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## 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. The “Consensus Statement on Concussion In Sport” (Zurich 2008)<sup>1</sup> – released after the 3rd International Conference on Concussion in Sport, defines concussion 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 used in defining the nature of a concussive head injury include:

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 neuropathological 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; however, it is important to note that, in a small percentage of cases, post-concussive symptoms may be prolonged.
5. No abnormality on standard structural neuroimaging is seen in concussion.”

## 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 on 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, it is critical to rule out a bleed, and doing so does not 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 (ie. not processing programs as quickly as possible, running at a slower speed, etc.). 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, conventional neuroimaging studies (CT, MRI) 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 (hockey, football, rugby) are among the most common sports where concussion is seen. Other sports, such as soccer and basketball, also often involve contact and therefore a higher concussion risk than non-contact activities. However, 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”.
- **Physical signs** of concussion include: loss of consciousness or impaired consciousness, poor coordination or balance, easy distractability 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.
- **Cognitive symptoms** include: confusion, amnesia, disorientation, poor concentration, and memory disturbance.
- **Emotional symptoms** include: feeling of depression or moodiness.

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 systems are anecdotal, based on the experience of their authors, with no scientific evidence to support them. In the second consensus statement on concussion in sport (Prague, 2004)<sup>2</sup>, the consensus panel wrote that it

“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 follow as a “recipe”, unfortunately this is not the case at this time.

The Zurich consensus group agreed that there are a number of “modifying factors” which may influence the investigation and management of concussion, and may predict the potential for more prolonged symptoms. These include:

- Number and duration of symptoms
- Prolonged loss of consciousness (> 1 minute), amnesia
- Concussive convulsion
- Repeated concussions over a period of time
- Recent concussion
- Repeated concussion occurring with progressively less force, or slower recovery after each successive concussion
- Children and adolescents
- Co and pre-morbidities (migraine, depression, ADHD, learning disability, sleep disorder)
- Medication and drug use (eg psychoactive drugs, anticoagulants)
- Dangerous style of play
- High risk sport or activity

In these settings, where possible, the athlete would be best managed in a multi-disciplinary manner coordinated by a physician with specific expertise in concussion 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, and rapid transport to hospital by ambulance. 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 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, or 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 to remember. 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 may be an increased risk of sustaining subsequent concussive injuries after a first concussion. 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 concussed. 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. A full neurologic assessment is important to rule out structural injury or other neurologic causes of symptoms. It is rarely helpful in the setting of pure concussion, though.

Balance and coordination testing is helpful. The Zurich consensus group developed the SCAT2 (Sport Concussion Assessment Tool 2), which can be downloaded from [parachutecanada.org](http://parachutecanada.org). This is an excellent assessment tool which can be used at the sideline or in the office. The SCAT2 describes a modified BESS (Balance Error Scoring System) which can be performed in the office. Remember, though, that many people will have some difficulty with balance, even when not concussed!

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? 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, and reciting strings of digits backwards. Serial subtraction tests such as “Serial 7’s” are often poorly performed even by non-concussed people, so are no longer used in assessment.

It is important to note that, without doing any “baseline” testing of 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 against in the future, should there be an injury during the season.

## 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 and cognitive (mental) activity increases post concussive symptom severity and prolongs their course. Thus, the most important initial management feature for concussion is rest, from both physical and cognitive exertion.** 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.

It is now clear that cognitive exertion aggravates post-concussive symptoms as well. This can include activities which require focus, concentration, memorization and multi-tasking. Students often find that going to school makes their symptoms worse, so may need to stay home until they feel better; that is, until these cognitive activities no longer make them feel worse. They should then start back to school part time (eg half days), progressing to full time if they have no problems. This can often be frustrating for the student, their parents and teachers, as it is impossible to state specifically how long they will need to be off. Once back to school, the student's workload should be managed appropriately, given that an increase in cognitive exertion may aggravate their symptoms. The patient may need to be off work, depending on the requirements of their job.

**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. If symptoms return at any step, the patient simply takes one step back, rather than two or three steps forward, then six steps back).

**A typical return to play or activity protocol is as follows:**

**(\*Please note that each level is a step, not a day. 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.

# CONCUSSIONS GUIDELINES FOR PHYSICIANS

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. This step-wise progression should be monitored by a physician.\****

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 of rest. 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 asymptomatic, and then progress to a medically-supervised step-wise return to play protocol such as suggested above. *An athlete should not return to play until cleared to do so by a physician.*

## 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 a 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.

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.

# CONCUSSIONS GUIDELINES FOR PHYSICIANS

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?

The Zurich consensus group agreed that the evaluation and management recommendations contained in the Consensus Statement (and described here) could be applied to children and adolescents down to the age of 10. However, with children, 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! Protective equipment use is often highlighted in relation to brain injury prevention, but it is not the only prevention strategy. 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 only when concussion is recognized. Nonetheless, it is important to ask about protective equipment when assessing a patient for concussion.

Although helmets provide excellent protection against injuries such as fractures and lacerations; they cannot effectively prevent all concussions – **there is no such thing as a concussion-proof helmet**. It is important to try to determine if the helmet is in good condition, and whether it is being worn properly. 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 may 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. Other helmets may come with replacement recommendations from the manufacturer. 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.

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.

While there is no evidence, strengthening of the neck muscles may one day prove to be useful 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. ThinkFirst Canada may be able to connect you to local Chapters or community workers for this purpose.

## 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 neuropsychological 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. Concussions do not appear on standard imaging tests.**
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!**

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<sup>1</sup> McCrory P, Meeuwisse W, Johnston K, Dvorak J, Aubry M, Molloy M, Cantu R. Consensus Statement On Concussion in Sport. 3rd International Conference on Concussion in Sport Held in Zurich, November 008. Clin J Sport Med 2009; 19: 185-200.

<sup>2</sup> McCrory P, Johnston K, Meeuwisse W, Aubry M, Cantu R, Dvorak J, Graf-Baumann T, Kelly J, Lovell M, Schamasch P. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. Br J Sports Med 2005; 39: 196-204.