observers. Many times the symptoms of a concussion may not be identified until the athlete recovers to the point where increased exertion causes symptoms to worsen. In fact, 4 out of 5 professional athletes do not even know that they have been concussed (Delaney et al, CJS 2001)

Although symptoms may not be immediately apparent, it is important to be aware of possible physical, cognitive and emotional changes. **You can never be too careful! Symptoms may actually be worse later the same day of an injury or even the next day.**

Athletes may be reluctant to report symptoms of concussion because of a fear that they will be removed from the game, or that it may jeopardize their status on a team or adversely affect promising careers. But, it is important to consider the permanent repercussions of a concussion. Without proper management, a concussion can result in permanent problems and seriously affect one’s quality of life.

It is important to tell a family member, friend, teammate, trainer or coach if you think you
have had a concussion. Memory loss or amnesia associated with the trauma is one hallmark of a concussion and some people may forget that they were injured until after the diagnosis is established. However if the athlete is aware of the signs of concussion, informing someone will help assure proper medical care. If you think you have had a concussion, you should immediately remove yourself from the game or practice.

5. Symptoms of a concussion

Following a concussion the athlete may experience many different kinds of symptoms. Contrary to popular belief most concussions occur without a loss of consciousness (LOC). It is not yet known exactly what happens to brain cells in a concussion, but the mechanism appears to involve a change in chemical function. It is important to remember that some symptoms may appear right away and some may show up later. Symptoms may be a little different for everyone although certain combinations of symptoms classically occur. Some may be subtle and may go unnoticed by the athlete, team medical staff or coaches. Also, some symptoms may be attributed to any accompanying neck strain, scalp bruises and other injuries, not just the brain injury. **LOC is not necessary for the diagnosis of a concussion, but if it occurs there should be professional help called immediately.

Some symptoms and signs include:

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<tr>
<th>Symptoms</th>
<th>Signs</th>
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<td>Nausea, vomiting</td>
<td>Difficulty concentrating</td>
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<td>Dizziness</td>
<td>Inappropriate playing behaviour</td>
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<td>Confusion</td>
<td>Decreased playing ability</td>
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<td>Fatigue</td>
<td>Inability to perform daily activities</td>
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<td>Light headedness</td>
<td>Reduced attention</td>
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<td>Headaches</td>
<td>Cognitive and memory dysfunction</td>
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<td>Irritability</td>
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<td>Disorientation</td>
<td>Vacant stare</td>
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<td>Seeing bright lights or stars</td>
<td>Loss of bowel and bladder control</td>
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<tr>
<td>Feeling of being stunned</td>
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<td>Depression</td>
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Other more “vague” symptoms that are described include “head rush”, “lack of focus”, mood changes, feeling “slowed down” and feeling “not myself”.

6. Screening and Diagnosis

Concussion is a common occurrence and usually resolves uneventfully. A concussion always has the potential to cause serious harm and always needs to be checked by a medical doctor. If symptoms are not gone in 10 days (simple concussion), further consultation by a concussion expert is recommended (complex concussion).

A number of concussion-grading systems have been proposed but consensus is that none can be supported or endorsed because none are based on scientific evidence. Severity is probably
impacted by a number of factors. For example severity may be impacted by the athlete’s history of previous head injuries. These may lead to a different, slower recovery, which is why concussion history should always be monitored. Return to exertional activity or play while still concussed and symptomatic may also prolong recovery.

Diagnosing a concussion may take several steps. Your doctor may ask questions about your concussion and sport history, the most recent injury and will conduct a neurological exam. This can include checking your memory and concentration, vision, coordination, reflexes and balance. Your doctor may request further tests:

*Computerized Tomography (CT scan)* - CT is fast, patient friendly and has the ability to image a combination of soft tissue, bone, and blood vessels. It is a sophisticated X-ray machine linked to a computer to produce detailed, two-dimensional images of the athlete’s brain. The athlete lies still on a movable table that is guided into a large X-ray machine where the images are taken. A CT scan is painless and usually takes around 10 minutes.

*Magnetic Resonance Imaging (MRI)* - An MRI uses magnetic fields and radio waves to generate images of the brain. The athlete lies inside a cylindrical machine for 15-60 minutes while images are made. This technique is also painless.

In the majority of sport related concussions there will not be any obvious damage found on these tests. At times they can be important to assess for other skull or brain injury but in general they currently have little to add to concussion management.

More important is the role of neuropsychological testing. This testing may identify subtle cognitive (i.e. memory, concentration) problems caused by the concussion and may at times help to contribute to return to play decisions. In addition, balance testing may be required. Ideally, neuropsychological and balance testing should have been done in “baseline” in your preseason medicals for good comparison.

**7. When should I return to play?**

A concussed athlete will be removed from play immediately and should be assessed by a medical doctor. Under NO circumstances should a player be returned to competition when concussed. Because symptoms may worsen later that night and next day, you should not return to the current game or practice. When concussed, your decision-making about this may not reflect the best judgment! Post-concussive symptoms may increase with increase in activity so it is important that return to play is gradual.
**Return to Play Steps**

The return to play process is gradual, and begins after the medical doctor has given the player clearance to return to activity. If any symptoms/signs return during this process, the player must be re-evaluated by a physician. No return to play if any symptoms or signs persist. Remember, symptoms may return later that day or the next, not necessarily when exercising!

**Step 1**. No activity, only complete rest. Proceed to step 2 only when symptoms are gone.

**Step 2**. Light aerobic exercise, such as walking or stationary cycling. Monitor for symptoms and signs. No resistance training or weight lifting. Progress to increased intensity and duration as tolerated (ie no symptoms next day!).

**Step 3**. Sport specific activities and training (e.g. skating).

**Step 4**. Drills without body contact. May add light resistance training at Step 3 or 4 and progress to heavier weights.

The time needed to progress from non-contact to contact exercise will vary with the severity of the concussion and the player. Go to **Step 5** after medical clearance.

**Step 5**. Begin drills with body contact.

**Step 6**. Game play.

**Note**: Players should proceed through return to play steps only when they do not experience symptoms or signs. Remember these are steps, not days! It may take more than one day to progress from one step to the next especially if symptoms have lasted for a while. If symptoms or signs return, the player should return to the previous step, and be re-evaluated by a physician.

Never return to play if symptoms persist!

8. **Coping with symptoms**

The best medical management for a concussion is rest. An athlete who has suffered a concussion may often feel lethargic and tired. It is important to admit this fatigue to yourself. Your brain is telling you that you need rest and it is extremely vital to listen to it. If you continue pushing yourself and struggling on, it is likely you will make yourself worse and less able to cope.

The first thing to fail when you get tired is your concentration. If there is something important to get done, it is best to complete it when you are fresh after resting. When your attention starts to fade you may need to stop, rest again and write down the important things for later.

Many patients who have suffered a concussion often complain of being very irritable. You many find that things that would not normally annoy you suddenly do. Patients sometimes find themselves losing their temper, snapping at family members or teammates and being very annoyed over things. This may be because one’s own self-control needs a fresh, working brain as well. In order to cope with this you need to be aware of emotions. Some athletes have learned personal...
relaxation methods such as imagery and progressive relaxation methods to optimize their coping skills.

Other symptoms such as dizziness and clumsiness appear because the brain is reacting slowly and less efficiently. Concussions can upset balance organs in the ear resulting in vertigo. The only way to deal with these types of symptoms is to take special care in actions. Move slowly and constantly be aware of your surroundings.

Other problems such as noise sensitivity and visual changes are also the product of a concussion. Putting up with noise and bright lights needs brain energy and you may find that you do not have the energy level to do so. You may be around a loud radio, bright lights or a stimulating environment and find yourself suffering from bad headaches. One answer to coping with this is to avoid loud noise and bright lights as much as possible. Many people find it helpful to wear sunglasses everywhere, even indoors.

When dealing with other symptoms it is crucial to only take medications that your doctor has prescribed or approved of. Also, do not drink alcohol until you have recovered fully. It may hinder the recovery and can put you at risk for further injury. Remember, although in most cases symptoms resolve spontaneously usually in a couple of weeks, in some cases the process of healing from a concussion may take a considerable amount of time. It is important to pace yourself and increase gradually. Make sure you can cope before making any changes and also consult with your family or friends before making any important decisions.

9. Coping with emotions

When coping with a concussion it is not uncommon for the athlete to become overwhelmed by a variety of emotions. Often times the athlete feels concerned, anxious and sometimes depressed. The first part of the healing process is knowing that these emotions are normal. After an injury, most athletes go through an initial stage of denial or disbelief. You may refuse to believe that you are injured or unable to participate in your selected sport. It is extremely tough to realize that after sustaining a concussion your body may not be able to respond as it did before. Other emotions such as anger and depression are also common when suffering a concussion. You may find yourself being angry and displaced and you may blame others for your injury. It is quite common to become very angry at your teammates, coaches, staff, family and friends. And, as you continue to become more aware about the extent of your injury depression may set in. This may include self-pity, crying, insomnia, etc. Because professional athletes are playing in a popular sport it gives them a large source of self-esteem. When you are unable to play and participate in that sport anymore you may become doubtful of your personal abilities. If your team continues to be successful without your participation you may struggle with your personal worth. You worry that if you are out of the game somebody will take your spot or permanent position. You may suffer a blow to your ego and it is not uncommon to isolate or alienate yourself.

As time continues most athletes learn to accept the injury. It is important to allow yourself to mourn and be sad and then move on. Attempting to be mad or tough and find blame for your injury is a waste of time. It is important to leave the “should haves” or “would haves” out of the picture and focus on the future. The reality is that you have suffered a concussion and you have to deal with it. This may include setting goals for yourself and maintaining a positive attitude. You may find yourself weighing the pros and cons of your future. Dealing with a serious concussion is very demanding and can result in economic loss and emotional burden for you and your family. A
positive, optimistic outlook can help to speed up the healing process and to lessen the emotional pain. The only thing that thinking negatively will do is discourage everyone around you.

It is also important to take an active role in your recovery and seek out the resources available to you. Continue to participate in team functions and activities, as your step-wise recovery allows you. Do not isolate yourself.

Lastly, it is important to be patient. Athletes may experience considerable emotional pressure to resume sports participation. Emotion might tell you that you can play hurt, but the reality is that risk of re-injury is too great. It can result in permanent damage and seriously affect your quality of life. Do not rush your recovery because it will only lead to negative results. Follow the advice of the trained medical staff and feel confident in the healing process.

10. Prevention

Any time a player is involved in a contact sport, there is a chance of sustaining a concussion. Approximately 85-90% of concussions are not reported until after the practice or game. Therefore, it is important to take a preventative approach when dealing with concussions. Prevention of concussion and head injury is most successful when athletes are properly educated and the rules are enforced. Respect for the mutual safety of fellow players should always be important. Hits to the head should be eliminated in sports. Because most often a concussion is an invisible injury it is important to share information with the people surrounding you. This will help them understand your own situation and educate them for the future.

Protective equipment can reduce the risk and severity of head injury in sports. It is important to have a good quality properly fitted helmet for collision sports. The helmet strap must be buckled tightly, and only one finger should fit between the strap and the chin. All protective equipment should be certified and well maintained.

Other information
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   The Toronto Star

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    ThinkFirst/ Pensez D’Abord Canada
ThinkFirst-SportSmart Concussion Education and Awareness Program

ThinkFirst Concussion Questionnaire

J.Scott Delaney, MD and Karen M. Johnston, MD, Ph.D

on behalf of the
ThinkFirst-SportSmart Concussion Education and Awareness Committee

Members of the College of Family Physicians of Canada
may claim Mainpro-M2 credits for this unaccredited educational program.
**GENERAL HISTORY**

<table>
<thead>
<tr>
<th>Patient Name: __________</th>
</tr>
</thead>
</table>

1. How do you currently reside?  
   a) Alone  
   b) With spouse/relatives  
   c) Roommate(s)  
   d) Other: __________

2. At what age did you start playing organized sports? __________

3. How many of the following activities do you presently participate in? *(Circle your response - may circle more than one answer)*  
   a) Boxing  
   b) Martial arts (judo/karate)  
   c) Wrestling  
   d) Football  
   e) Ice hockey  
   f) Basketball  
   g) Rugby  
   h) Soccer  
   i) Equestrian  
   j) Snowboarding  
   k) Skiing  
   l) Inline skating  
   m) Mountain biking  
   n) Gymnastics  
   o) Cheerleading  
   p) Trampoline  
   q) Diving  
   r) Motorcycle or automobile racing  
   s) Skydiving  
   t) Mountain climbing  
   u) Other sports: __________  
   **Main sport currently is: __________**

4. For those activities in which you are actively participating, please indicate those activities in which you usually wear a helmet or head protection? *(Circle your response - may circle more than one answer)*  
   a) Boxing  
   b) Martial arts (judo/karate)  
   c) Wrestling  
   d) Football  
   e) Ice hockey  
   f) Basketball  
   g) Rugby  
   h) Soccer  
   i) Equestrian  
   j) Snowboarding  
   k) Skiing  
   l) Inline skating  
   m) Mountain biking  
   n) Gymnastics  
   o) Cheerleading  
   p) Trampoline  
   q) Diving  
   r) Motorcycle or automobile racing  
   s) Skydiving  
   t) Mountain climbing  
   u) Other sports: __________

5. For those activities in which you are actively participating, please indicate those activities in which you usually wear a mouthguard? *(Circle your response - may circle only one answer)*  
   a) Which type of mouthguard do you usually wear while participating in sports?  
   i) stock type (no molding to teeth needed before use)  
   ii) boil and bite (molds to teeth after immersion in boiling water)  
   iii) custom made type that covers front teeth mainly  
   custom made type that covers all teeth including back teeth (molars)  
   l) Inline skating  
   m) Mountain biking  
   n) Gymnastics  
   o) Cheerleading  
   p) Trampoline  
   q) Diving  
   r) Motorcycle or automobile racing  
   s) Skydiving  
   t) Mountain climbing  
   u) Other sports: __________

---

2
### SYMPTOM HISTORY

**Questions 6-15:** Refer to symptoms from all sports and activities played in the **LAST FEW YEARS**

**Note:**
A - "After being hit in the head playing sports" refers to any contact with your head; either from another player, yourself, the ground or another object (ex. goal posts, ball, puck, stick, etc.) that may have occurred while playing sports or during another athletic activity.

B - Duration of symptoms for the following questions can be listed in number of seconds, minutes, hours, days, weeks, etc.

<table>
<thead>
<tr>
<th>Question</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. In the past few years, after being hit in the head playing sports, did you ever suffer a <strong>concussion</strong>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If YES:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) List the number of times you had a concussion while playing sports in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) List the longest duration you experienced symptoms from a concussion in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) List the longest duration you were unable to play sports (had to “sit out”) because of a concussion in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Please indicate who usually told you that you were unable to play sports because of your concussions (ex. trainer, nurse, doctor, parent, decided yourself, etc.):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. In the past few years, after being hit in the head playing sports, were you ever “<strong>knocked out</strong>” or <strong>knocked unconscious</strong>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If YES:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) List the number of times you were knocked unconscious in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) List the number of times that you experienced a concussion that included being knocked unconscious in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) List the longest duration you were knocked unconscious in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) List the longest duration you were unable to play sports (had to “sit out”) after being knocked unconscious in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. In the past few years, after being hit in the head playing sports, did you ever feel <strong>confused</strong> for a period of time? This feeling is sometimes referred to as getting “<strong>dinged</strong>” or having your “<strong>bell rung</strong>”. You may have felt lightheaded, not remembered the play, not known where you were, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If YES:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) List the number of times you were “dinged” in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) List the number of times that you experienced a concussion with confusion in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) List the longest duration you felt confused after being “dinged” in the past few years:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) List the longest duration you were unable to play sports (had to “sit out”) after being “dinged” in the past few years:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. In the past few years, after being hit in the head playing sports, did you ever experience **headaches**?

<table>
<thead>
<tr>
<th>YES _________</th>
<th>NO _________</th>
</tr>
</thead>
</table>

**If YES:**

a) List the number of times you experienced headaches after being hit in the past few years: 

b) List the number of times that you experienced a concussion with headaches after being hit in the past few years: 

c) List the longest duration you experienced headaches after being hit in the past few years: 

d) List the longest duration you were unable to play sports because of these headaches in the past few years: 

---

10. In the past few years, after being hit in the head playing sports, did you ever experience **dizziness** or **balance problems**?

<table>
<thead>
<tr>
<th>YES _________</th>
<th>NO _________</th>
</tr>
</thead>
</table>

**If YES:**

a) List the number of times you experienced dizziness or balance problems after being hit in the last few years: 

b) List the number of times that you experienced a concussion with dizziness after being hit in the last few years: 

c) List the longest duration you experienced dizziness after being hit in the last few years: 

d) List the longest duration you were unable to play sports because of dizziness after being hit in the last few years: 

---

11. In the past few years, after being hit in the head playing sports, did you ever have memory difficulties (difficulty remembering things) after you were hit? This may have included not being able to remember the plays that were called, forgetting where you were, forgetting the score, etc.

<table>
<thead>
<tr>
<th>YES _________</th>
<th>NO _________</th>
</tr>
</thead>
</table>

**If YES:**

a) List the number of times you experienced memory difficulties after you were hit in the last few years: 

b) List the number of times that you experienced a concussion with memory difficulties after being hit in the last few years: 

c) List the longest duration you experienced memory difficulties after being hit in the last few years: 

d) List the longest duration you were unable to play sports because of memory difficulties after being hit in the last few years: 

12. In the past few years, after being hit in the head playing sports, did you ever experience **blurred** or **abnormal vision**? This may have included a feeling of having tunnel vision, having difficulty focusing on objects, seeing abnormal colours, etc.  

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If **YES**, explain what kind of vision changes occurred:
____________________________________________________________________________________________
____________________________________________________________________________________________

If **YES**:

a) List the number of times you experienced blurred or abnormal vision after you were hit in the last few years: __________

b) List the number of times that you experienced a concussion with blurred or abnormal vision after being hit in the last few years: __________

c) List the longest duration you experienced blurred or abnormal vision after being hit in the last few years: __________

d) List the longest duration you were unable to play sports because of blurred or abnormal vision after being hit in the last few years: __________

13. In the past few years, after being hit in the head playing sports, did you ever experience **nausea** (feeling sick to your stomach or wanting to vomit)?  

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If **YES**:

a) List the number of times you experienced nausea after being hit in the last few years: __________

b) List the number of times that you experienced a concussion with nausea after being hit in the last few years: __________

c) List the longest duration you experienced nausea after being hit in the last few years: __________

d) List the longest duration you were unable to play sports because of nausea after being hit in the last few years: __________

14. In the past few years, after being hit in the head playing sports, did you ever experience **hearing problems** (including ringing in the ears)?  

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If **YES**:

a) List the number of times you experienced hearing problems after being hit in the last few years: __________

b) List the number of times that you experienced a concussion with hearing problems after being hit in the last few years: __________

c) List the longest duration you experienced hearing problems after being hit in the last few years: __________

d) List the longest duration you were unable to play sports because of hearing problems after being hit in the last few years: __________
15. Are there **any other symptoms** you experienced in the last few years after being hit in the head playing sports? These may have included inability to tolerate bright lights, irritability or emotional changes, slurred speech, etc.

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

If **YES**, explain what kind of symptoms occurred:

_____________________________________________________________________________________________

_____________________________________________________________________________________________

If **YES**:

a) List the number of times you experienced these symptoms after being hit in the last few years: __________
b) List the number of times that you experienced a concussion with these symptoms after being hit in the last few years: __________
c) List the longest duration you experienced these symptoms after being hit in the last few years: __________
c) List the longest duration you were unable to play sports because of these symptoms after being hit in the last few years: __________

### SYMPTOM HISTORY

**Questions 16-19:** Refer to your **PAST EXPERIENCE** (as far back as you can remember):

**Note:**
Duration of symptoms for the following questions can be listed in number of **seconds, minutes, hours, days, weeks, etc.**

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

16. In your lifetime, after being hit in the head **during sports or an athletic activity**, have you ever been told that you have had a **concussion**?

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

If **YES**:

a) List how many times you had a concussion: __________
b) List the longest duration that you had symptoms from a concussion: __________
c) List the longest duration you were unable to participate in sports or activities because of a concussion: __________
d) Who **usually** told you that you had a concussion: *(Please check one)*
   
   - Trainer __________
   - Nurse __________
   - Doctor __________
   - Parent __________
   - Yourself __________
   - Other (explain) _______________________________________________________________________

17. In your lifetime, after being hit in the head **during sports or an athletic activity**, have you ever been “**knocked out**” or **knocked unconscious**?

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

If **YES**,  
a) List how many times you were knocked out: __________
b) List the longest duration that you were knocked out: __________
c) List the longest duration you were unable to participate in sports because you were knocked out: __________
18. In your lifetime have you ever had any **concussions** that did not occur during sports or an athletic activity? These may have happened during an accident in the car or at home, after a fall, during an assault or a fight, etc.

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

If YES, please explain how these occurred and how old you were:
____________________________________________________________________________________________
____________________________________________________________________________________________

If YES:
a) List how many times you had a concussion: __________
b) List the longest duration that you had symptoms from a concussion: __________
c) List the longest duration you were unable to participate in sports or activities because of a concussion: __________
d) Who *usually* told you that you had a concussion: *(Please check one)*
   - Trainer _______ Nurse _______ Doctor _______ Parent _______ Yourself _______
   - Other (explain) __________________________________________________________________________

19. In your lifetime, after being hit in the head that did not occur during sports or an athletic activity, have you ever been “knocked out” or **knocked unconscious**? This may have occurred after being hit in the head during an accident in the car or at home, after a fall, during an assault or a fight, etc.

<table>
<thead>
<tr>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
</table>

If YES, please explain how often this occurred, how old you were, what happened, and how long your symptoms lasted.
____________________________________________________________________________________________
____________________________________________________________________________________________

If YES,
a) List how many times you were knocked out: __________
b) List the longest duration that you were knocked out: __________
c) List the longest duration you were unable to participate in sports because you were knocked out: __________

20. Concussions may occur not only with a hit to the head but also a hit to the body (ex body check in hockey, “whiplash”). Did you ever experience any of the symptoms mentioned in this form after a hit to the body? If so, when and which symptoms?
____________________________________________________________________________________________
____________________________________________________________________________________________
____________________________________________________________________________________________

*Note* - The contents of the questionnaire have been modified from the following documents:


SPORT-RELATED CONCUSSION GUIDELINES FOR THE COACH/ TRAINER

What is a concussion?
A concussion is a brain injury that cannot be seen on x-rays or CT scans. It affects the way a person may think and remember things for a short time. Concussions can cause a variety of symptoms.

What are the symptoms and signs of concussion?
It is important to know that an athlete does not need to be knocked out (lose consciousness) to have had a concussion. A variety of problems may happen after a concussion, including:

<table>
<thead>
<tr>
<th>Thinking Problems</th>
<th>Child’s Complaints</th>
<th>Other Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Does not know time, date, place, period of game, opposing team, score of game</td>
<td>• Headache</td>
<td>• Poor coordination or balance</td>
</tr>
<tr>
<td>• General confusion</td>
<td>• Dizziness</td>
<td>• Blank stare/glassy eyed</td>
</tr>
<tr>
<td>• Cannot remember things that happened before and after the injury</td>
<td>• Feels dazed</td>
<td>• Vomiting</td>
</tr>
<tr>
<td>• Knocked out</td>
<td>• Feels “dinged” or stunned; “having my bell rung”</td>
<td>• Slurred speech</td>
</tr>
<tr>
<td></td>
<td>• Sees stars, flashing lights</td>
<td>• Slow to answer questions or follow directions</td>
</tr>
<tr>
<td></td>
<td>• Ringing in the ears</td>
<td>• Easily distracted</td>
</tr>
<tr>
<td></td>
<td>• Sleepiness</td>
<td>• Poor concentration</td>
</tr>
<tr>
<td></td>
<td>• Loss of vision</td>
<td>• Strange or inappropriate emotions (ie. laughing, crying, getting mad easily)</td>
</tr>
<tr>
<td></td>
<td>• Sees double or blurry</td>
<td>• Not playing as well</td>
</tr>
<tr>
<td></td>
<td>• Stomachache/nausea</td>
<td></td>
</tr>
</tbody>
</table>

What causes a concussion?
Any blow to the head, face or neck, or a blow to the body which causes a sudden jarring of the head may cause a concussion (ie. a ball to the head, being checked into the boards in hockey).

What should you do if an athlete gets a concussion?
The athlete should stop playing the sport right away. He/she should not be left alone and should be seen by a doctor as soon as possible that day. If an athlete is knocked out, call an ambulance to take him/her to a hospital immediately. Do not move the athlete or remove athletic equipment like a helmet; wait for paramedics to arrive.

An athlete with a concussion should not go back to play that day, even if he/she says he/she is feeling better. Problems caused by a head injury can get worse later that day or night. He/she should not return to sports until he/she has been seen by a doctor.

Drafted by Dr. L. Purcell and Dr. J. Kissick on behalf of the ThinkFirst-SportSmart Concussion Education and Awareness Program. July 2005 Version
ThinkFirst-SportSmart Concussion Education and Awareness Program

How long will it take for the athlete to get better?
The signs and symptoms of a concussion (see chart above) often last for 7-10 days but may last much longer. In some cases, children may take many weeks or months to heal. Having had previous concussions may increase the chance that a person may take longer to heal.

How is a concussion treated?
It is very important that an athlete does not go back to sports if he/she has any concussion symptoms or signs. Return to sport and activity must follow a step-wise approach:

1) No activity, complete rest. Once back to normal and cleared by a doctor, go to step 2.
2) Light exercise such as walking or stationary cycling, for 10-15 minutes.
3) Sport specific activity (ie. skating in hockey, running in soccer), for 20-30 minutes.
4) “On field” practice such as ball drills, shooting drills, and other activities with NO CONTACT (ie. no checking, no heading the ball, etc.).
5) “On field” practice with body contact, once cleared by a doctor.
6) Game play.

Note: Each step must take a minimum of one day. If an athlete has any symptoms of a concussion (e.g. headache, feeling sick to his/her stomach) that come back either with activity, or later that day, he/she should stop the activity immediately and rest for 24 hours. The athlete should be seen by a doctor and cleared before starting the step wise protocol again.

Each step must take a minimum of one day, since concussion symptoms may be felt later in the day after activity.

When can an athlete with a concussion return to sport?
It is very important that an athlete not play any sports if he/she has any signs or symptoms of concussion. The athlete must rest until he/she is completely back to normal. When he/she has been back to normal and has been seen by a doctor, he/she can then go through the steps of increasing activity described above. When the athlete has progressed through these steps with no symptoms or problems, and has received clearance from a doctor, he/she may return to play. If you are unsure if an athlete should play, remember…when in doubt, sit them out.
ThinkFirst-SportSmart Concussion Education and Awareness Program

SPORT-RELATED CONCUSSION: GUIDELINES FOR PARENTS

What is a concussion?
A concussion is a brain injury that cannot be seen on x-rays or CT scans. It affects the way your child may think and remember things, and can cause a variety of symptoms.

What are the symptoms and signs of concussion?
It is important to know that your child does not need to be knocked out (lose consciousness) to have had a concussion. A variety of problems may happen after a concussion, including:

<table>
<thead>
<tr>
<th>Thinking Problems</th>
<th>Child’s Complaints</th>
<th>Other Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Does not know time, date, place, period of game, opposing team, score of game</td>
<td>• Headache</td>
<td>• Poor coordination or balance</td>
</tr>
<tr>
<td>• General confusion</td>
<td>• Dizziness</td>
<td>• Blank stare/glassy eyed</td>
</tr>
<tr>
<td>• Cannot remember things that happened before and after the injury</td>
<td>• Feels dazed</td>
<td>• Vomiting</td>
</tr>
<tr>
<td>• Knocked out</td>
<td>• Feels “dinged” or stunned; “having my bell rung”</td>
<td>• Slurred speech</td>
</tr>
<tr>
<td></td>
<td>• Sees stars, flashing lights</td>
<td>• Slow to answer questions or follow directions</td>
</tr>
<tr>
<td></td>
<td>• Ringing in the ears</td>
<td>• Easily distracted</td>
</tr>
<tr>
<td></td>
<td>• Sleepiness</td>
<td>• Poor concentration</td>
</tr>
<tr>
<td></td>
<td>• Loss of vision</td>
<td>• Strange or inappropriate emotions (ie. laughing, crying, getting mad easily)</td>
</tr>
<tr>
<td></td>
<td>• Sees double or blurry</td>
<td>• Not playing as well</td>
</tr>
<tr>
<td></td>
<td>• Stomachache/stomach pain, nausea</td>
<td></td>
</tr>
</tbody>
</table>

What causes a concussion?
Any blow to the head, face or neck, or a blow to the body which causes a sudden jarring of the head may cause a concussion (ie. a ball to the head, being checked into the boards in hockey).

What should you do if your child gets a concussion?
Your child should stop playing his/her sport right away. He/she should not be left alone and should be seen by a doctor as soon as possible that day. If your child is knocked out, call an ambulance to take him/her to a hospital immediately. Do not move your child until the paramedics arrive.

How long will it take for my child to get better?
The signs and symptoms of concussion (see above) often last for 7-10 days but may last much longer. In some cases, children may take many weeks or months to heal. Having had previous concussions may increase the chance that a child may take longer to heal.

How is a concussion treated?
The most important treatment for a concussion is rest. The child should not exercise, go to school or do any activities that may make him/her worse, like riding a bike, play wrestling with brothers/sisters/friends, video games, or working on the computer. If your child goes back to activities before he/she is completely better, he/she is more likely to get worse, and to have symptoms longer. Even

Drafted by Dr. L. Purcell and Dr. J. Kissieck on behalf of the ThinkFirst-SportSmart Concussion Education and Awareness Program. July 2005 Version
tho ush it is ve ry har d for an acti ve child to re st, t hi s is t he m ost im por tant s t e p. Onc e yo ur child i s co mple tely bet te r at re st, he/she can sta rt a s tep-wi se i ncre a se i n a cti vi ti es (see “When ca n my child re tur n to spor t?”). I t i s imp ort ant t hat yo ur child i s se en by a d octor be f ore he/she be gins t he s teps needed t o re tur n to acti vi ty, t o ma ke su re he/she i s co mple tely bet te r. If po ssible, yo ur child shou ld be se en by a d octor wi th ex per ience i n t re ati ng concus si ons.

When ca n my child re tur n to sc ho ol?
S ometi mes chi ldren who ha ve a con cussi on ma y fi nd i t har d t o co ncen trate i n sc ho ol and ma y get a worse hea dache o r fe el si ck t o t heir s t omach i f t hey a re i n sc ho ol. Chi ldren shou ld sta y ho me f ro m sc ho ol i f t heir s ympto ms get w o rse wi le t hey a re i n cl ass. Onc e t hey fe el be t te r, t hey ca n tr y goi ng ba ck t o sc ho ol a t fi r st f or h alf da ys a nd i f t hey a re o kay wi th t hat, t hen t hey ca n go ba ck fu ll ti me.

When ca n my child re tur n to spor t?
I t i s ve ry imp ort ant t hat yo ur child no t go ba ck t o spor ts i f he/she ha s an y con cussi on s ympto ms o r si gns.

Return to sport and acti vi ty must f ollo w a s tep-wi se a pproa ch:

1) No acti vi ty, co mple t e re st. Onc e back t o norm al a nd cleare d by a d octor, go t o s te p 2.
2) Li ghte xerci se su ch a s wa lking o r sta ti onary cy cli ng, fo r 10-15 mi nutes.
3) Sp ort si sp e ci fi c acti vi ty (i.e., sk a ti ng i n ho ckey, ru nni ng i n so cc er), fo r 20-30 mi nutes.
4) “O n f i eld” prac ti ce su ch a s ba ll dr ills, shoo ting dr ills, a nd o ther acti vi ti es wi th NO CO N TAC T (i.e., no checki ng, no he adi ng t he ball, etc.).
5) “O n f i eld” prac ti ce wi th bo dy co ntac t, o nce c leare d by a d octor.
6) Ga me pla y.

Note: E ach s t ep mu st ta ke a mi ni mum o f o ne d a y. If yo ur child ha s an y s ympto ms o f a con cussi on (e.g., hea dache, fe eli ng si ck t o hi s/her s t omach) t hat co me ba ck ei ther duri ng acti vi ty, o r l aเตt er t hat d a y, yo ur child shou ld sto p t he acti vi ty immedi a tely a nd re st fo r 24 ho u rs. Yo ur child shou ld be se en by a d octor a nd c leare d a gai n be fo re s tarti ng t he s tep-wi se pr oto col a gai n.

When shou l d I ta ke my child t o t he do cto r?
E ve ry child who ge ts a he ad i njury shou ld be se en by a d octor as so on as pos si ble. Yo u shou ld ta ke hi m/her ba ck t o t he do cto r IMMEDIATELY i f, a fte r be ing t o l d yo ur child ha s a con cussi on, he/she ha s wors e ning o f s ympto ms su ch a s:

1. bei ng mo re co nfused
2. ha s a hea dache t hat i s ge t ti ng w o rse
3. vo mits mo re t ha n o nce
4. do esn’t wa ke up
5. ha s an y tr ouble w alki ng
6. ha s a s eizure
7. ha s str ange be ha vi o r

Pro blems ca use d by a he ad i njury ca n ge t wo rs e laเตt er th at d a y o r ni ght. Th e ch ild shou ld no t be l eft a lone a nd shou ld be ce he cke d throu gho ut t he ni ght. If yo u ha ve an y co ncerns ab out t he ch ild’s b reathing o r ho w he/she i s s eeping, wa ke hi m/her up. O th erwi se, let hi m/her s eep. If he/she se ems t o be ge t ti ng w o rse, yo u shou ld se e yo ur do cto r im me di ate ly. No c hild s hou l d go ba ck t o spor t un ti l t hey ha ve be e n c leare d t o do so by a d octor.
Concussion in Sport

Always Assess Airway, Breathing and Circulation

All players who experience a concussion must be seen by a physician as soon as possible. A concussion is a brain injury.

A Concussion may involve loss of consciousness. However, a concussion most often occurs without a loss of consciousness.

Mechanism: Blow to the head, face or jaw, or even elsewhere on the body. May also result from a whiplash effect to the head and neck.

Common Symptoms and Signs

* Symptoms and signs may have a delayed onset (may be worse later that day or even the next morning), so players should continue to be observed even after the initial symptoms and signs have returned to normal.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Poor balance or coordination</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Slow or slurred speech</td>
</tr>
<tr>
<td>Feeling dazed</td>
<td>Poor concentration</td>
</tr>
<tr>
<td>Seeing stars</td>
<td>Delayed responses to questions</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>Vacant stare</td>
</tr>
<tr>
<td>Ringing in ears</td>
<td>Decreased playing ability</td>
</tr>
<tr>
<td>Tiredness</td>
<td>Unusual emotions, personality change,</td>
</tr>
<tr>
<td></td>
<td>and inappropriate behaviour</td>
</tr>
<tr>
<td>Nausea, vomiting</td>
<td></td>
</tr>
<tr>
<td>Irritability</td>
<td></td>
</tr>
<tr>
<td>Confusion, disorientation</td>
<td></td>
</tr>
</tbody>
</table>

Caution: All players should consult a physician after a concussion. Coaches, trainers, players and parents should not attempt to treat a concussion without a physician’s involvement.

Initial response

* If there is loss of consciousness – Initiate Emergency Action Plan and Call an Ambulance. Assume possible neck injury.

Concussion:
- Remove the player from the current game or practice
- Do not leave the player alone; monitor signs and symptoms
- Do not administer medication
- Inform the coach, parent or guardian about the injury
- The player should be evaluated by a medical doctor
- The player must not return to play in that game or practice.
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Return to Play Steps

The return to play process is gradual, and begins after a doctor has given the player clearance to return to activity. If any symptoms/signs return during this process, the player must be re-evaluated by a physician. No return to play if any symptoms or signs persist. Remember, symptoms may return later that day or the next, not necessarily when exercising!

Step 1. No activity, only complete rest. Proceed to step 2 only when symptoms are gone.

Step 2. Light aerobic exercise, such as walking or stationary cycling. Monitor for symptoms and signs. No resistance training or weight lifting.

Step 3. Sport specific activities and training (e.g. skating).

Step 4. Drills without body contact. May add light resistance training and progress to heavier weights.

The time needed to progress from non-contact to contact exercise will vary with the severity of the concussion and the player. Go to step 5 after medical clearance.

Step 5. Begin drills with body contact.

Step 6. Game play.

Note: Players should proceed through return to play steps only when they do not experience symptoms or signs and a physician has given clearance. If symptoms or signs return, the player should return to the previous step, and be re-evaluated by a physician.

Never return to play if symptoms persist!

Prevention Tips

<table>
<thead>
<tr>
<th>Players</th>
<th>Coach/Trainer/Referee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make sure your helmet fits snugly and that the strap is fastened</td>
<td>Eliminate all checks to the head</td>
</tr>
<tr>
<td>Get a custom fitted mouth guard</td>
<td>Eliminate all hits from behind</td>
</tr>
<tr>
<td>Respect other players</td>
<td>Recognize signs and symptoms of concussion</td>
</tr>
<tr>
<td>No hits to the head</td>
<td>Inform and educate players about the risks of concussion</td>
</tr>
<tr>
<td>No hits from behind</td>
<td></td>
</tr>
</tbody>
</table>

Education Tips

Smart Hockey: More Safety, More Fun! Injury Prevention Program
ThinkFirst Canada website (www.thinkfirst.ca)

Members of the College of Family Physicians of Canada may claim Mainpro-M2 credits for this unaccredited educational program

Drafted by Dr. K. Johnston and Dr. C. Tator on behalf of the ThinkFirst-SportSmart Concussion Education and Awareness Program.
Version - June 2005
Summary and Agreement Statement of the 2nd International Conference on Concussion in Sport, Prague 2004

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Preamble
This paper is a revision and update of the Vienna consensus recommendations developed following the 1st International Symposium on Concussion in Sport.1 The Prague agreement statement is designed to build on the principles outlined in the original Vienna document and to develop further conceptual understanding of this problem. This document is developed for use by doctors, therapists, health professionals, coaches and other people involved in the care of injured athletes, whether at the recreational, elite or professional level.

Background Perspective
In November 2001, the 1st International Symposium on Concussion in Sport was held in Vienna, Austria. This meeting was organized by the International Ice Hockey Federation (IIHF) in partnership with the Federation Internationale de Football (FIFA) and the International Olympic Committee Medical Commission (IOC). As part of the resulting mandate for the future, the need for leadership and updates was identified. To meet that mandate the 2nd International Symposium on Concussion in Sport was organized by the same group and held in Prague, Czech Republic in November 2004.

The original aims of the symposia were to provide recommendations for the improvement of safety and health of athletes who suffer concussive injuries in ice hockey, football (soccer) as well as other sports. To this end a range of experts were invited to both meetings to address specific issues of epidemiology, basic and clinical science, injury grading systems, cognitive assessment, new research methods, protective equipment, management, prevention and long term outcome. At the conclusion of the initial conference, a small group of experts were given a mandate by the conference delegates and organizing bodies to draft a document describing the agreement position reached by those in attendance at that meeting. That document was co-published in the British Journal of Sports Medicine, Clinical Journal of Sport Medicine and Physician and Sportsmedicine.

The wider interest base resulting from the first meeting and document was reflected by the expanded representation. New groups at the second meeting included trauma surgeons, sport psychologists and others. This same group has produced the current document as an update of the original Vienna consensus document and includes a sideline assessment form with a pocket sized summary card for use by clinicians.

This protocol represents a work in progress and, as with all other recommendations or proposals, it must be updated as new information is added to the current state of the literature and understanding of this injury.

BACKGROUND ISSUES

Definition of Concussion
Over 35 years ago, the Committee on head injury nomenclature of the Congress of Neurologic Surgeons proposed a ‘consensus’ definition of concussion.23 This definition was recognized as having a number of limitations in accounting for the common symptoms of concussion. In the Vienna document, a revised consensus definition was proposed as follows:

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

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 neurologic function that resolves spontaneously.
3. Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury.
4. Concussion results in a graded set of clinical syndromes that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course.
5. Concussion is typically associated with grossly normal structural neuroimaging studies.

No changes were made to the definition by the Prague Group beyond noting that in some cases post-concussive symptoms may be prolonged or persistent.

Pathophysiological Basis of Concussion

At this time, there is no existing animal or other experimental model that accurately reflects a sporting concussive injury. It is noted that in experimental models of more severe injury a complex cascade of biochemical, metabolic and gene expression changes occur. Whether similar metabolic changes occur in sports concussion however, remains speculative at this time.

Concussion Grading Scales

The Vienna recommendation that injury grading scales be abandoned in favor of combined measures of recovery to determine injury severity (and/or prognosis) and hence individually guide return to play decisions received continued support.

It was also noted that concussion severity could only be determined in retrospect after all concussion symptoms have cleared, the neurologic examination is normal, and cognitive function has returned to baseline. There is limited published evidence that concussion injury severity correlates with the number and duration of acute concussion signs and symptoms and/or degree of impairment on neuropsychological testing. The ongoing development of validated injury severity scales continues in the published literature.

Subtypes of Concussion

One of the issues that was speculated upon at the Vienna conference was whether concussion represents a unitary phenomenon with a linear spectrum of injury severity or whether different concussion sub-types exist. These sub-types may represent differences in clinical manifestations (confusion, memory problems, loss of consciousness), anatomic localization (e.g., cerebral versus brainstem), biomechanical impact (rotational versus linear force), genetic phenotype (ApoE4 positive versus ApoE4 negative), neuropathological change (structural injury versus no structural injury) or an as yet undefined difference. These factors may operate independently or interact with each other. It is clear that the variations in clinical outcome with the same impact force require a more sophisticated approach to the understanding of this phenomenon than currently available.

The Significance of Loss of Consciousness

The traditional approach to severe traumatic brain injury utilizing loss of consciousness (LOC) as the primary measure of injury severity has acknowledged limitations in assessing the severity of sporting concussive injury. Findings in this field describe LOC association with specific early deficits but does not necessarily imply severity. As such the presence of LOC as a symptom would not necessarily classify the concussion as complex (see below).

The Significance of Amnesia

There is renewed interest in the role of post-traumatic amnesia and its role as a surrogate measure of injury severity. Published evidence suggests that the nature, burden and duration of the clinical post-concussive symptoms may be more important than the presence or duration of amnesia alone. Further it must be noted that retrograde amnesia varies with the time of measurement post-injury and hence is poorly reflective of injury severity.

Pediatric Concussive Injury

The general recommendations outlined in the Vienna document were originally designed for the management of adult sporting concussion. Agreement was reached however, that identified those recommendations as relevant and useful to management of children as well. In broad terms it was felt that the recommendations should be applicable to children (defined as 5–18 years of age) whereby children should not be returned to playing or training until clinically completely symptom free. Additional research is needed to better clarify the potential differences between adults and children with regard to recovery from injury and to develop cognitive assessment tools that better evaluate the younger athlete.

Formal cognitive assessment is currently problematic until late teen years due to the ongoing cognitive maturation that occurs during this period which, in turn, makes the utility of comparison to either the person’s own baseline performance or to population norms limited.

Because of the different physiological response during childhood to head trauma a conservative return to play approach is recommended. It may be appropriate to extend the amount of time of asymptomatic rest and/or the length of the graded exertion in children and adolescents. Future research is needed in this area.

A NEW CLASSIFICATION OF CONCUSSION IN SPORT

Historically, concussions have been classified with a number of different grading systems. In the Vienna Statement,
this approach was abandoned. One of the key developments by the Prague Group is the understanding that concussion may be categorized for management purposes as either simple or complex.

**Simple Concussion**

In simple concussion, an athlete suffers an injury that progressively resolves without complication over 7–10 days. In such cases, apart from limiting playing or training while symptomatic, no further intervention is required during the period of recovery and the athlete typically resumes sport without further problem. Formal neuropsychological screening does not play a role in these circumstances although mental status screening should be a part of the assessment of all concussed athletes. Simple concussion represents the most common form of this injury and can be appropriately managed by primary care physicians or by certified athletic trainers working under medical supervision.\(^{21}\) The cornerstone of management is rest until all symptoms resolve and then a graded program of exertion before return to sport. All concussions mandate evaluation by a medical doctor.

**Complex Concussion**

Complex concussion encompasses cases where athletes suffer persistent symptoms (including persistent symptom recurrence with exertion), specific sequelae (eg, concussive convulsions, prolonged loss of consciousness (>1 minute) or prolonged cognitive impairment following the injury. This group may also include athletes who suffer multiple concussions over time or where repeated concussions occur with progressively less impact force. In this group, there may be additional management considerations beyond simple return to play advice. Formal neuropsychological testing and other investigations should be considered in complex concussions. It is envisaged that such athletes would be managed in a multidisciplinary manner by physicians with specific expertise in the management of concussive injury such as a sport medicine doctor with experience in concussion, sports neurologist or neurosurgeon.

**CLINICAL ISSUES**

**Pre-participation Physical Examination**

Recognizing the importance of concussion history, and appreciating the fact that many athletes will not recognize all the concussions they may have suffered in the past, a detailed concussion history is of value.\(^{22–25}\) Such a history may pre-identify athletes that fit into the “complex” category outlined above and provides an opportunity for the physician to educate the athlete in regard to the significance of concussive injury.

A structured concussion history should include specific questions as to previous symptoms of a concussion not just perceived number of past concussions. It is also worth noting that dependence upon the recall of concussive injuries by teammates or coaches has been demonstrated to be unreliable.\(^{22}\) The clinical history should also include information about all previous head, face or neck injuries as these may have clinical relevance to the present injury. It is worth emphasizing that in the setting of maxillofacial injuries and neck, co-existent concussive injuries may be missed unless specifically assessed. Specific questions pertaining to disproportionate impact versus symptom severity matching may alert the clinician to a progressively increasing vulnerability to injury.

As part of the clinical history it is advised that details regarding protective equipment employed at time of injury be sought, both for recent and remote injuries. The benefit of this approach allows for modification and optimization of protective behavior and an opportunity for education.

It is specifically recommended that:

1. Both a baseline cognitive assessment (such as the Prague SCAT test in the absence of computerized neuropsychological testing) and symptom score is performed as part of the preparticipation evaluation.
2. Although formal baseline neuropsychological screening may be beyond the resources of many sports or individuals, it is recommended that in organized high risk sports consideration be given to having cognitive evaluation regardless of the age or level of performance.

**Signs and Symptoms of Acute Concussion**

The suspected diagnosis of sports concussion made on the sideline is applicable to both medical and non-medical personnel and can include clinical symptoms, physical signs, cognitive impairment and/or loss of consciousness.

If any one of the following symptoms or problems is present, a head injury should be suspected and appropriate management instituted. These will be summarized on the Sideline Concussion Assessment Tool (SCAT) that accompanies this document.

**a) Cognitive Features**

Unaware of period, opposition, score of game
Confusion
Amnesia
Loss of consciousness

**b) Typical Symptoms (see SCAT for standard symptom scale)**

Headache or pressure in the head
Balance problems or dizziness
Nausea
Feeling “dinged”, “foggy”, stunned or “dazed”
Visual problems (eg, Seeing stars or flashing lights, double vision)
Hearing problems (eg, ringing in the ears)
Irritability or emotional changes

Other symptoms such as a subjective feeling of slowness and fatigue in the setting of an impact may indicate that a concussion has occurred or has not fully resolved.\(^{26}\)

**c) Physical Signs**

Loss of consciousness/impaired conscious state
Poor coordination or balance
Concussive convulsion/impact seizure
Gait unsteadiness/loss of balance
Slow to answer questions or follow directions
Easily distracted, poor concentration  
Displaying inappropriate emotions (eg, laughing, crying)  
Vomiting  
Vacant stare/glassy eyed  
Slurred speech  
Personality changes  
Inappropriate playing behavior (eg, running the wrong direction)  
Significantly decreased playing ability  

Sideline evaluation of cognitive function is an essential component in the assessment of this injury. Brief neuropsychological test batteries that assess attention and memory function have been shown to be practical and effective. Such tests include the Maddocks questions\textsuperscript{27} and the Standardised Assessment of Concussion (SAC).\textsuperscript{23} It is worth noting that standard orientation questions (eg, time, place, person) have been shown to be unreliable in the sporting situation when compared with memory assessment.\textsuperscript{26,29}

It is recognized however that abbreviated testing paradigms are designed for rapid concussion evaluation on the sidelines and are not meant to replace comprehensive neuropsychological testing which is sensitive to detect subtle deficits that may exist beyond the acute episode; nor should they be used as a stand alone tool for the ongoing management of sports concussions. It should also be recognized that the appearance of symptoms may be delayed several hours following a concussive episode.

**Convulsive and Motor Phenomena**

A variety of acute motor phenomena (eg, tonic posturing) or convulsive movements may accompany a concussion.\textsuperscript{30,31} Although dramatic, these clinical features are generally benign and require no specific management beyond the standard treatment of the underlying concussive injury.

**Development of the Sport Concussion Assessment Tool (SCAT)**

In appendix 1, the SCAT is outlined. The intent was to create a standardized tool that could be used for patient education as well as for physician assessment of sports concussion. The SCAT was developed by combining the following existing tools into a new standardized tool:

2. Management of Concussion Sports Palm Card-American Academy of Neurology & Brain Injury Association\textsuperscript{32}
3. Standardized Assessment of Concussion-SAC\textsuperscript{33}
4. Sideline Concussion Check-UPMC, Thinksafe, Sports Medicine New Zealand Inc and the Brain Injury Association
7. The UK Jockey Club Assessment of Concussion\textsuperscript{34}
8. Maddocks questions\textsuperscript{27}

The authors gave input through a process of collaboration and iterative review. The SCAT was evaluated for face and content validity on the basis of scientific literature\textsuperscript{35} and clinical experience of the authors. The memory questions, specifically, were modified from the validated Maddocks questions to make these questions less football-specific.\textsuperscript{27}

**INVESTIGATIONAL ISSUES**

**Neuropsychological Assessment Post Concussion**

The application of neuropsychological testing in concussion has been shown to be of value and continues to contribute significant information in concussion evaluation.\textsuperscript{10,11,36,37} It has been demonstrated that cognitive recovery may precede or follow clinical symptom resolution suggesting that the assessment of cognitive function should be an important component in any return to play protocol.\textsuperscript{15} It must be emphasized however, that neuropsychological assessment should not be the sole basis of a return to play decision but rather be seen as an aid to the clinical decision making. Although neuropsychological screening may be performed or interpreted by other health care professionals, the final return to play decision should remain a medical one in which a multidisciplinary approach has been taken.

Neuropsychological testing should not be done while the athlete is symptomatic since it adds nothing to return-to-play decisions and it may contaminate the testing process by allowing for practice effects to confound the results. In certain cases however, serial post-injury follow up is valuable both as a means to encourage athlete compliance as well as for comparison purposes.

Overriding principles common to all neuropsychological test batteries is the need for and benefit of baseline pre-injury testing and serial follow-up. Recent work with computerized platforms however, suggests that performance variability may be a key measure for acute concussion diagnosis even in the absence of a baseline test. This strategy is currently the subject of ongoing research. Inherent problems with most neuropsychological tests include the normal ranges, sensitivity and specificity of tests and practice or learning effect as well as the observation that players may return to baseline while still symptomatic.\textsuperscript{36} Computerized testing utilizing infinitely variable test paradigms may overcome some of these concerns. Computerized testing also has the logistical advantage that the tests may be administered by the team physician (or be web-based) rather than requiring a neuropsychologist for a formal assessment. The strengths and weaknesses of such testing have been recently reviewed.\textsuperscript{37}

It is recommended that neuropsychological testing remain one of the cornerstones of concussion evaluation in complex concussion. It is not currently regarded as important in the evaluation of simple concussion. While this modality contributes significantly to both understanding of the injury and management of the individual, neuropsychological testing should not be the sole basis of management decisions, either for continued time out or return to play decisions.

**Objective Balance Assessment**

Balance testing, either with computerized platforms or clinical assessment, may offer additional information in
concussed athletes and may be used as a part of the overall concussion management strategy, particularly where symptoms or signs indicate a balance component.\textsuperscript{58}  

**Neuroimaging**

It was recognized in the Vienna agreement document that conventional structural neuroimaging is usually normal in concussive injury. Given that caveat, the following suggestions are made: Brain CT (or where available MR brain scan) contributes little to concussion evaluation but should be employed whenever suspicion of an intra-cerebral structural lesion exists. Examples of such situations may include prolonged disturbance of conscious state, focal neurologic deficit or worsening symptoms.

Newer structural MRI modalities including gradient echo, perfusion and diffusion weighted imaging have greater sensitivity for structural abnormalities however the lack of published studies as well as absent pre-injury neuroimaging data limits the usefulness of this approach in clinical management at the present time.

In addition, the predictive value of various MR abnormalities that may be incidentally discovered is not established at the present time. Promising new functional imaging (e.g., PET/SPECT/MRI) technologies, while demonstrating some compelling findings, are still at early stages of development.\textsuperscript{39–41}

Although neuroimaging may play a part in the assessment of complex sports concussions or more severe brain injury, it is not essential for simple concussive injury.

**Genetic Testing**

Genetic genotyping has been demonstrated to be of benefit in traumatic brain injury. Published studies have demonstrated that ApoE4 is a risk factor for adverse outcome following all levels of brain injury.\textsuperscript{42–48} Similarly ApoE4 has been shown to be a risk factor for the development of chronic traumatic encephalopathy on boxers.\textsuperscript{89} The significance of ApoE4 in sports concussion risk or injury outcome is unclear. Other published studies have noted the association of a particular calcium subunit gene abnormality with brain swelling following minor head trauma.\textsuperscript{95} Although still in the early stages of understanding, routine genetic screening cannot be recommended at the present time and furthermore physicians are urged to be mindful of the ethical implications of such testing.

**Experimental Concussion Assessment Modalities**

Different electrophysiological recording techniques such as, evoked response potential (ERP) and electroencephalogram (EEG) have demonstrated reproducible abnormalities in the post concussive state.\textsuperscript{51–52} However; not all studies reliably differentiated concussed athletes from controls.\textsuperscript{54–57} The clinical significance of these changes remains to be established.

In addition, biochemical serum markers of brain injury (including S-100b, NSE, MBP, GFAP) have been proposed as means by which cellular damage may be detected if present.\textsuperscript{58,59} However, there is currently not sufficient evidence to justify the use of these markers clinically.

**CONCUSSION MANAGEMENT**

**Acute Injury**

When a player shows ANY symptoms or signs of a concussion:
1. The player should not be allowed to return to play in the current game or practice.
2. The player should not be left alone; and regular monitoring for deterioration is essential over the initial few hours following injury.
3. The player should be medically evaluated following the injury.
4. Return to play must follow a medically supervised stepwise process.
   - A player should never return to play while symptomatic.
   - “When in doubt, sit them out!”

**Return to Play Protocol**

As described above, the majority of injuries will be simple concussions and such injuries recover spontaneously over several days. In these situations, it is expected that an athlete will proceed rapidly through the stepwise return to play strategy.\textsuperscript{40}

During this period of recovery in the first few days following an injury, it is important to emphasize to the athlete that physical AND cognitive rest is required. Activities that require concentration and attention may exacerbate the symptoms and as a result delay recovery.

The return to play following a concussion follows a stepwise process:
1. No activity, complete rest. Once asymptomatic, proceed to level 2.
2. Light aerobic exercise such as walking or stationary cycling, no resistance training.
3. Sport specific exercise (e.g., skating in hockey, running in soccer), progressive addition of resistance training at steps 3 or 4.
4. Non-contact training drills.
5. Full contact training following medical clearance.
6. Game play.

With this stepwise progression, the athlete should continue to proceed to the next level if asymptomatic at the current level. If any post concussion symptoms occur, the patient should drop back to the previous asymptomatic level and try to progress again after 24 hours.

In cases of complex concussion, the rehabilitation will be more prolonged and return to play advice will be more circumspect. It is envisaged that complex cases should be managed by physicians with a specific expertise in the management of such injuries.

An additional consideration in return to play is that concussed athletes should not only be symptom free but also should not be taking any pharmacological agents/medications that may effect or modify the symptoms of concussion. Where antidepressant therapy may be commenced during the
The Role of Pharmacological Therapy

Pharmacological therapy in sports concussion may be applied in two distinct situations. The first of these is the management of specific symptoms (e.g., sleep disturbance, anxiety) in complex concussion and the second situation is where drug therapy is used to modify the underlying pathophysiology of the condition with the aim of shortening the duration of the concussion symptoms.61

In broad terms, this approach to management should be only considered in complex sports concussions and by clinicians experienced in concussion management.

Sports Psychology

In addition sport psychology approaches may have potential application in this injury, particularly in complex concussion.62 Caregivers are also encouraged to evaluate the concussed athlete for affective symptoms such as depression as these may be common in concussion.60

OTHER ISSUES

Prevention

There is no clinical evidence that currently available protective equipment will prevent concussion. In certain sports, protective equipment may prevent other forms of head injury which may be an important issue for those sports.

Consideration of rule changes (i.e., head checking in ice hockey) to reduce the head injury rate may be appropriate where a clear-cut mechanism is implicated in a particular sport. Similarly, rule enforcement is a critical aspect of such approaches and referees play an important role.

An important consideration in the use of protective equipment is the concept of risk compensation.63 This is where the use of protective equipment results in behavioral change such as the adoption of more dangerous playing techniques, which can result in a paradoxical increase in injury rates. This may be a particular concern in child and adolescent athletes where head injury rates are often higher than in adult athletes.64

Medical Legal Considerations

While agreement exists pertaining to principal messages conveyed within this document, the authors acknowledge that the science of concussion is at early stages and therefore management and return to play decisions remain largely in the realm of clinical judgment on an individualized basis.

Education

As the ability to treat or reduce the effects of concussive injury after the event is minimal, education of athletes, colleagues and the general public is a mainstay of progress in this field. Athletes and their health care providers must be educated regarding the detection of concussion, its clinical features, assessment techniques and principles of safe return to play. Methods to improve education including web-based resources, educational videos and international outreach programs such as Think First (www.thinkfirst.ca) are important in delivering the message. In addition, concussion working groups plus the support and endorsement of enlightened sport groups such as FIFA, IOC and IIHF who initiated this endeavor have enormous value and must be pursued vigorously.

The promotion of fair play and respect for opponents are ethical values that should be encouraged in all sports and sporting associations. Similarly coaches, parents and managers play an important part in ensuring these values are implemented on the field of play.

Research Methods

A number of research protocols and data evaluating concussion injury assessment, injury susceptibility and brain function post injury were presented at both the Vienna and Prague conferences. All of these techniques, while offering great potential for injury assessment, must be considered experimental at this time. Elite and professional teams are well placed to contribute to these efforts through athlete recruitment for studies demonstrating the scientific value of such approaches.

Such research is essential in contributing to the science of concussion and will potentially provide valuable information for such important issues as clinical management, return to play guidelines and long term outcome. Therefore, research should be continued and encouraged, both by academics and by sporting organizations.

Future

The issue of sports concussion management is continually evolving and the usefulness of expert consensus in establishing a standard of care has been demonstrated by the Vienna agreement. The consensus group established at that meeting has provided ongoing leadership in this field based on the initial mandate established at that time.1 We expect that this Prague agreement will be revised and updated at future meetings.

APPENDIX

Sport Concussion Assessment Tool (SCAT)

REFERENCES


This tool represents a standardized method of evaluating people after concussion in sport. This Tool has been produced as part of the Summary and Agreement Statement of the Second International Symposium on Concussion in Sport, Prague 2004.

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

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.
3. Concussion may result in neuropsychological changes but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury.
4. Concussion results in a graded set of clinical syndromes that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course.
5. Concussion is typically associated with grossly normal structural neuroimaging studies.

**Post Concussion Symptoms**

Ask the athlete to score themselves based on how they feel now. It is recognized that a low score may be normal for some athletes, but clinical judgment should be exercised to determine if a change in symptoms has occurred following the suspected concussion event.

It should be recognized that the reporting of symptoms may not be entirely reliable. This may be due to the effects of a concussion or because the athlete's passionate desire to return to competition outweighs their natural inclination to give an honest response.

If possible, ask someone who knows the athlete well about changes in affect, personality, behavior, etc.

Remember. concussion should be suspected in the presence of ANY ONE or more of the following:
- Symptoms (such as headache), or
- Signs (such as loss of consciousness), or
- Memory problems

Any athlete with a suspected concussion should be monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle.

For more information see the “Summary and Agreement Statement of the Second International Symposium on Concussion in Sport” in the April, 2005 edition of the Clinical Journal of Sport Medicine (vol 15), British Journal of Sports Medicine (vol 39), Neurosurgery (vol 59) and the Physician and Sportsmedicine (vol 33). This tool may be copied for distribution to teams, groups and organizations. ©2005 Concussion in Sport Group

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**The SCAT Card**

**Sport Concussion Assessment Tool (SCAT)**

**Athlete Information**

What is a concussion? A concussion is a disturbance in the function of the brain caused by a direct or indirect force to the head. It results in a variety of symptoms (like those listed below) and may, or may not, involve memory problems or loss of consciousness.

How do you feel? You should score yourself on the following symptoms, based on how you feel now.

**Post Concussion Symptom Scale**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>“Pressure in head”</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Neck Pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Vision problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Hearing problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>“Don’t feel right”</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Feeling “dinged”</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Confusion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Feeling slowed</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Feeling like “in a fog”</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>More emotional than usual</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

(follow up symptoms only)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sadness</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Nervous or Anxious</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sleeping more than usual</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other:</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

What should I do?

Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

**Signs to watch for:**
Problems could arise over the first 24-48 hours. You should not be left alone and must go to a hospital at once if you:
- Have a headache that gets worse
- Are very drowsy or can’t be awakened (woken up)
- Can’t recognize people or places
- Have repeated vomiting
- Behave unusually or seem confused; are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on your feet; have slurred speech

Remember, it is better to be safe. Consult your doctor after a suspected concussion.

**What can I expect?**
Concussion typically results in the rapid onset of short-lived impairment that resolves spontaneously over time. You can expect that you will be told to rest until you are fully recovered (that means resting your body and your mind). Then, your doctor will likely advise that you go through a gradual increase in exercise over several days (or longer) before returning to sport.
Sport Concussion Assessment Tool (SCAT)

The SCAT Card
(Sport Concussion Assessment Tool)

Medical Evaluation

Name: ___________________________ Date __________
Sport/Team: _______________________ Mouth guard? Y N

1) SIGNS
Was there loss of consciousness or unresponsiveness? Y N
Was there seizure or convulsive activity? Y N
Was there a balance problem/unsteadiness? Y N

2) MEMORY
Modified Maddocks questions (check correct)

At what venue are we? __: Which half is it? __: Who scored last? __:

What team did we play last? __: Did we win last game? __?

3) SYMPTOM SCORE
Total number of positive symptoms (from reverse side of the card) = ______

4) COGNITIVE ASSESSMENT

5 word recall

Immediate Delayed
(Examples) (after concentration tasks)

Word 1 __________ cat __ __
Word 2 __________ pen __ __
Word 3 __________ shoe __ __
Word 4 __________ book __ __
Word 5 __________ car __ __

Month in reverse order:
Jun-May-Apr-Mar-Feb-Jan-Dec-Nov-Oct-Sep-Aug-Jul (circle incorrect)

or

Digits backwards (check correct)

5-2-8 3-9-1
6-2-9-4 4-3-7-1
8-3-2-7-9 1-4-9-3-6
7-3-9-1-4-2 5-1-8-4-6-8

Ask delayed 5-word recall now

5) NEUROLOGIC SCREENING

Pass Fail
Speech __ __
Eye Motion and Pupils __ __
Pronator Drift __ __
Gait Assessment __ __

Any neurologic screening abnormality necessitates formal neurologic or hospital assessment

6) RETURN TO PLAY

Athletes should not be returned to play the same day of injury.
When returning athletes to play, they should follow a stepwise symptom-limited program, with stages of progression. For example:

1. rest until asymptomatic (physical and mental rest)
2. light aerobic exercise (e.g. stationary cycle)
3. sport-specific exercise
4. non-contact training drills (start light resistance training)
5. full contact training after medical clearance
6. return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages. Medical clearance should be given before return to play.

Instructions:
This side of the card is for the use of medical doctors, physiotherapists or athletic therapists. In order to maximize the information gathered from the card, it is strongly suggested that all athletes participating in contact sports complete a baseline evaluation prior to the beginning of their competitive season. This card is a suggested guide only for sports concussion and is not meant to assess more severe forms of brain injury. Please give a COPY of this card to the athlete for their information and to guide follow-up assessment.

Signs:
Assess for each of these items and circle Y (yes) or N (no).

Memory: If needed, questions can be modified to make them specific to the sport (e.g. “period” versus “half”)

Cognitive Assessment:
Select any 5 words (an example is given). Avoid choosing related words such as “dark” and “moon” which can be recalled by means of word association. Read each word at a rate of one word per second. The athlete should not be informed of the delayed testing of memory (to be done after the reverse months and/or digits). Choose a different set of words each time you perform a follow-up exam with the same candidate.

Ask the athlete to recite the months of the year in reverse order, starting with a random month. Do not start with December or January. Circle any months not recited in the correct sequence.

For digits backwards, if correct, go to the next string length. If incorrect, read trial 2. Stop after incorrect on both trials.

Neurologic Screening:
Trained medical personnel must administer this examination. These individuals might include medical doctors, physiotherapists or athletic therapists. Speech should be assessed for fluency and lack of slurring. Eye motion should reveal no diplopia in any of the 4 planes of movement (vertical, horizontal and both diagonal planes). The pronator drift is performed by asking the patient to hold both arms in front of them, palms up, with eyes closed. A positive test is pronating the forearm, dropping the arm, or drift away from midline. For gait assessment, ask the patient to walk away from you, turn and walk back.

Return to Play:
A structured, graded exertion protocol should be developed; individualized on the basis of sport, age and the concussion history of the athlete. Exercise or training should be commenced only after the athlete is clearly asymptomatic with physical and cognitive rest. Final decision for clearance to return to competition should ideally be made by a medical doctor.

For more information see the “Summary and Agreement Statement of the Second International Symposium on Concussion in Sport” in the April, 2005 Clinical Journal of Sport Medicine (vol 15), British Journal of Sports Medicine (vol 39), Neurosurgery (vol 59) and the Physician and Sportsmedicine (vol 33). ©2005 Concussion in Sport Group
Current Concepts in Concussion Rehabilitation

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How poor are they that have not patience! What wound did ever heal but by degrees?
William Shakespeare (Othello)

Introduction
Management of concussion injury in sport remains one of the biggest challenges faced by those caring for athletes, partly due to the high incidence and prolonged recovery period. Concussion may demand a lengthy recovery with prolonged down time and may impede many aspects of a player's life including career, sociability, family relations, professional and social relationships, and finances. Concussion largely remains the invisible injury that has no fixed timeline for recovery and, until resolved, oppresses the player with fear of the long-term consequences of the impact. That said, the concept of rehabilitation from concussion is relatively new, a surprising notion given that rehabilitation from injury plays a significant role in the life of most elite-level athletes. Of course most of what the athlete knows about rehabilitation has been learned from experience with orthopedic injury, not brain injury. In contrast, the concept of rehabilitation is familiar to those caring for brain-injured individuals, but it is applied more often after moderate or severe brain trauma rather than following mild head injury or concussion. James Garrick reminds us that there has been an evolution in the management of sports injury with “the employment of earlier and more active rehab programs” [1]. How then can we transpose that progressive thinking to concussion?

Rehabilitation Strategies
DeLisa et al. [2] describe six strategies to help mitigate disability from injury: 1) prevent or correct additional disability, 2) enhance systems unaffected by the pathologic condition, 3) enhance functional capacity of systems affected by the disease, 4) use adaptive equipment to promote function, 5) modify social and vocational environment, and 6) use psychologic techniques to enhance patient performance and education. We look at each of these in the context of concussion injury with the goal being to develop a sport concussion rehabilitation program.

Prevent or correct additional disability
It has long been recognized that even when the athlete is asymptomatic at rest, postconcussion symptoms may return with exertion, particularly if the athlete has been symptomatic for a prolonged period of time. The pathophysiology underlying this finding has not been elucidated; however, a clue may be gleaned from the work of Haykowsky et al. [3]. With resistance and Valsalva maneuvers (eg, biceps curl), significant elevations in intracranial pressure have been documented. This mirrors the experience of athletes who have recurrent symptoms with resistance training (many of whom associate only aerobic activity as exertion, not weight lifting). This finding of symptom aggravation with increasing levels of exertion is the basis for the graded return to activity programs currently in place (Table 1) [4•,5,6•,7]. The importance of being solidly asymptomatic prior to embarking on such a program cannot be overstated. Proactive measures must be taken at each step to ensure that the athlete’s symptoms remain at bay throughout the process, not just during exertion, but also later the day of exertion, as well as the next
Table 1. Return to play protocol

<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No activity, complete rest; once asymptomatic, proceed to level 2</td>
</tr>
<tr>
<td>2</td>
<td>Light aerobic exercise such as walking or stationary cycling</td>
</tr>
<tr>
<td>3</td>
<td>Sport-specific training (e.g., skating in hockey, running in soccer)</td>
</tr>
<tr>
<td>4</td>
<td>Noncontact training drills</td>
</tr>
<tr>
<td>5</td>
<td>Full contact training after medical clearance game play</td>
</tr>
<tr>
<td>6</td>
<td>Game play</td>
</tr>
</tbody>
</table>

(Adapted from the Canadian Academy of Sports Medicine [4+].)

The return to play following a concussion follows a stepwise process:

1. No activity, complete rest; once asymptomatic, proceed to level 2
2. Light aerobic exercise such as walking or stationary cycling
3. Sport-specific training (e.g., skating in hockey, running in soccer)
4. Noncontact training drills
5. Full contact training after medical clearance game play
6. Game play

morning. Depending on duration of symptomatic status (weeks to months) the length of this program may vary (days to weeks). For the obvious reasons described above, resistance training is added late in the protocol. Whereas an orthopedic model serves well for certain aspects of concussion rehabilitation, there is a potential trap here. An athlete is used to rehabilitating through pain, a strategy that often succeeds in orthopedic rehabilitation. However, the same strategy of pushing through pain originating from concussion (headaches, dizziness) is more likely to lead to a “one step forward, two steps backward” situation with resulting setback. From the outset, the athlete should be made aware of this clear difference (Table 1).

Enhance systems unaffected by the pathologic condition

Unlike most sport injuries, concussion has a global, diffuse effect on the athlete’s function and well being. Generalized fatigue may be an important component to the symptomatology accompanied by specific sensory and neurocognitive changes. Therefore, concussion must be considered more of a systemic rather than a local problem and the value of rest, withdrawal from demanding environments, and general health advocacy measures must be emphasized. Rather than enhancing or maintaining other systems, measures to minimize activity are called for. This approach creates its own difficulties for the athlete given that physical fitness has generally been a lifelong commitment; therefore, new strategies at early levels of rehabilitation are now being explored (e.g., yoga, pilates) in an effort to provide both ongoing fitness maintenance and a structured physical program that does not exacerbate the problem. Endeavors of this type have led to some success. Such programs must be carefully monitored and adjusted to the athlete’s tolerance on an individual basis, with a high level of input from medical staff.

Enhance functional capacity of systems affected by the disease

Strategies to cope with neurocognitive effects of head injury have met with success and are well documented in the head injury literature. Similar strategies have potential value in concussion although they have not been systematically explored. Balance deficits are commonly seen in concussion and balance retraining may have a role to play in recovery [8]. Although pharmacologic management of associated headache is commonly unsuccessful, treatment of associated sleep disruption has met with some success. In general, however, the common recurring theme of improvement with rest is documented and remains the mainstay of early management.

Use of adaptive equipment to promote function

In isolated situations systems retraining (e.g., vestibular, visual systems) may offer some advantage if that function is notably affected. Adaptive equipment may also be incorporated into the rehabilitation protocol with the use of sport-specific equipment such as a skating treadmill in hockey.

Modify social and vocational environment

Considering that interaction in a team environment is a critical dimension in the life of an athlete, this strategy deserves consideration given its potential to either benefit or further harm the athlete. Team interaction provides the social and career milieu in which the athlete develops, all the while imposing its own supports and stressors [9+]. A balance of the “pros and cons” of that environment must be weighed for each individual case. In certain circumstances it may be best for an athlete to stay with the team whereas for another, temporary return to a home environment may be the best option. Despite the team environment, the athlete needs direct access to health care givers (athletic therapists, trainers, team doctors, consultants). Such contact, in person or by phone or electronic mail, will permit regular follow-up evaluation and provide a venue for questions and concerns. Other contributing factors in the environment are related to lifestyle issues and substance use. Frank discussion is mandated to minimize the impact of such factors on concussion recovery.

Psychologic techniques to enhance patient performance and education

In our rather limited armamentarium, this strategy may be the single greatest tool currently available to help recovery. Other than rest, what else helps? Interest in this area has stemmed and developed from the observation that there is significant overlap between some symptoms of concussion and affective disorders such as depression, anxiety, irritability, insomnia, and personality change.

Depression

Our clinical observations have shown that concussed athletes often report symptoms of depression. Neuroimaging studies of patients suffering from depression of different etiologies have consistently identified metabolic abnormalities involving frontal, cingulate and temporal cortices suggesting common disruption of specific frontal-striatal and basotemporal limbic pathways. Across studies, the most robust and consistent find-
ing is decreased frontal lobe function, although normal as well as hyper frontal activity has also been reported [10]. Our research with concussed athletes with persistent postconcussive symptoms (PCS) who do or do not complain of symptoms of depression has yielded interesting and convergent preliminary results. Recently, we ran a study aiming to confirm our previous results [11] and to quantify with functional MRI (fMRI) changes in brain activity in concussed athletes with persistent PCS. Regional brain activations associated with a working verbal and visual memory task were acquired from a group of 12 concussed athletes and 25 matched control subjects, using blood oxygen level-dependent (BOLD) fMRI. The results obtained have confirmed that verbal and visual working memory tasks in conjunction with fMRI may be useful in identifying an underlying frontocortical dysfunction following concussion. Analysis of fMRI data revealed that the athletes as a group had weaker BOLD changes within the dorsolateral prefrontal and orbitofrontal cortices, and this observation was true for both the verbal and the visual versions of the task. With respect to depression, the athletes were administered the Beck Depression Inventory (BDI) and an analysis was run to establish whether a correlation existed between the scores obtained on the BDI and the cerebral activation patterns associated with the working memory tasks. Interestingly, those athletes who obtained normal scores or who had results consistent with only a mild depression (<22/63; n = 7) showed similar patterns of activation as the control group, albeit with generally weaker percent signal changes in the regions of interest. In contrast, those athletes who had BDI scores (>22/63; n = 5) suggestive of a moderate depression showed atypical patterns characterized in general by a lack of BOLD signal change in dorsolateral prefrontal as well as in medial orbitofrontal cortices (Fig. 1). Thus, these preliminary results suggest that in the presence of depression, there is a lack of activation in those frontal regions typically activated when a working memory task is being performed. Studies in this field are in their infancy and these relationships are not yet well understood. It is notable that even when some concussion symptoms of somatic origin are decreasing with recovery (headache, dizziness) others involving mood states may increase (Meeuwisse W, Lederc S; Personal communication).

Sport psychology
Recent work with sport psychology colleagues documented early evidence that mental training techniques used for other sport injuries, and familiar to many sport medicine doctors, may have a role to play in concussion management. More specifically, Horton et al. [12] hypothesized that concussed athletes who participated in an athlete support intervention group would improve their psychologic state by reducing effects such as anger, confusion, frustration, anxiety, depression, and isolation (i.e., total mood disturbance [TMD]) compared with those in a control group. These authors felt that support groups would help concussed athletes by educating them on their injury and by helping to prevent isolation while dealing with the demands of rehabilitation and at the same time not participating in their sport [13,14]. Participants in the study by Horton et al. [12] were elite-level athletes who sustained a concussion while participating in their sport and who showed persistent postconcussion symptoms, loss of consciousness, or post-traumatic amnesia.

The authors' hypothesis was supported as athletes in the experimental group reported lower TMD scores [12]. Interestingly, their results also indicated that simply putting subjects in a support group may have improved their psychologic state, as evidenced by better TMD scores at pretesting compared with the control group. These results need to be viewed with caution as the number of participants were small (n = 14) and some factors were not controlled for, including the provision of social support, trait characteristics of the athletes, past experiences, other stressors, sex, and injury severity. Nonetheless, the results of this research offer initial support for the suggestion by Bloom et al. [9*] about including psychologic techniques in the rehabilitation of concussed athletes. In sum, although research studies in sport psychology approaches

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**Figure 1.** Percent blood oxygen level-dependent (BOLD) signal change in the dorsolateral prefrontal cortex (DLPC) and medial orbitofrontal cortex (mOorbFC) associated with a verbal working memory task for three groups: normal controls (n = 25), mildly depressed (n = 7), moderately depressed (n = 5). Mean behavioral results are as follows: normal control group = 73%; mildly depressed group = 80%; moderately depressed group = 76%. Irrespective of the behavioral scores, normal Beck Depression Inventory (BDI) scores obtained by control subjects correlate positively with an increase in DLPC and a decrease in mOorbFC. Concussed athletes with mild BDI scores show only a slight increase in DLPC and a marked decrease in mOorbFC. Those with moderate BDI scores show almost no activation in DLPC and no change in mOorbFC.
for concussion are in their infancy, the important role of utilizing psychologic skills and strategies for performance enhancement is not [15].

Goals and Practical Application
With this knowledge base how can we practically apply these principles to improve management and rehabilitation for our athletes? Houts and Scott [16] emphasized that rehabilitation goal planning should 1) involve the patient (athlete), 2) set reasonable goals, 3) describe patient behavior when the goal is reached, 4) set a deadline (timeline), and 5) spell out method.

Use an orthopedic model and ankle injury rehabilitation as an example, Anderson [17] describes a stepwise, multiple-phase, ankle rehabilitation program using a rehabilitation checklist as a measuring tool for progress. This checklist is also an efficient means of communication between the athlete’s health care providers. Anderson emphasizes that the first phase “requires patience and rest.” Within the context of concussion, we (and the athlete) are left to wonder why an investment of 4 months to rehabilitate a high ankle sprain is considered acceptable, whereas 4 months for brain rehabilitation is considered untoward!

The concussion rehabilitation program will therefore be structured and supervised in such a way that it will incorporate the fact that postconcussion symptoms may return with exertion. The checklist will include repeated athlete documentation of the PCS scale submitted on a regular basis. It is Dr. Johnston’s experience that athletes may be more likely to admit their symptoms on a sheet of paper than to an individual. This is a valuable resource in baseline, during resting (step 1) and throughout rehabilitation. A gradual increase in activity is provided with an assurance of no symptoms recurrence and backtracking if they return (Table 2).

### Table 2. Postconcussion symptoms scale

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Nausea</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Confusion/disorientation</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Difficulty recalling</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Emesis</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Fatigue</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sleeping more than usual</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sensitivity to light/noise</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Increased sadness</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Nervousness</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Numbness or tingling</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sensation of being “in a fog”</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Difficulty with concentration</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Difficulty with memory</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total score</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Adapted from Lovell and Collins [19].)
Training-induced physiologic adaptations depend primarily on the intensity of overload. Heart rate is a good means to monitor exercise intensity. Most players will have access to a heart rate monitor that can be used to gauge exercise stress. If the player exercises in a warm environment, the heart rate responds as a function of the environmental stress and the exercise intensity. Thus, heart rate reflects total stress, which makes it a desirable variable to monitor. If the athlete does not know his or her maximum heart rate, then use the age-predicted formula (220 minus age) to estimate the maximum heart rate. In step 2 of the program, the appropriate exercise intensity for a 20-year-old would be 50% to 55% of heart rate maximum, or 100 to 110 beats/min. Examples of continuous aerobic exercise appropriate for the hockey player are fast walking, slow jogging, cycling on a stationary bicycle, and exercise machines such as an elliptical trainer, rowing ergometer, stepper, and skating treadmill. The skating treadmill offers the opportunity to monitor and control the workload while mimicking in many ways the athlete’s familiar exercise pattern. When resistance exercise is added to the program, start with a low weight (about 50% of 1-repetition maximum [1RM]) and low repetitions ([reps] about 6–10 reps). If resistance exercise is included in steps 4 through 7, the progression should increase the number of reps with each exercise to about 20 reps before proceeding to increase the load. Because both intracranial and diastolic blood pressure increase during resistance exercise, take the cautious approach to avoid recurrent symptoms.

At this point, sport-specific drills are incorporated into the program. For example, in a current hockey rehabilitation paradigm developed in conjunction with the National Hockey League (NHL) New York Rangers, specific hockey drills may be used to advance through the protocol. The athlete will start on a bike or treadmill, complete control of duration, heart rate, respiratory rate, and resistance being in the hands of the medical supervisor. A skating treadmill may then be added and the athlete will progress to the ice (first in workout clothing followed by full equipment) in a conditioning skate with drills and no pucks. Although there is no difference in VO₂max with or without equipment, hockey equipment decreases speed and mechanical efficiency, all variables which need to be taken into account during rehabilitation [18]. Level 4 has the addition of pucks and shooting, thereby increasing workload in no contact flow drills (Fig. 2). Level 5 incorporates a practice situation with potential for full contact, three against three competition on half ice, and finally game play. Specific positions (eg, goal tender) will dictate variations on this general approach.

Similar programs may be developed incorporating maneuvers from soccer (Fig. 3, Table 4), American football, and other sports. Ideally these are developed in a collaborative effort with doctor, therapist, trainer, and coach.

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Symptoms may return with exertion; so what is exertion? Certainly aerobic and resistance training are exertion but the athlete may be surprised to learn that activities of daily living (e.g., mowing the lawn, shoveling snow) may be considered exertion on a background of concussion. Physiotherapy for an associated neck injury (which may have occurred at the time of the concussion) may also represent exertion and should be carefully monitored. To reiterate, one needs to be specific with the athlete in this regard and seek out aggravating activities in the face of persistent or recurrent symptoms.

Neck and Concussion

Finally, increasingly there is an awareness that neck and concussion injury interplay with one another: 1) the neck may be injured at the time of the concussion, 2) a whiplash type of neck injury can also result in a concussion, 3) rehabilitating a neck injury can represent exertion to the point that concussion symptoms may be aggravated, and 4) neck and concussion headache symptoms may be difficult to separate. Therefore, treatment of neck symptoms may sometimes alleviate combined concussion headache.
symptoms. Further research is needed to explore these interactions and develop treatment plans.

Conclusions

It comes as no surprise to sport medicine professionals that efficient rehabilitation of an athletic injury optimizes the athlete's ability to recover. Using recovery strategies familiar to those of us caring for athletes in combination with general rehabilitation principles, we are exploring new ground in concussion rehabilitation. As with all other sport injuries, a comprehensive structured rehabilitation program offers advantages in concussion management and may well be the key to successful and timely return to play.
Acknowledgments
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References and Recommended Reading
Papers of particular interest, published recently, have been highlighted as:
• Of importance
• Of major importance


Although not sport specific, this article shows how such a program may be implemented into a comprehensive concussion program.


The first to explore sport psychological issues in concussion and this approach may well serve to be key to future management directions.
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