

# 11 Concussion – Onfield and Sideline Evaluation

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## Introduction

In sports medicine, clinicians must be able to recognize and manage a spectrum of brain injury. Fortunately, serious brain injury is rare in team sport and the majority of head injuries seen are mild. Nevertheless, all individuals involved in athletic care need to have a thorough understanding of the early management of the head-injured athlete, the risks of deterioration, and the potential sequelae of such injuries that may impact on the athlete's ability to return to sport or even in later life.

## Epidemiology

The crude incidence for all traumatic brain injuries is estimated at approximately 300 per 100,000 population per year with the majority (80–90%) of those suffering a mild TBI. The US Center for Disease Control estimates that 1.6–3.8 million sports-related concussions are hospitalized each year in the United States. Other studies suggest that the number of unreported concussions may be 10-fold higher.

## Definition of Concussion

The “Concussion in Sport Group” (CISG) definition has now become the accepted clinical operational definition of this condition. This definition states that:

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

1. Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an “impulsive” force transmitted to the head.

2. *Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, symptoms and signs may evolve over a number of minutes to hours.*
3. *Concussion may result in neuro-pathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuro-imaging studies.*
4. *Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. However, it is important to note that in some cases symptoms may be prolonged.”*

## Symptoms and Signs of Acute Concussion

The diagnosis of acute concussion usually involves the assessment of a range of domains including clinical symptoms, physical signs, cognitive impairment, neurobehavioral features, and sleep disturbance. These are outlined on the SCAT3 and (Concussion Recognition Tool (CRT) forms (Figures 11.1 and 11.2).

The suspected diagnosis of concussion can include one or more of the following clinical domains:

1. Symptoms – somatic (e.g., headache), cognitive (e.g., feeling like in a fog), and/or emotional symptoms (e.g., lability)
2. Physical signs (e.g., loss of consciousness (LOC), amnesia)
3. Behavioral changes (e.g., irritability)
4. Cognitive impairment (e.g., slowed reaction times)
5. Sleep disturbance (e.g., insomnia)

If any one or more of these components are present, a concussion should be suspected and the appropriate management strategy instituted.

The common symptoms of concussion have been examined in prospective studies and include headache, dizziness, blurred vision, and nausea. These symptoms are not specific to concussion and in some cases may present in a delayed manner, which highlights a key issue that acute concussion is an evolving injury.

## Fieldside Recognition of Concussion

Frequently, in episodes of mild concussion (“bell ringers”), the athlete will be dazed or stunned for a period of seconds only and continue playing. Alert medical and training staff should closely observe the actions of a player who has received a knock on the head for any signs of impaired performance. Visual clues to the presence of concussion are outlined on the CRT (Figure 11.2) and include loss of responsiveness or lying motionless on ground, slow to get up, unsteady on feet or falling over, grabbing or clutching head, dazed or blank look, and unaware of surrounding plays or events.

## Concussion Injury Severity and Recovery

The classification of severity of concussive injury is a contentious area. The CISG recommended that no specific anecdotal scale be used and that all concussive injury management measure individual recovery to determine return to play (RTP) rather than an anecdotal grading systems and arbitrary exclusion periods.



Name \_\_\_\_\_ Date/Time of Injury: \_\_\_\_\_ Examiner: \_\_\_\_\_  
 Date of Assessment: \_\_\_\_\_

**What is the SCAT3?¹**

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used in athletes aged from 13 years and older. It supersedes the original SCAT and the SCAT2 published in 2005 and 2009, respectively¹. For younger persons, ages 12 and under, please use the Child SCAT3. The SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool¹. Preseason baseline testing with the SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, groups and organizations. Any revision or any reproduction in a digital form requires approval by the Concussion in Sport Group.

**NOTE:** The diagnosis of a concussion is a clinical judgment, ideally made by a medical professional. The SCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgement. An athlete may have a concussion even if their SCAT3 is "normal".

**What is a concussion?**

A concussion is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific signs and/or symptoms (some examples listed below) and most often does not involve loss of consciousness. Concussion should be suspected in the presence of **any one or more** of the following:

- Symptoms (e.g., headache), or
- Physical signs (e.g., unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour (e.g., change in personality).

**SIDELINE ASSESSMENT**

**Indications for Emergency Management**

**NOTE:** A hit to the head can sometimes be associated with a more serious brain injury. Any of the following warrants consideration of activating emergency procedures and urgent transportation to the nearest hospital:

- Glasgow Coma score less than 15
- Deteriorating mental status
- Potential spinal injury
- Progressive, worsening symptoms or new neurologic signs

**Potential signs of concussion?**

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop participation, be evaluated by a medical professional and **should not be permitted to return to sport the same day** if a concussion is suspected.

Any loss of consciousness? "If so, how long?" _____	<input type="checkbox"/> Y <input type="checkbox"/> N
Balance or motor incoordination (stumbles, slow/laboured movements, etc.)?	<input type="checkbox"/> Y <input type="checkbox"/> N
Disorientation or confusion (inability to respond appropriately to questions)?	<input type="checkbox"/> Y <input type="checkbox"/> N
Loss of memory: "If so, how long?" _____	<input type="checkbox"/> Y <input type="checkbox"/> N
"Before or after the injury?" _____	<input type="checkbox"/> Y <input type="checkbox"/> N
Blank or vacant look:	<input type="checkbox"/> Y <input type="checkbox"/> N
Visible facial injury in combination with any of the above:	<input type="checkbox"/> Y <input type="checkbox"/> N

**1 Glasgow coma scale (GCS)**

<b>Best eye response (E)</b>	
No eye opening	1
Eye opening in response to pain	2
Eye opening to speech	3
Eyes opening spontaneously	4
<b>Best verbal response (V)</b>	
No verbal response	1
Incomprehensible sounds	2
Inappropriate words	3
Confused	4
Oriented	5
<b>Best motor response (M)</b>	
No motor response	1
Extension to pain	2
Abnormal flexion to pain	3
Flexion/Withdrawal to pain	4
Localizes to pain	5
Obeys commands	6
<b>Glasgow Coma score (E + V + M)</b>	<b>of 15</b>

GCS should be recorded for all athletes in case of subsequent deterioration.

**2 Maddocks Score³**

"I am going to ask you a few questions, please listen carefully and give your best effort."

Modified Maddocks questions (1 point for each correct answer)

At what venue are we at today?	0	1
Which half is it now?	0	1
Who scored last in this match?	0	1
What team did you play last week / game?	0	1
Did your team win the last game?	0	1
<b>Maddocks score</b>	<b>of 5</b>	

Maddocks score is validated for sideline diagnosis of concussion only and is not used for serial testing.

**Notes:** Mechanism of Injury ("tell me what happened?"):

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Any athlete with a suspected concussion should be REMOVED FROM PLAY, medically assessed, monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle until cleared to do so by a medical professional. No athlete diagnosed with concussion should be returned to sports participation on the day of Injury.**

Figure 11.1 SCAT3 assessment tool

(Source: Concussion in Sport Group © 2013 – SCAT3. *British Journal of Sports Medicine* 2013; 47(5): 259.)

## BACKGROUND

Name: \_\_\_\_\_ Date: \_\_\_\_\_  
 Examiner: \_\_\_\_\_  
 Sport/team/school: \_\_\_\_\_ Date/time of injury: \_\_\_\_\_  
 Age: \_\_\_\_\_ Gender:  M  F  
 Years of education completed: \_\_\_\_\_  
 Dominant hand:  right  left  neither  
 How many concussions do you think you have had in the past? \_\_\_\_\_  
 When was the most recent concussion? \_\_\_\_\_  
 How long was your recovery from the most recent concussion? \_\_\_\_\_  
 Have you ever been hospitalized or had medical imaging done for a head injury?  Y  N  
 Have you ever been diagnosed with headaches or migraines?  Y  N  
 Do you have a learning disability, dyslexia, ADD/ADHD?  Y  N  
 Have you ever been diagnosed with depression, anxiety or other psychiatric disorder?  Y  N  
 Has anyone in your family ever been diagnosed with any of these problems?  Y  N  
 Are you on any medications? If yes, please list:  Y  N

SCAT3 to be done in resting state. Best done 10 or more minutes post exercise.

## SYMPTOM EVALUATION

### 3 How do you feel?

"You should score yourself on the following symptoms, based on how you feel now".

	none	mild	moderate	severe			
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22) \_\_\_\_\_

Symptom severity score (Maximum possible 132) \_\_\_\_\_

Do the symptoms get worse with physical activity?  Y  N  
 Do the symptoms get worse with mental activity?  Y  N

self rated  self rated and clinician monitored  
 clinician interview  self rated with parent input

**Overall rating:** If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self?

Please circle one response:

no different  very different  unsure  N/A

**Scoring on the SCAT3 should not be used as a stand-alone method to diagnose concussion, measure recovery or make decisions about an athlete's readiness to return to competition after concussion. Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.**

## COGNITIVE & PHYSICAL EVALUATION

### 4 Cognitive assessment

Standardized Assessment of Concussion (SAC)<sup>4</sup>

**Orientation** (1 point for each correct answer)

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1

**Orientation score** \_\_\_\_\_ of 5

**Immediate memory**

List	Trial 1	Trial 2	Trial 3	Alternative word list					
elbow	0	1	0	1	0	1	candle	baby	finger
apple	0	1	0	1	0	1	paper	monkey	penny
carpet	0	1	0	1	0	1	sugar	perfume	blanket
saddle	0	1	0	1	0	1	sandwich	sunset	lemon
bubble	0	1	0	1	0	1	wagon	iron	insect
<b>Total</b>									

**Immediate memory score total** \_\_\_\_\_ of 15

**Concentration: Digits Backward**

List	Trial 1	Alternative digit list			
4-9-3	0	1	6-2-9	5-2-6	4-1-5
3-8-1-4	0	1	3-2-7-9	1-7-9-5	4-9-6-8
6-2-9-7-1	0	1	1-5-2-8-6	3-8-5-2-7	6-1-8-4-3
7-1-8-4-6-2	0	1	5-3-9-1-4-8	8-3-1-9-6-4	7-2-4-8-5-6
<b>Total of 4</b>					

**Concentration: Month in Reverse Order** (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
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**Concentration score** \_\_\_\_\_ of 5

### 5 Neck Examination:

Range of motion  Tenderness  Upper and lower limb sensation & strength

**Findings:** \_\_\_\_\_

### 6 Balance examination

Do one or both of the following tests.

Footwear (shoes, barefoot, braces, tape, etc.) \_\_\_\_\_

**Modified Balance Error Scoring System (BESS) testing<sup>5</sup>**

Which foot was tested (i.e. which is the non-dominant foot)  Left  Right

Testing surface (hard floor, field, etc.) \_\_\_\_\_

**Condition**

Double leg stance: \_\_\_\_\_ Errors

Single leg stance (non-dominant foot): \_\_\_\_\_ Errors

Tandem stance (non-dominant foot at back): \_\_\_\_\_ Errors

**And / Or**

**Tandem gait<sup>6,7</sup>**

Time (best of 4 trials): \_\_\_\_\_ seconds

### 7 Coordination examination

**Upper limb coordination**

Which arm was tested:  Left  Right

**Coordination score** \_\_\_\_\_ of 1

### 8 SAC Delayed Recall<sup>4</sup>

**Delayed recall score** \_\_\_\_\_ of 5

Figure 11.1 (contd.)

## INSTRUCTIONS

Words in *italics* throughout the SCAT3 are the instructions given to the athlete by the tester.

### Symptom Scale

*"You should score yourself on the following symptoms, based on how you feel now".*

To be completed by the athlete. In situations where the symptom scale is being completed after exercise, it should still be done in a resting state, at least 10 minutes post exercise.

For total number of symptoms, maximum possible is 22.

For Symptom severity score, add all scores in table, maximum possible is 22x6 = 132.

### SAC<sup>4</sup>

#### Immediate Memory

*"I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order."*

#### Trials 2 & 3:

*"I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before."*

Complete all 3 trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. **Score 1 pt. for each correct response.** Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

#### Concentration

##### Digits backward

*"I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7."*

If correct, go to next string length. If incorrect, read trial 2. **One point possible for each string length.** Stop after incorrect on both trials. The digits should be read at the rate of one per second.

##### Months in reverse order

*"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November ... Go ahead"*

**1 pt. for entire sequence correct**

##### Delayed Recall

The delayed recall should be performed after completion of the Balance and Coordination Examination.

*"Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."*

**Score 1 pt. for each correct response**

## Balance Examination

### Modified Balance Error Scoring System (BESS) testing<sup>5</sup>

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)<sup>5</sup>. A stopwatch or watch with a second hand is required for this testing.

*"I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances."*

#### (a) Double leg stance:

*"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."*

#### (b) Single leg stance:

*"If you were to kick a ball, which foot would you use? [This will be the dominant foot] Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*

#### (c) Tandem stance:

*"Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*

### Balance testing – types of errors

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. **The modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10.** If an athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of **five seconds** at the start are assigned the highest possible score, ten, for that testing condition.

**OPTION:** For further assessment, the same 3 stances can be performed on a surface of medium density foam (e.g., approximately 50 cm x 40 cm x 6 cm).

### Tandem Gait<sup>6,7</sup>

*Participants are instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 meter line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. A total of 4 trials are done and the best time is retained. Athletes should complete the test in 14 seconds. Athletes fail the test if they step off the line, have a separation between their heel and toe, or if they touch or grab the examiner or an object. In this case, the time is not recorded and the trial repeated, if appropriate.*

## Coordination Examination

### Upper limb coordination

#### Finger-to-nose (FTN) task:

*"I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended), pointing in front of you. When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of the nose, and then return to the starting position, as quickly and as accurately as possible."*

**Scoring: 5 correct repetitions in < 4 seconds = 1**

**Note for testers:** Athletes fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions. Failure should be scored as 0.

## References & Footnotes

1. This tool has been developed by a group of international experts at the 4th International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2012. The full details of the conference outcomes and the authors of the tool are published in The BJSM Injury Prevention and Health Protection, 2013, Volume 47, Issue 5. The outcome paper will also be simultaneously co-published in other leading biomedical journals with the copyright held by the Concussion in Sport Group, to allow unrestricted distribution, providing no alterations are made.
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6. Schneiders, A.G., Sullivan, S.J., Gray, A., Hammond-Tooke, G. & McCrory, P. Normative values for 16-37 year old subjects for three clinical measures of motor performance used in the assessment of sports concussions. Journal of Science and Medicine in Sport. 2010; 13(2): 196-201.
7. Schneiders, A.G., Sullivan, S.J., Kvamstrom, J.K., Olsson, M., Yden, T. & Marshall, S.W. The effect of footwear and sports-surface on dynamic neurological screening in sport-related concussion. Journal of Science and Medicine in Sport. 2010; 13(4): 382-386

Figure 11.1 (contd.)

## ATHLETE INFORMATION

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. The athlete should not be left alone and must go to a hospital at once if they:

- Have a headache that gets worse
- Are very drowsy or can't be awakened
- 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 their feet; have slurred speech

**Remember, it is better to be safe.**

**Consult your doctor after a suspected concussion.**

### Return to play

Athletes should not be returned to play the same day of injury.

When returning athletes to play, they should be **medically cleared and then follow a stepwise supervised program**, with stages of progression.

For example:

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
No activity	Physical and cognitive rest	Recovery
Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity, 70% maximum predicted heart rate. No resistance training	Increase heart rate
Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
Non-contact training drills	Progression to more complex training drills, eg passing drills in football and ice hockey. May start progressive resistance training	Exercise, coordination, and cognitive load
Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
Return to play	Normal game play	

There should be at least 24 hours (or longer) for each stage and if symptoms recur the athlete should rest until they resolve once again and then resume the program at the previous asymptomatic stage. Resistance training should only be added in the later stages.

If the athlete is symptomatic for more than 10 days, then consultation by a medical practitioner who is expert in the management of concussion, is recommended.

**Medical clearance should be given before return to play.**

### Scoring Summary:

Test Domain	Score		
	Date: _____	Date: _____	Date: _____
Number of Symptoms of 22			
Symptom Severity Score of 132			
Orientation of 5			
Immediate Memory of 15			
Concentration of 5			
Delayed Recall of 5			
<b>SAC Total</b>			
BESS (total errors)			
Tandem Gait (seconds)			
Coordination of 1			

### Notes:

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## CONCUSSION INJURY ADVICE

(To be given to the **person monitoring** the concussed athlete)

This patient has received an injury to the head. A careful medical examination has been carried out and no sign of any serious complications has been found. Recovery time is variable across individuals and the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

**If you notice any change in behaviour, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please contact your doctor or the nearest hospital emergency department immediately.**

### Other important points:

- Rest (physically and mentally), including training or playing sports until symptoms resolve and you are medically cleared
- No alcohol
- No prescription or non-prescription drugs without medical supervision. Specifically:
  - No sleeping tablets
  - Do not use aspirin, anti-inflammatory medication or sedating pain killers
- Do not drive until medically cleared
- Do not train or play sport until medically cleared

Patient's name \_\_\_\_\_

Date/time of injury \_\_\_\_\_

Date/time of medical review \_\_\_\_\_

Treating physician \_\_\_\_\_

Clinic phone number \_\_\_\_\_

Contact details or stamp

Figure 11.1 (contd.)

## Pocket CONCUSSION RECOGNITION TOOL

To help identify concussion in children, youth and adults



### RECOGNIZE & REMOVE

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

#### 1. Visible clues of suspected concussion

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

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

#### 2. Signs and symptoms of suspected concussion

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

- |                          |                            |
|--------------------------|----------------------------|
| - Loss of consciousness  | - Headache                 |
| - Seizure or convulsion  | - Dizziness                |
| - Balance problems       | - Confusion                |
| - Nausea or vomiting     | - Feeling slowed down      |
| - Drowsiness             | - "Pressure in head"       |
| - More emotional         | - Blurred vision           |
| - Irritability           | - Sensitivity to light     |
| - Sadness                | - Amnesia                  |
| - Fatigue or low energy  | - Feeling like "in a fog"  |
| - Nervous or anxious     | - Neck Pain                |
| - "Don't feel right"     | - Sensitivity to noise     |
| - Difficulty remembering | - Difficulty concentrating |

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### 3. Memory function

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

- "At what venue are we at today?"  
"Which half is it now?"  
"Who scored last in this game?"  
"What team did you play last week / game?"  
"Did your team win the last game?"

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

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

### RED FLAGS

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

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

### Remember:

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

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

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Figure 11.2 Concussion Recognition Tool (CRT)

(Source: Concussion in Sport Group © 2013 – Concussion Recognition Tool. *British Journal of Sports Medicine* 2013; 47(5): 267.)

## Concussion Management

The practical management of concussion can be divided into three broad areas where the issues and treatment priorities differ considerably. These areas are immediate/onfield, early, and late management.

### Immediate or Onfield Management

The key objectives when assessing any athlete who has sustained an acute head or brain injury are the following:

1. Institute an appropriate triage on the FoP
2. Conduct a proper secondary survey in conjunction with a sideline assessment of the injured athlete
3. Manage the injury appropriately, minimizing the risk of any “secondary” injury, such as might be seen with coexistent hypoxia or hypotension
4. Safely remove the athlete from the Field of Play to an appropriate medical facility for further investigation and assessment
5. Determine subsequently when it is safe for the athlete to RTP

The major priorities at this early stage are the basic principles of first aid, for example, ensure a patent airway with adequate oxygenation, ventilation, and circulation. Once these basic aspects of first aid care have been achieved and the patient is stabilized, then consideration of removal of the patient from the FoP to an appropriate facility is necessary. It is essential that all EDs who have an onfield injury management role in their sport have formal training and certification both in first aid and trauma management.

At this time, careful assessment for the presence of a cervical spine or other injury is critical. If an alert patient complains of neck pain, has evidence of neck tenderness or deformity, or has neurological signs suggestive of a spinal injury, then cervical immobilization and transportation with suitable spinal immobilization equipment is required. If the patient is unconscious, then a cervical injury should be assumed until proven otherwise.

Concussive convulsions in collision sport are an uncommon but dramatic association of minor head injury. Clinicians need to follow the first aid principles above and wait for the convulsion to spontaneously resolve (see Chapter 11). Following the convulsion, the athlete should be managed as for a standard concussion.

Once this first aid process has been completed and the patient is stabilized, a full medical and neurological assessment examination should follow. Onsite doctors are in an ideal position to initiate the critical early steps in medical care to ensure optimal recovery from a head injury.

When examining a head-injured athlete, a structured and focused neurological examination is important. Because the major management priorities at this stage are to exclude a catastrophic intracranial injury, this part of the examination should focus on key clinical findings such as

1. the level of consciousness (measured using the Glasgow Coma Scale);
2. pupil response and conjugate eye movement;
3. motor function; and
4. thorough examination of the skull and scalp for evidence of trauma.

The importance of this initial neurologic examination is that it serves as a reference to which other repeated neurologic examinations may be compared.



Vital signs must be recorded following an injury. Hypotension is rarely due to brain injury, except as a terminal event, and alternate sources for the decrease in blood pressure should be aggressively sought and treated. This includes major scalp lacerations especially in young children or a cervical spinal cord injury. Restlessness is a frequent accompaniment of brain injury and can be an early indicator of increased intracranial pressure, intracranial bleeding, or hypoxia, all of which can aggravate any underlying brain injury. If the patient is unconscious but restless, attention should be given to the possibility of increasing cerebral hypoxia, a distended bladder, or painful injuries elsewhere. When time permits, a more thorough physical examination should be performed to exclude coexistent injuries elsewhere in the body.

### Early Management

This refers to the situation where an athlete has been brought to the athlete medical room for assessment. Assessment of injury severity is best performed in a quiet medical room rather than in the middle of a football field in front of 100,000 screaming fans. This assessment should be performed by a medical practitioner. If no doctor is available for this assessment, then the athlete needs to be referred to hospital where this can be performed.

When assessing the acutely concussed athlete, various aspects of the history and examination are important. The SCAT3 tool (see Figure 11.1) outlines a complete structured medical assessment of the injured athlete.

When examining a concussed athlete, a full neurological examination is important. Because the major management priorities at this stage are to establish an accurate diagnosis and exclude a catastrophic intracranial injury, this part of the examination should be particularly thorough.

In recent times, the application of simple cognitive tests has created considerable interest as a means to objectively assess concussed athletes. The standard approach of asking the orientation items (e.g., day, date, year, time, date of birth, etc.) has been shown to be unreliable following concussive injury. This aspect of memory remains relatively intact in the face of concussive injury and should not be used. More useful, as demonstrated in prospective studies, are questions of recent memory. These are incorporated in the SCAT3 tool (Figure 11.1).

Although a trainer or nonmedical person may utilize the CRT to suspect the diagnosis of concussion, all concussed athletes should be referred for an urgent medical assessment. Most high-level amateur and professional teams will, in fact, have their own medical staff who make the diagnosis, however, where teams lack this facility, then concussed athletes need to be referred to hospital for a medical assessment.

Having determined the presence of a concussive injury, the patient needs to be serially monitored until full recovery ensues. If the concussed player is discharged home after an initial assessment, then they should be in the care of a responsible adult. It is the author's policy to give the patient and the attendant a head injury advice card upon discharge. This is incorporated in the SCAT3 tool (Figure 11.1).

**Who should be referred to hospital?** The treating clinician at a sporting event also must decide who should be referred to hospital or directly to a neurosurgical center. There are a number of urgent indications that are listed in Table 11.1. While it is acknowledged that a number of these indications are based on anecdotal rather than evidence-based information, these are widely accepted. The overall approach should be “when in doubt, refer.” Where no physician is present and the initial management is in the hands of an athletic trainer, physical therapist, or paramedic, then an urgent medical referral should be considered mandatory in all cases of head injury.

Fractured skull	Confusion or impairment of consciousness >30 min
Penetrating skull trauma	Loss of consciousness >5 min
Deterioration in conscious state following injury	Persistent vomiting or increasing headache postinjury
Focal neurological signs	Any convulsive movements
More than one episode of concussive injury in a session	Where there is assessment difficulty (e.g., an intoxicated patient)
Children with head injuries	High-risk patients (e.g., hemophilia, anticoagulant use)
Inadequate postinjury supervision	High-risk injury mechanism (e.g., high-velocity impact)

**Table 11.1** Indications for urgent hospital referral and/or neuroimaging

### Who needs diagnostic investigations?

The indications for urgent neuroimaging in the initial evaluation of the head-injured patient are the same as those outlined in Table 11.1. The primary goal of imaging is to establish whether there is an intracranial hemorrhage. A depressed level of consciousness and, in particular, a GCS  $\leq 8$ , are the strongest predictors of intracranial hemorrhage. Other signs that suggest surgical pathology include focal motor weakness and an asymmetrical pupil examination.

An important and more difficult question is who needs a head computed tomography (CT) scan when his/her level of consciousness is normal (i.e., GCS is 15)? Guidelines such as the Canadian Head CT Rules and the New Orleans Criteria suggest that factors such as age >60 years, headache, vomiting, intoxication, retrograde amnesia, confusion, LOC, seizures, visible trauma above the clavicles, and injury mechanism indicate a need for a head CT. However, a normal head CT scan does not always exclude a traumatic brain injury (TBI) or the need for neurosurgical consultation. About 20% of patients admitted to hospital after even mild TBI may develop posttraumatic abnormalities on subsequent imaging even after the initial head CT scan was normal.

### Late Management and Return to Play

This refers to the situation where a player has sustained a concussive injury previously and is now presenting for advice or clearance prior to resuming sport. The main management priorities at this stage are the assessment of recovery and the application of the appropriate return to sport guidelines. Any clearance to return to sport is the province of a medical practitioner, ideally with experience of these sporting injuries, and should not be undertaken by nonmedical personnel.

RTP decisions remains difficult. Expert consensus guidelines recommend that players should not be returned to competition until they have recovered completely from their concussive injury. Currently, however there is no single gold standard measure of brain disturbance and recovery following concussion. Instead, clinicians must rely on a number of indirect measures to inform clinical judgment. In practical terms, this involves a multifaceted clinical approach, which includes assessment of symptoms, modifying factors, physical signs (such as balance), and neurocognitive function. Furthermore, individual International Federations may have specific recommendations for return to competition and/or the FoP and these need to be considered as part of the RTP paradigm.

It was unanimously agreed at the CISG meeting that no RTP on the day of concussive injury should occur. There is data demonstrating that at the collegiate and high school levels, athletes allowed to RTP on the same day may demonstrate neuropsychological deficits postinjury that may not be evident on the sidelines and are more likely to have delayed onset of symptoms. The principal concern of premature RTP of a concussed athlete is that due to the impaired cognitive function (e.g., slowed information

processing and reduced attention), the athlete will sustain further injury (both concussive and other) when returning to a dangerous playing environment.

*The guiding policy should be that until completely symptom free, concussed athletes should not resume any training or competition.* Once the acute concussive symptoms resolve at rest and exercise, a graduated plan of return to low-level aerobic training, followed by non-contact drills and finally contact play will allow close monitoring of the development of any adverse symptoms. Persisting or newly developing symptoms necessitate further follow-up and detailed medical evaluation. An outline of a graduated RTP strategy is presented on the final page of the SCAT3 tool (Figure 11.1).

Most sports-related concussive injuries are uncomplicated and recover fully over 1–3 weeks. However, it is worth noting that detailed neuropsychological testing shows that 20% or more athletes will still have unrecognized cognitive deficits 10 days after concussion. For this reason, reliance on nonscientific nostrums (“miss a week”) or symptoms alone to guide RTP is not recommended as best practice care. This fact highlights the important role of neuropsychological testing to inform clinical decision making and as one of the cornerstones of management. In postconcussive athletes with persistent symptoms or cognitive deficits (>14 days), consideration of referral to a multidisciplinary concussion program may be worthwhile. At the end of the day, good clinical judgment should prevail over written guidelines.

One of the key problems to consider in this setting are mental health issues (such as depression, anxiety, and suicide) that have been reported as consequence of TBI including sports concussion. All players with ongoing symptoms or a prolonged clinical course should be screened for depression using standard clinical tools, for example, Hospital Anxiety and Depression Scale, Beck Depression Inventory, and so on.

## Concussion in Child and Adolescent Athletes

The CISG evaluation and management recommendations can be applied to children and adolescents down to the age of 13 years. Below that age, children report concussion symptoms differently from adults and require age-appropriate symptom checklists as a component of assessment. An additional consideration in assessing the child or adolescent athlete with a concussion is that the clinical evaluation by the healthcare professional may need to include both patient and parent input, and possibly teacher input when appropriate. A child SCAT3 has been developed to assess concussion for individuals aged 5–12 years.

Because of the different physiological response and longer recovery after concussion and specific risks (e.g., diffuse cerebral swelling) related to head impact during childhood and adolescence, a more conservative RTP approach is recommended. It is appropriate to extend the amount of time of asymptomatic rest and/or the length of the graded exertion in children and adolescents. It is never appropriate for a child or adolescent athlete with concussion to RTP on the same day as the injury, regardless of the level of athletic performance.

## Prevention of Concussion

There are relatively few methods by which concussive brain injury may be minimized in sport. The brain is not an organ that can be conditioned to withstand injury. Thus, extrinsic mechanisms of injury prevention must be sought.

Helmets have been proposed as a means of protecting the head and theoretically reducing the risk of brain injury. In sports where high-speed collisions, missile injuries (e.g., baseball) or falls onto hard surfaces (e.g., gridiron, ice hockey), there is published evidence for the effectiveness of sport-specific helmets to be of benefit in reducing head injuries, particularly skull fractures. For other sports such as soccer and rugby, no sport-specific helmets have been shown to be of proven benefit in reducing rates of head injury. Some believe that the use of protective equipment may alter

playing behavior deleteriously so that the athlete actually increases his or her risk of brain injury.

Although the use of correctly fitting mouth guards can reduce the rate of dental orofacial and mandibular injuries, the evidence that they reduce cerebral injuries is largely theoretical, and clinical evidence for a beneficial effect in reducing concussion rates has not yet been demonstrated scientifically.

Consideration of rule changes (i.e., no head checking in ice hockey) and rule enforcement to reduce the head injury rate may be appropriate where a clearcut mechanism is implicated in a particular sport. For most sports, however, head injuries are an accidental byproduct of normal play and hence rule changes or rule enforcement has little effect on head injury rates. Nevertheless, the promotion of fair play and respect for opponents are ethical values that should be encouraged in all sports and by sporting associations. Education of players, coaches, parents, and other staff play an important part in ensuring these values are implemented on the Field of Play.

Neck muscle conditioning may be of value in reducing impact forces transmitted to the brain. Biomechanical concepts dictate that the energy from an impacting object is dispersed over the greater mass of an athlete if the head is held rigidly. Although attractive from a theoretical standpoint, there is little scientific evidence to demonstrate the effectiveness of such measures.

As the ability to treat or reduce the effects of concussive injury after the event is minimal, education of athletes, colleagues, and those working with them as well as the general public is a mainstay of progress in this field. Athletes and their healthcare providers must be educated regarding the detection of concussion, its clinical features, assessment techniques, and principles of safe RTP. Methods to improve education including various web-based resources (e.g., [www.concussionsafety.com](http://www.concussionsafety.com)), educational videos, outreach programs, concussion working groups, and the support and endorsement of enlightened sport groups must be pursued vigorously.

## Other Specific Issues

### Diffuse Cerebral Swelling and Second Impact Syndrome

Second impact syndrome is frequently mentioned in the concussion literature but, surprisingly, has little scientific evidence for its existence. It is a term used to describe the potential catastrophic consequences resulting from a second concussive blow to the head before an individual has fully recovered from the symptoms of a previous concussion. The second head injury is believed to result in the loss of cerebrovascular autoregulation, which in turn leads to brain swelling secondary to increased cerebral blood flow. There is a lack of evidence to support the claim that the second impact is a risk factor for diffuse cerebral swelling. However, there is evidence that acute (and delayed) brain swelling may occur following a single blow to the head, in association with a structural injury such as a subdural hematoma and also in disorders of calcium channels, suggesting a possible genetic basis for some of these cases. Such events are virtually only seen in children and adolescents. The diagnosis is usually made with an urgent CT brain scan or magnetic resonance imaging (MRI).

Clinical examination, for example, papilledema on fundoscopy, decerebrate posturing, may also provide a clue to the diagnosis. If cerebral swelling is suspected or noted on imaging studies, an urgent neurosurgical consultation is required. Mortality in this condition approaches 100%.

## Chronic Traumatic Encephalopathy

Tremendous media attention surrounding sport-related concussion has been directed toward the potential for long-term problems in athletes with high exposure to head contact (i.e., both concussive and subconcussive impacts) during a career in contact sport. This attention has been fueled by the publication of autopsy case studies of retired professional athletes and research reporting increased mortality rate due to neurodegenerative diseases in former professional athletes. There is also evidence from retrospective surveys supporting an association between long-term cognitive, psychiatric, and neurobehavioral problems and participation in sport. In this setting, there is limited neurophysiological and radiological evidence to suggest persistent disturbance of brain function in the absence of overt pathological change that may occur following concussive injury. In recent years, chronic traumatic encephalopathy (CTE) has been redefined from the original condition resembling Alzheimer's disease in professional boxers to a new condition observed in athletes, military personnel, and other nonsporting individuals that shares many features with known psychiatric disorders and other forms of dementia. Although the clinical phenotype is not yet clarified, CTE is characterized by distinct neuropathological findings. The strongly presented causal assumptions in the literature relating to concussive and subconcussive brain impact exposure derived from the case studies are scientifically premature, especially given the absence of prospective, or longitudinal studies on the topic. In addition to the limitations associated with verifying clinicopathological correlation, further research is required in order to better delineate this disease process.

## Conclusion

Management of head injury in sport is a critical aspect of sports medicine care. As the ability to treat or reduce the effects of brain injury after the event is minimal, education of athletes, colleagues, and the general public is a mainstay of progress in this field. Athletes, referees, administrators, parents, coaches, and healthcare providers must be educated regarding the detection of concussion, its clinical features, assessment techniques, and principles of safe RTP. Methods to improve education including web-based resources, educational videos, and international outreach programs are important in delivering the message. In addition, concussion working groups, plus the support and endorsement of enlightened sport groups such as FIFA, IOC, IRB, and IIHF have enormous value and must be pursued vigorously. 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 that these values are implemented on the Field of Play.

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