CONCUSSION MANAGEMENT IN 2014

WHAT MUST WE LEARN FROM THE ZURICH CONSENSUS STATEMENT?

– Written by Paul McCrory, Australia

Sport-related concussion is the most topical and contentious area of sports medicine today. No other condition in medicine attracts more column inches of newspaper copy, more electronic media stories and in the USA, is the only medical condition that has its management legislatively mandated. Over the past 15 years, numerous professional bodies have published treatment guidelines on this topic[1–5].

Commencing in 2001, the International Concussion in Sport Group (CISG) has held four consensus meetings that have established the key management concepts and global research agenda in the field[6]. The most recent conference was held in Zurich in November 2012. The consensus statement produced from this meeting was published in March 2013 and provides the most up to date knowledge on concussion in sport[6]. The CISG guidelines have influenced the clinical management of concussion in professional sports worldwide. This paper discusses the current best practice clinical management of concussion in light of the Zurich 2013 guidelines.

HOW IS CONCUSSION DEFINED IN 2014

Concussion is a subset of traumatic brain injury which is a broad term encompassing a spectrum of injuries to the brain resulting from trauma. Concussion is defined as a syndrome of neurological impairment that results from traumatic biomechanical forces directly or indirectly transmitted to the brain. Although the pathophysiology of concussion remains poorly understood,

> ***concussion is the only medical condition that has its management legislatively mandated***

Sport	Concussion incidence (per 1000 player hours exposure)
Horse racing (amateur)	*95*
Horse racing (jumps)	*25*
Professional boxing	*13*
Australian football and rugby	*5*
Ice hockey	*1.5*
Football (soccer)	*0.4*
Football (USA NFL)	*0.2*

Table 1: Concussion incidence by sport.

the current consensus is that it reflects a disturbance of brain function rather than a structural injury.

HOW COMMON IS CONCUSSION?

The incidence of concussion varies by sport. The approximate incidence of concussion by common participation sports is shown in Table 1.

WHAT ARE THE POTENTIAL COMPLICATIONS FOLLOWING CONCUSSION?

Concussion reflects a 'functional' injury of the brain rather than structural damage. Consequently, the changes are usually temporary and recover spontaneously if managed correctly. The recovery process however, is variable from person to person and injury to injury. While most cases of concussion recover uneventfully within 10 to 14 days of injury, complications or adverse outcomes may include:

- Impaired performance and increased injury risk on return to play.
- Acute, progressive diffuse cerebral swelling.
- Prolonged symptoms.
- Depression and other mental health issues.
- Cumulative cognitive deficits (chronic traumatic encephalopathy).

Risk factors for complications or adverse outcomes following concussion remain unclear. While there is a suggestion that genetic factors may play an important role, the current expert consensus is that premature return to play (and the subsequent risk of a second concussive injury before the athlete has fully recovered from the initial concussion) may predispose to poorer outcomes following a concussive injury.

The role of recurrent head trauma in the development of potential long-term complications such as chronic trauma encephalopathy and depression has received considerable press in both the scientific and lay press in recent years. Pathological case reports and cross sectional studies have suggested that retired NFL footballers, who have had recurrent head trauma during their careers, disproportionately suffer from cognitive impairment, depression and other mental health problems[7]. At this time, however, very little is known about what type, frequency or amount of trauma is necessary to induce the condition and more importantly why only a small number of athletes are at risk for chronic traumatic encephalopathy. Nevertheless, this concern should reinforce the need for conservative management strategies designed to ensure player safety.

MANAGING CONCUSSION SAFELY?

The key components of concussion management include:

1. Confirming the diagnosis (which includes differentiating concussion from other pathologies, in particular structural head injuries).
2. Determining when the player has recovered so that they can be safely returned to competition.

Confirming the diagnosis

The clinical history is most important in making a diagnosis of concussion. Common symptoms of concussion include headache, nausea, dizziness and balance problems, blurred vision or other visual disturbance, confusion, memory loss and a feeling of slowness or fatigue. While most symptoms appear rapidly following a concussive incident, some symptoms may be delayed or evolve over time. The diagnosis should be suspected in any player that presents with any of these symptoms following trauma to the head or neck. If video footage of the incident is available (from video camera, mobile phone camera etc), reviewing the footage may provide the clinician with important information.

Clinical features that are more specific to a diagnosis of concussion include: loss of consciousness, concussive convulsions, confusion and/or attentional deficit, memory disturbance and balance disturbance. These features however, may not be present in all cases. For example, loss of consciousness is seen in only 10 to 20% of cases of concussion. Questioning close relatives, especially parents or guardians in the case of children and adolescents, is often valuable. Any report that the individual 'does not seem right' or 'is not themselves' following trauma is strongly suggestive of a concussive injury.

The use of a graded symptom checklist is often helpful. The advantages of the symptom checklist are that it covers the range of symptoms commonly observed following concussion and provides a measure of symptom severity. The Zurich 2013 consensus statement includes a comprehensive Sport Concussion Assessment Tool (SCAT3) (p549) to facilitate medical assessment of athletes following a concussive injury. For non-medical personnel, the Concussion Recognition Tool (p548) provides sideline assessment advice.

KEY POINTS

1. *The Zurich 2013 consensus statement is the most widely accepted management guideline.*
2. *A simple assessment tool (e.g. the SCAT3) is the cornerstone of concussion assessment and management. All clinicians who work with concussion should be very familiar with it.*
3. *Concussion is often best managed in a multidisciplinary approach.*
4. *In considering the best practice management of concussion, the priority remains the welfare of the player, both in the short- and long-term.*

Clinical features of concussion typically resolve within 10 to 14 days of injury and the possibility of structural head injury should be kept in mind in any case where symptoms persist beyond this time. Following an uncomplicated concussion, conventional imaging techniques such as skull X-ray, CT brain scan and MRI are typically normal.

Differentiating concussion from structural pathologies

It is not possible to rule out structural brain injury with certainty during a side-line assessment and for that reason this possibility must be considered in every case. Clinical features that may raise concerns of structural head injury and warrant urgent investigation include:

- The mechanism of injury e.g. high velocity impact.
- Immediate and/or prolonged loss of consciousness.
- Seizures.
- Vomiting (in adults).
- Focal neurological deficit.
- Any deterioration in clinical state such as worsening headache and/or deterioration in conscious state.
- Medical comorbidities e.g. clotting disorders.
- Situations where the neurological exam cannot be adequately performed (e.g. patient intoxicated).

In a concussed individual with any of these adverse warning signs, urgent neuroimaging is required to exclude intracranial haemorrhage or other pathology.

Estimating the severity of injury

Over the years, numerous concussion severity scales have been proposed. International scientific consensus has moved away from anecdotal severity grading systems (e.g. mild, moderate or severe or grade 1, 2 and 3 concussion) towards an objective measure of recovery following the injury using a combination of symptom checklist, physical examination and cognitive assessment.

Evaluation in the emergency room or office by medical personnel

An athlete with concussion may be evaluated in the emergency room or doctor's office as a point of first contact following injury or may have been referred from another care provider. In addition to the points outlined above, the key features of this examination should encompass:

- A medical assessment including a comprehensive history and detailed neurological examination including a thorough assessment of mental status, cognitive functioning, gait and balance.
- A determination of the clinical status of the patient, including whether there has been improvement or deterioration since the time of injury. This may involve seeking additional information from video analysis, parents, coaches, teammates and eyewitnesses to the injury.
- A determination of the need for emergent neuroimaging in order to exclude a more severe brain injury involving a structural abnormality.
- Determination of the need for specialist referral.
- Provision of advice regarding recovery and return to play.

Determining when the player has recovered so that they can safely return to competition

The decision regarding the timing of return to play following a concussive injury is a difficult one to make. Expert consensus guidelines recommend that players should not be allowed to return 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 indirect measures to inform clinical judgment. In practical terms this involves a comprehensive clinical approach, including:

- A period of cognitive and physical rest to facilitate recovery.
- Monitoring for recovery of post-concussion symptoms and signs.
- Neuropsychological testing to estimate recovery of cognitive function.
- Graduated return to activity with monitoring for recurrence of symptoms.
- A final medical clearance before resuming full contact training and/or playing.

Period of cognitive and physical rest to facilitate recovery

Early rest is important to allow recovery following a concussive injury. Physical activity, physiological stress (e.g. altitude and flying) and cognitive loads (e.g. school work, videogames and computers) can all worsen symptoms and possibly delay recovery following concussion. Individuals should be advised to rest from these activities in the early stages (initial 24 to 48 hours) after a concussive injury, particularly while symptomatic. Similarly, the use of alcohol, opiate analgesics, anti-inflammatory medication, sedatives or recreational drugs can exacerbate symptoms following head trauma, delay recovery or mask deterioration and should also be avoided. Specific advice should also be given on cessation of activities that place the individual at risk of further injury (e.g. driving, operating heavy machinery).

Graduated Concussion Rehabilitation Programme

Rehabilitation stage	Stage goal	Functional exercise	Objective
Stage 1	No activity	Complete physical and cognitive rest	Recovery
Stage 2	Light aerobic exercise*	Walking, swimming or stationary cycling keeping intensity <70% maximum predicted heart rate. No resistance training.	Increase heart rate
Stage 3	Sport-specific exercise	Light training drills (e.g. running, ball work). No head impact activities.	Add movement
Stage 4	Non-contact training drills	Progression to more complex training drills. May start progressive resistance training.	Exercise, co-ordination and cognitive load
Stage 5	Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
Stage 6	Return to play	Normal game play	Normal play

Table 2: Graduated Concussion Rehabilitation Programme.* Light aerobic exercise can be commenced 24 to 48 hours after resolution of symptoms.

Monitoring for recovery of post-concussion symptoms and signs

Monitoring of post-concussion symptoms and signs can be facilitated by the use of the SCAT3.

Use of neuropsychological tests to estimate recovery of cognitive function

Cognitive deficits associated with concussion are typically subtle and may exist in a number of domains. Common deficits that follow concussion in sport include reduced attention and ability to process information, slowed reaction times and impaired memory. The use of neuropsychological tests in the management of concussion overcomes the reliance on subjective symptoms, which are known to be poorly recognised and variably reported. These tests allow detection of cognitive deficits, which have been observed to outlast symptoms in many cases of concussion. There are a number of levels of complexity of cognitive testing including formal neuropsychological testing, screening computerised cognitive test batteries and basic paper-and-pencil evaluation (i.e. SCAT3). Overall, it is important to remember that neuropsychological testing is only one component of assessment and therefore should not be the sole basis of management decisions.

Graduated return to activity

Following a concussive injury, players should be returned to play in a graduated fashion (Table 2) once clinical features have resolved and cognitive function returned to 'normal'. When considering

return to play, the athlete should be off all medications at the time of commencement of the rehabilitation phase and/or at the final medical assessment. Overall, a more conservative approach (i.e. longer time to return to sport) should be used in cases where there is any uncertainty about the player's recovery ("if in doubt, sit them out").

Progression through the rehabilitation programme should occur with at least 24 hours between stages. The player should be instructed that if any symptoms recur while progressing through their return to play programme that they should drop back to the previous asymptomatic level and try to progress again after a further 24 hour period has passed.

A final medical clearance before resuming full contact training and/or playing

A player who has suffered from a concussive injury must not be allowed to return to play before having a medical clearance. In accordance with current consensus guidelines, there is no mandatory period of time that a player must be withheld from play following a concussion. However, the minimum requirement is that a player must be symptom-free at rest and with exertion, have a normal neurological examination, returned to baseline of balance function and determined to have returned to baseline level of cognitive performance.

GAME-DAY EVALUATION AND TREATMENT

The management plan outlined above applies to concussive injuries being managed on game day. The main difference is that players diagnosed with concussion on game day should not be returned to play on the day of their injury.

With all concussive injuries, the critical game day management relates to the basic first aid principles, which apply when dealing with any unconscious player (i.e. airway, breathing, circulation). Care must be taken with the player's cervical spine, which may have also been injured in the collision. When in doubt (e.g. unconscious or non-lucid athlete), the player should be removed from the field on a stretcher with appropriate cervical spine precautions and transported to an appropriate facility for formal assessment.

The key components of game day concussion management involve making an accurate diagnosis, differentiating concussion from structural pathologies and careful monitoring of the injured player.

The pocket Concussion Recognition Tool (p548) is an important practical instrument that can be utilised on-field or on the sideline to screen for concussion. For a more detailed assessment, the player should be moved to a quiet room, away from the field of play (e.g. change rooms, medical room etc) for a detailed neurological examination and use of the full SCAT3. The aim is to confirm the diagnosis of concussion and to differentiate between concussion and high-risk intracranial or cervical pathology.

A player with any of the following should be sent immediately to hospital for assessment:

- Loss of consciousness.
- Neck pain or spinal cord symptoms.
- Seizures.
- Neurological signs.
- Prolonged confusion (>15 minutes).
- Persistent vomiting or increasing headache post-injury.

- Deterioration of conscious state post-injury (e.g. increased drowsiness).
- Obvious skull fracture (Cerebrospinal fluid rhinorrhoea/otorrhoea) or facial trauma.
- Development of new symptoms.
- High risk patients (e.g. known bleeding disorders).
- Where there is difficulty with assessment or uncertain follow-up (e.g. no responsible adult supervision).

Overall, if there is any doubt, the player should be referred to hospital for urgent medical assessment.

Players who have a normal neurological examination, are improving following their injury and have a competent person looking after them may be discharged home. These players and their caregiver (parent, partner etc) should be given clear and practical instructions, particularly regarding abstinence from alcohol and driving, medication use, physical exertion and timing of medical follow-up. Players should not be discharged home alone and a player who has been concussed should not drive until fully recovered. The SCAT3 form has a patient head injury hand out which may be given to the responsible caregiver and contains a list of the clinical features to be concerned about and an emergency plan in the event of deterioration.

Players should be followed up early after a concussive injury (to monitor progress in the sub-acute stages of their injury) and for medical clearance before they return to full contact and collision training or game play.

Tools such as the SCAT3 facilitate regular re-assessment of concussed players and provide simple and practical advice for patient education (see attachment). It is important to note that abbreviated sideline evaluation tools are designed for rapid concussion evaluation. They are not meant to replace a more comprehensive cognitive assessment and should not be used as a stand-alone tool for the ongoing management of concussive injuries.

MANAGEMENT OF CONCUSSION IN CHILDREN

There is evidence that younger athletes take longer to recover following a concussive injury than adults and that return to play on the day of the injury leads to subsequent cognitive deterioration. Moreover, there are specific risks (e.g. diffuse cerebral swelling) related to head impact during childhood and adolescence. Consequently, a more conservative approach is recommended in all concussed footballers under 18 years of age, regardless of the level of competition in which they participate.

The diagnosis of concussion, monitoring concussive symptoms and physical and cognitive assessment must be modified in children because of physical, cognitive and language development. As such, a 'childSCAT3' has been developed for use in children ages 5 to 12 years. For children ages 13 to 17 years, the SCAT3 should be used. It will be noted that the childSCAT3 includes both a child-report and parent-report symptom scale. It is very important to include the parent/teacher/coach/guardian in assessing the child with concussion.

Once the diagnosis of concussion has been made, the priority in children is successful return to learning and return to school before considering return to play. Medical clearance is required before the child may return to school. In most instances, the child will only require 1 to 2 days off school, however in others, longer periods of rest will be required. Once the child's symptoms are not exacerbated by reading or using the computer, he/she may return to school, but a careful plan will need to be developed for the parents and teachers that provide appropriate accommodations for the child, such as shorter school day, longer time to complete assignments, repeating instructions and frequent breaks (see page 4 of the childSCAT3). Only after successful return to school

Any report that the individual 'is not themselves' following trauma is strongly suggestive of a concussive injury

without worsening of symptoms may the child be allowed to commence return to sport. Medical clearance is required and a stepwise, supervised programme should be used (see page 4 childSCAT3).

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

3. Memory function

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

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

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

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

RED FLAGS

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

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

Remember:

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

SCAT3™

Sport Concussion Assessment Tool – 3rd Edition

For use by medical professionals only

Name | Date/Time of Injury: Date of Assessment: | Examiner:

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, respectively[2]. 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 Tool[1]. 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?	☐ Y	☐ N
"If so, how long?"		
Balance or motor incoordination (stumbles, slow/laboured movements, etc.)?	☐ Y	☐ N
Disorientation or confusion (inability to respond appropriately to questions)?	☐ Y	☐ N
Loss of memory:	☐ Y	☐ N
"If so, how long?"		
"Before or after the injury?"		
Blank or vacant look:	☐ Y	☐ N
Visible facial injury in combination with any of the above:	☐ Y	☐ N

1 Glasgow coma scale (GCS)

Best eye response (E)	
No eye opening	1
Eye opening in response to pain	2
Eye opening to speech	3
Eyes opening spontaneously	4
Best verbal response (V)	
No verbal response	1
Incomprehensible sounds	2
Inappropriate words	3
Confused	4
Oriented	5
Best motor response (M)	
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
Glasgow Coma score (E + V + M)	of 15

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

2 Maddocks Score[3]

"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)

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
Maddocks score		of 5

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.

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 excercise.

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)[4]

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
Total									

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
Total of 4					

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
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[5]

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[6,7]

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[4]

Delayed recall score of 5

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 22 x 6 = 132.

SAC[4]

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[5]

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[5]. 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 a 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[6,7]

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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3. Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine. 1995; 5(1): 32–3.

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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., Kvarnstrom. 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

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			
SAC Total			
BESS (total errors)			
Tandem Gait (seconds)			
Coordination of 1			

Notes:

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

Clinic phone number

Patient's name

Date/time of injury

Date/time of medical review

Treating physician

Contact details or stamp