



How to Treat Quiz

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NEED TO KNOW

Following a suspected concussion, immediate removal from play is essential, with no same-day return and continued monitoring of symptoms; severe or worsening symptoms may indicate the need for immediate medical attention.

Recovery will generally follow a predictable trajectory, and progressive exposure to activity is a key component of recovery.

Patients do not need to be asymptomatic before starting a gradual return to school/work and return to play; however, keep activity within their level of symptom tolerance and avoid high-risk activities (eg, contact sport) until medical clearance.

Assessment includes a thorough medical history, measurement of subjective symptom burden, a brief analysis of cognitive function and balance, and provocative testing such as vestibular/ocular motor testing.

Refer atypical concussion (protracted recovery or post-concussion syndrome) for specialist assessment and intervention.

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Sports concussion in children and adolescents

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BACKGROUND

AWARENESS of concussion continues to grow because of increased media attention and retired athletes speaking out about their personal struggles following years of head trauma.

The ever-increasing understanding of the neurobiological basis of concussive injury and its short- and long-term consequences, as well as evolving assessment and management strategies, will facilitate the optimal outcome for patients – a timely recovery.

Traumatic brain injury is among the most common causes of neurological morbidity.¹ Despite 70-90% of these injuries being mild, their effects can still be life-altering.¹

Concussion is described as an impairment in functional status following a traumatic brain injury and is characterised by a combination of physical, emotional, cognitive and sleep-related symptoms.²

Concussion is often considered a sporting injury; however, falls (51%) are overall the most common mechanism of injury and are particularly prominent in early childhood.³

During adolescence, sports-related concussion is the primary source of injury, and consequently there is often a significant increase in the velocity of the impact forces involved.⁴

Recreational activities outside of organised sport also contribute significantly to concussive injuries and may in some cases (such as mountain biking [see figure 1] or horse riding) be among the more severe mechanisms of injury. Greater involvement in higher-risk activities, combined with anatomical, physiological and neurobiological factors, may explain why recovery from concussion can be more prolonged in children and adolescents than in adults, with 10-30% of cases taking many weeks or months to resolve.⁵

Early detection of injury, proper evaluation and appropriate guidelines for return-to-learn and return-to-play are key factors that may influence trajectory of recovery. However, many parents are unclear on how to recognise concussion and manage a child with the condition. In addition, the mechanism of injury may go unwitnessed, particularly outside of organised sport, or delayed symptom onset may lead to the misattribution of symptoms, prolonging the time to initial presentation. The burden of managing typical concussions generally falls on GPs, who are challenged by insufficient time and resources to systematically diagnose and manage these patients, and who may, in some cases, not be familiar with current best practice.⁶

This How to Treat discusses the assessment and management of typical concussion injuries in children and adolescents, and aims to ensure GPs

can provide appropriate return-to-play and return-to-school guidance.

DEFINITIONS AND PRESENTATION

CONCUSSION is a mild traumatic brain injury that occurs as a result of linear or rotational contact forces directly to the head or the body, with transmission of acceleration-deceleration forces to the brain (see figure 2).⁷ Rapid head deceleration induces neuronal shearing with subsequent microstructural axonal damage that is often more pronounced when there is a rotational movement involved.⁷ As a result of the mechanical forces transmitted to the brain, a complex cascade of neurometabolic and neuroinflammatory events promote the release of excitatory neurotransmitters, dysregulate cerebral blood flow, and create an energy crisis due to both an increased demand and decreased production of ATP.⁸

Consequently, a combination of physical, cognitive, emotional and sleep-related symptoms may be immediately apparent or may arise in the subsequent minutes or hours (see table 1).

Symptoms experienced by patients with concussion may vary widely and change over time, making it difficult to accurately predict the severity of total symptom load for a patient at the time of injury.

Among the most common early symptoms of a concussion are headache, dizziness, imbalance, disorientation/confusion and nausea/vomiting. Amnesia of the traumatic event may occur, and this is sometimes accompanied by further memory loss of events either side of the injury.

Loss of consciousness, often viewed as a quintessential element of a concussion, reportedly occurs in only 8-10% of all concussions, but may be missed if the injury goes unwitnessed.⁹ Loss of consciousness and impact seizure are not necessarily indicative of a more serious injury or longer recovery period but may be grounds for further monitoring and/or imaging.¹⁰

For acute on-field assessment and removal from play, concussion is a yes or no diagnosis. If a concussion is suspected, the player should be removed and not allowed to return on the same day. Adherence to this basic principle remains a common concern, particularly at the grass-roots level, and is a primary risk factor of prolonged morbidity from concussion.

Box 1 lists the criteria used to diagnose a concussion.

Some parents assume that if their child has a head impact, even if minor, that this must be a concussion. Because of the non-specific nature of common symptoms of concussion, many young people may unnecessarily follow a concussion protocol only to find there is another explanation of symptoms (for example, hyperthermia or a premonitory history of migraine).

The mechanism of injury matters, and the impact characteristics of injury will determine if a concussion has occurred. Children and adolescents, for the most part, play a different game from their adult counterparts.

In addition to factors such as reaction time, postural stability, proprioception and decision-making ability, which may impact the vulnerability of young people to concussive insults, the paediatric brain is also at greater risk because of a number of mechanical and compositional properties (for example, increased water content, decreased myelin and increased transition of forces due to decreased neck strength).^{9,11} These properties also result in increased vulnerability of the immature brain to secondary insults (for example, second-impact syndrome), which can detrimentally affect outcomes.¹² Therefore, under no circumstances should same-day return to sport be considered when concussion is suspected.

Also note that the female adolescent has a delay in the normalisation of cerebral blood flow, together with more slender and vulnerable axons, making them more likely to present with a greater severity and range of symptoms, as well as being more susceptible to a prolonged



Figure 1. A broken helmet following a mountain bike riding injury. While helmets may not prevent concussion, they can protect against skull fractures and more severe injuries.

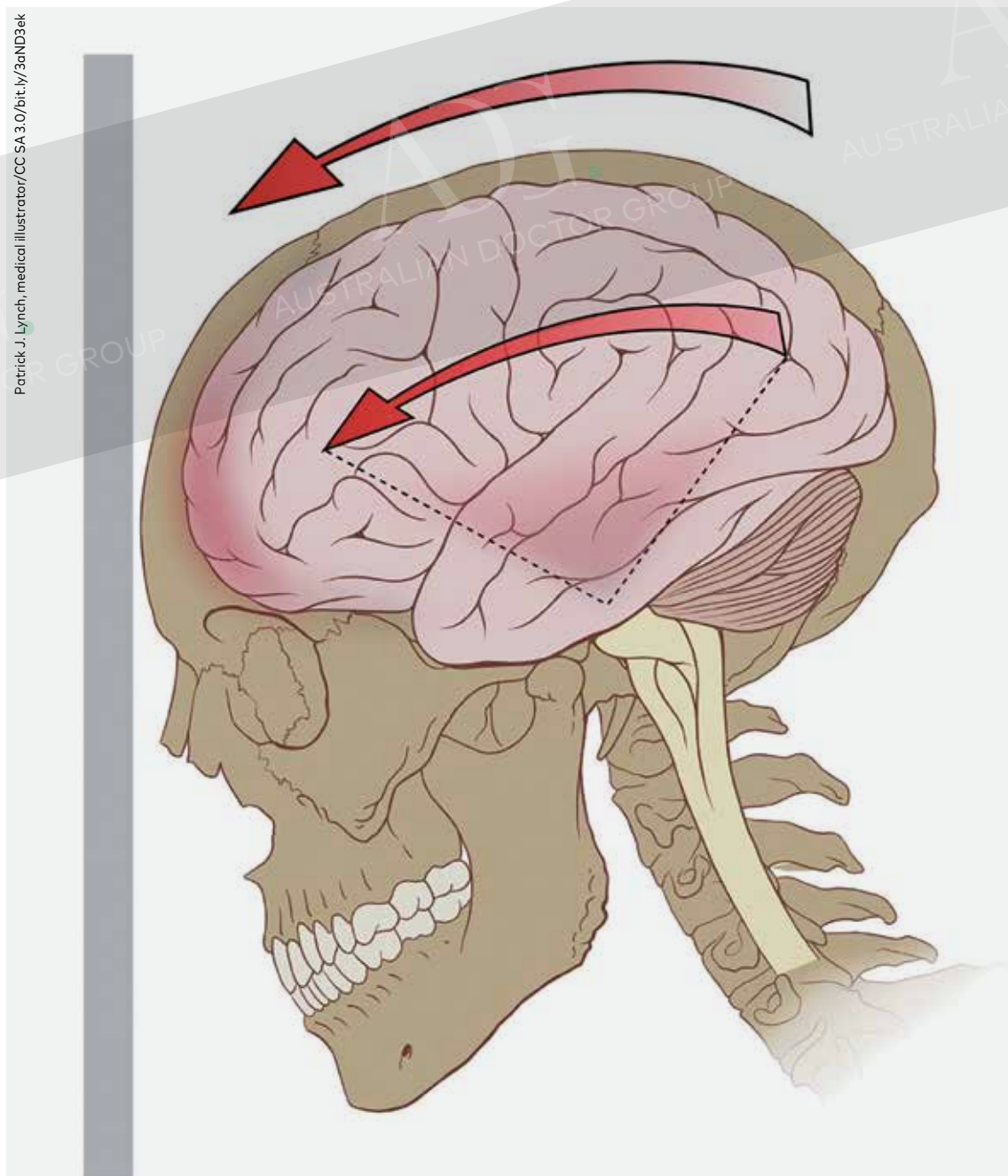


Figure 2. Mechanism of injury in concussion.

recovery.^{9,13} It has been theorised that weaker neck musculature, hormones and/or being more likely to report symptoms more frequently than males may further account for this disparity.¹⁴

ASSESSMENT

Initial assessment

AN important first step following a head impact is to exclude the presence of other significant structural trauma (see box 2).

Once the items in box 2 have been ruled out, a sideline concussion examination can be undertaken with only one symptom or other abnormality required as grounds for complete and immediate removal from gameplay.

Table 1. Concussion symptom domains

Physical	<ul style="list-style-type: none"> • Headache • Nausea/vomiting • Sensitivity to light/noise • Visual problems • Fatigue • Dazed or stunned • Dizzy, balance problems
Cognitive	<ul style="list-style-type: none"> • Feeling mentally 'foggy' • Feeling slowed down • Answer questions slowly • Difficulty concentrating • Forgetful of event • Repeats questions • Drop in academic performance
Emotional	<ul style="list-style-type: none"> • Irritability • Sadness/depression • Personality change • Anxiety/panic • More emotional • Less emotional/apathetic
Sleep	<ul style="list-style-type: none"> • Drowsy • Sleeping more • Sleeping less • Difficulty falling/staying asleep

Box 1. Criteria used to diagnose a concussion

The three criteria used to diagnose a concussion are:

- A viable mechanism of injury.
- Typical signs and symptoms that follow in a sequential and predictable pattern.
- No other plausible reason for the symptoms.

Source: McCrory P et al 2017¹⁵

Box 2. Initial assessment

- Exclude the presence of other significant structural trauma:
 - Intracranial haemorrhage.
 - Extradural haematoma (see figure 3).
 - Cervical spine injury.
 - Other acute intracranial injury.
 - Skull fracture (see figure 4).
- Immobilise anyone displaying signs of more severe or life-threatening injury using appropriate cervical spinal precautions and transfer them to the nearest ED.
- Signs and symptoms which may point to a more serious injury include:
 - Prolonged loss of consciousness.
 - Persistent or worsening headache.
 - Repeated vomiting.
 - Seizures.
 - Loss of co-ordination.
 - Weakness or numbness in fingers or toes.

Source: Browne GJ et al 2016⁹

The Child Sport Concussion Assessment Tool 5 (Child-SCAT5, ages 5-12) and Sport Concussion Assessment Tool 5 (SCAT-5, ages 13 and older) are validated assessment tools for sideline use by a clinician.^{16,17} These measure

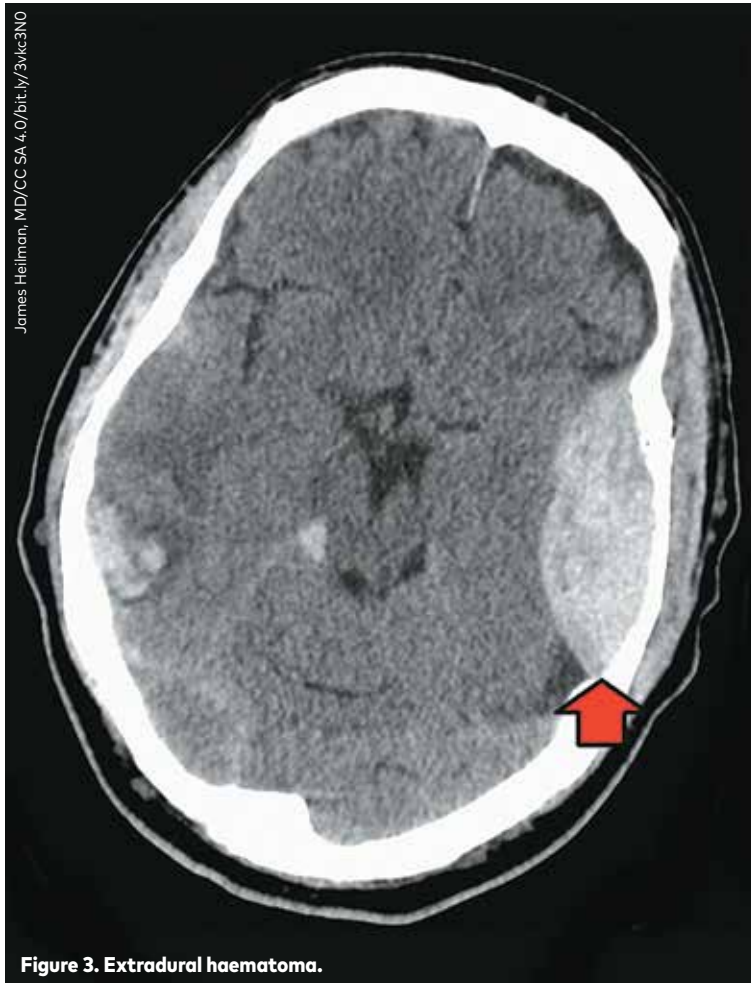


Figure 3. Extradural haematoma.

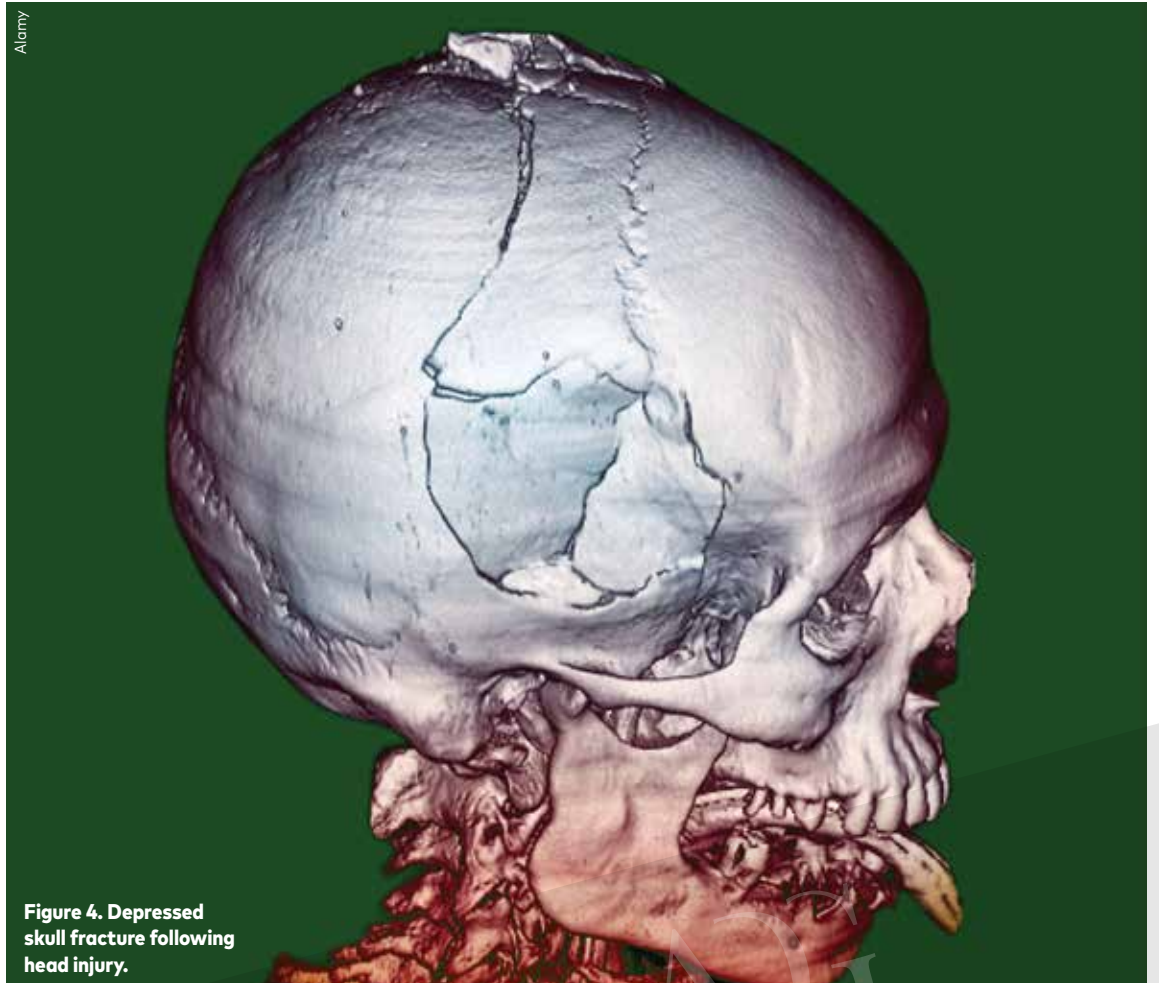


Figure 4. Depressed skull fracture following head injury.

Box 3. Signs and symptoms indicating further attention is warranted (HEAD BUMPS)

- Headache.
- Eye trouble (blurred/double vision).
- Abnormal behaviour.
- Dizziness.
- Balance dysfunction.
- Unsteady on feet.
- Memory impaired.
- Poor concentration.
- Something's not quite right.

Source: Browne GJ et al 2016⁹

both symptom burden and the athlete's balance and cognitive function.

It is also important to highlight that delayed onset of symptoms or signs of deterioration, either on the same day or in the days following impact, should be closely monitored and may indicate a need for urgent medical attention. The development of any of the features of HEAD BUMPS (see box 3) warrants further medical assistance.

Re-evaluation in primary care

Assessment on initial presentation to the GP includes a careful history of the events surrounding the injury. Determine the patient's current symptom severity, and during the minutes, hours and days following the event. It is important to not only establish the details of the causal event, but to also develop an understanding of pre-morbid risk factors that may influence recovery and treatment.

Obtain a thorough medical history to assess baseline neurological and neuropsychological functioning (for example, previous concussions or prior diagnosis of ADHD, ASD or epilepsy). History may also elucidate the presence of a separate underlying driver of symptoms (for example, vestibular migraine or mood disorder) that may require distinct treatment.

Also ask about the patient's return to academia and their physical activity status, current medications,



Figure 5. Saccades are rapid eye movements between fixation points.

sleep-related issues and other events that may be contributing to additional stress or anxiety.

In some circumstances, the primary care provider may consider a more comprehensive physical examination.¹⁸ This includes neurological screening (abnormal pupillary responses, extraocular movements and motor or sensory function), which may raise concern of a more serious traumatic brain injury requiring immediate referral to ED. This article will focus only on those high-yield elements that can be quickly and accurately performed in the primary care office setting. Vestibular/Ocular Motor Screening (VOMS [see figure 5]) has

been shown to be sensitive enough to diagnose concussion and when combined with the Modified Balance Error Scoring System (mBESS [see figure 6]), can predict prolonged recovery.¹⁹⁻²¹

In a typical concussion, a process of transient functional change is followed by dynamic restoration of brain physiology.

Note that because of the potential risk of orthostatic instability (for example, postural hypotension and postural orthostatic tachycardia syndrome), measure resting seated/

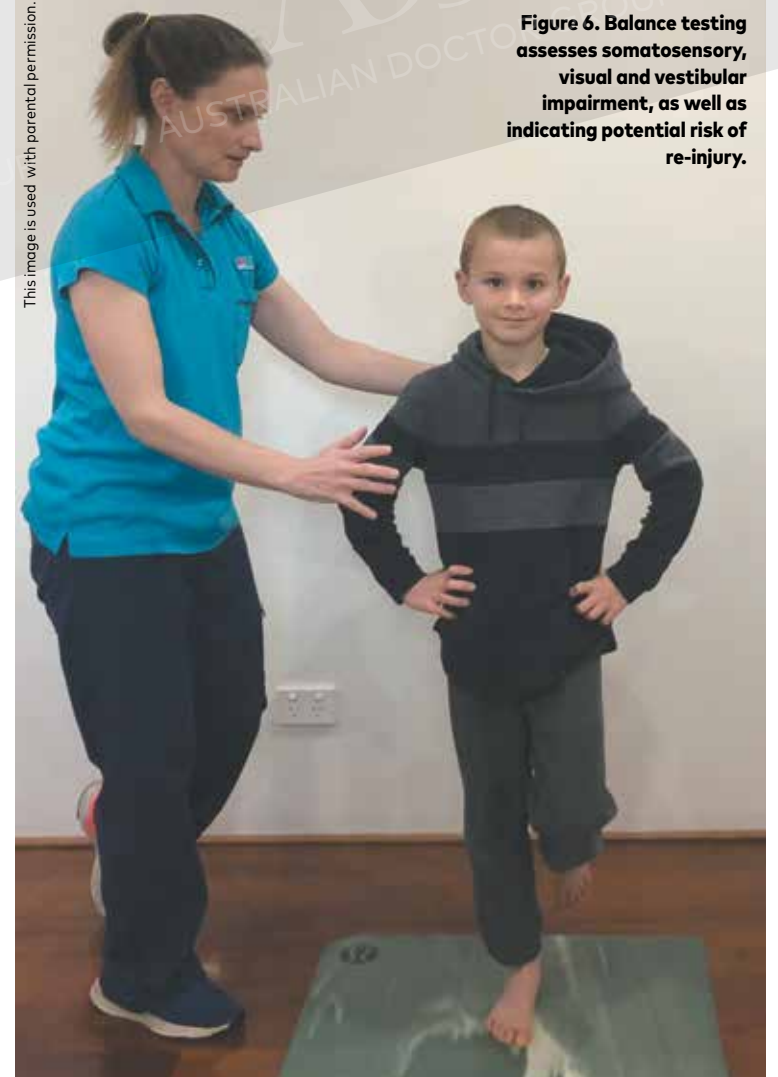


Figure 6. Balance testing assesses somatosensory, visual and vestibular impairment, as well as indicating potential risk of re-injury.

supine and standing blood pressure and heart rate.²²

A positive result may require specialist input and alter treatment plan and expectations.

In some cases, the GP may not have any baseline examination data for comparison; it is therefore important to recognise the wide variation in developmental skills among young

people and what this means for the clinical interpretation of data.

While in many cases, full neurocognitive testing is not practical in the primary care setting, an abbreviated form using the SCAT5 framework is less time-consuming in providing this valuable clinical information. If significant disruption of neurocognitive processes is suspected, then more formal analysis may be advised through a platform such as the Immediate Post-concussion Assessment and Cognitive Test (ImPACT).²³

Table 2 lists the assessments suitable for use in general practice.

Box 4 lists the contexts within which to frame the assessment of

Box 4. Context within which to frame assessment of children and adolescents⁹

- Neuronal development.
- Physical, cognitive, behavioural and emotional maturation.
- The influences of home, school and community supports.
- Demands placed on the child or adolescent.

Source: Browne GJ et al 2016⁹

◀ children and adolescents. Physicians can query the patient's pre-injury status and may also repeat the assessments at a later point or points to mitigate the misinterpretation of results and hastily drawing conclusions.

MANAGEMENT

RECOVERY from a typical concussion, in many cases, occurs in a predictable fashion; symptom burden reduces over time, with recovery achieved in most cases within the first few weeks following injury (see figure 7). This can be used to the clinician's advantage in prescribing a recovery program.

The overall role of the clinician is to facilitate the rapid and complete recovery of the child following injury. In the first week following a typical concussion, self-pacing of physical and cognitive activity within the patient's window of symptom tolerance is appropriate, provided daily symptoms are monitored and regularly reviewed.²⁴ In the case of more persistent symptoms and prolonged recovery, the clinician's role is to identify symptom drivers (vestibular, cognitive, psychological, cervicogenic) to allow for targeted treatment.

In a typical concussion, a process of transient functional change is followed by dynamic restoration of brain physiology. Young people generally take more time to recover from injury than adults, typically taking from two to four weeks. When considering recovery, be aware that clinical recovery, which is based on symptom resolution, may not equate to recovery at a brain level (normal cerebral functioning). Neurophysiological recovery often outlasts clinical recovery, with continued dynamic brain restoration occurring. Provocative clinical testing is an effective way of evaluating the brain's physiologic stress capacity. Tolerance to provocative testing indicates that the brain is recovering and is robust enough to start graded activity. An example of such a test is the Kasch pulse recovery three-minute step test (see table 3).²⁵ Satisfactory recovery requires both clinical and physiological resolution of injury.

Anticipatory guidance remains the mainstay of management. Reassurance, education about their injury and brief psychological counselling in the early phase can reduce the risk for the later development of post-concussion syndrome. There is now strong evidence to support an earlier return to activity (if it is performed at an appropriate level) and moving away from long periods of rest.²⁶ A prescriptive recovery plan, such as the Concussion Action Plan (CAP), can simplify this process, giving clear direction on how to progress (see figure 8). A sound approach to returning to physical and cognitive

Table 2. Assessments suitable for use in general practice

To determine	Assessment	Detail
Current symptom burden	Post-Concussion Symptom Scale	This lists 22 physical, cognitive, emotional and sleep-related symptoms, each scored from 0 to 6 with a maximum possible score of 132 (this scale is included in the SCAT5)
Post-traumatic amnesia (PTA)	Abbreviated Westmead Post-Traumatic Amnesia Score (A-WPTAS)	PTA will generally have resolved by this stage, and although the patient will be unable to distinguish loss of consciousness from PTA (there will just be a memory gap), they will often have been told about the immediate aftermath of the injury by onlookers A-WPTAS is routinely used in EDs to determine PTA and injury severity The presence of prolonged PTA helps determine the severity of injury and potential need for specialist follow-up care
Vestibular/ocular functioning	Vestibular/Ocular Motor Screening (VOMS)	VOMS examines the patient's smooth pursuits, saccades or rapid eye movements, vestibular/ocular reflex, visual motion sensitivity and near point-of-convergence This is a rapid test designed to provoke symptoms (measured as changes from baseline symptom score on a 10-point visual analogue scale) and elicit irregular/uncontrolled eye movements (impaired visual tracking, convergence insufficiency or nystagmus) in patients with vestibular dysfunction
Static and dynamic postural stability	Modified Balance Error Scoring System (mBESS)	MBESS combined with tandem gait is a useful method of quickly assessing a patient's balance through three static poses (double leg, tandem and single leg) performed for 10 seconds each with eyes closed, and a 3m tandem walk performed both forwards and backwards, with eyes open and then closed Record errors such as opening eyes, removing hands from hips, and uncontrolled or excessive sway

Box 5. Possible signs of atypical concussive injury

- High symptom burden (PCSS score of 35 or more).
- Repeated injury or recurrent sub-concussive impacts.
- Hospital admission.
- History of prior concussions.
- Mental health comorbidities.
- Predisposition: genetics, psychological, anatomical, learning difficulties, ADHD, migraine.
- Post-concussion syndrome.
- Failure of progress using the CAP.

the patient and family to a concussion service.

Exercise is an effective tool to promote recovery from injury-related brain dysfunction, improve balance and co-ordination, and reverse the effects of deconditioning.²⁷ It is equally important to gradually reintroduce cognitive activity so that the brain can readapt to the individual's day-to-day cognitive demands. The CAP describes in detail the gradual return to activity, both physical and cognitive, which children should follow at home with their parents and carers. The CAP and further information to support the gradual return to physical and cognitive activity are available on the Sydney Children's Hospitals Network's Kids Health website (kidshealth.schn.health.nsw.gov.au).

As the patient is progressing through the CAP, it may become evident that specific instructions and/or education may be required regarding concerning or dominant symptoms (for example, headache or dizziness). In such cases, it may be useful if the GP provides a home-based aftercare instruction plan. A range of home-based aftercare instruction and education plans are available for patients and families and are readily accessible for primary care providers online.

Around 10-30% of patients will have symptoms that do not resolve with appropriate intervention.⁵ In these cases, symptoms are often the overall factor driving the injury, and under these circumstances, may be slowing or inhibiting patient recovery. These specific concussion deficits typically need ongoing specialist assessment, tailored interventions, and specific non-pharmacologic and pharmacologic treatments, which may be highly resource intensive. Management of these patients is challenging, and they are best referred to a specialist clinic that can provide a multidisciplinary and interdisciplinary approach (for example, the Kids Concussion Service at the Children's Hospital at Westmead, Sydney).

Box 5 lists the possible signs of an atypical concussive injury.

LONG-TERM RISK

CONCUSSIONS account for 5-13% of all reported sport-related injuries, and this number may be even higher because of under-reporting.³⁰ It is generally accepted that once an athlete has achieved full physiological recovery from their first concussion, they are not at increased risk of sustaining an additional concussive injury or suffering a worse outcome as a result of their previous concussion.³¹⁻³³ While there

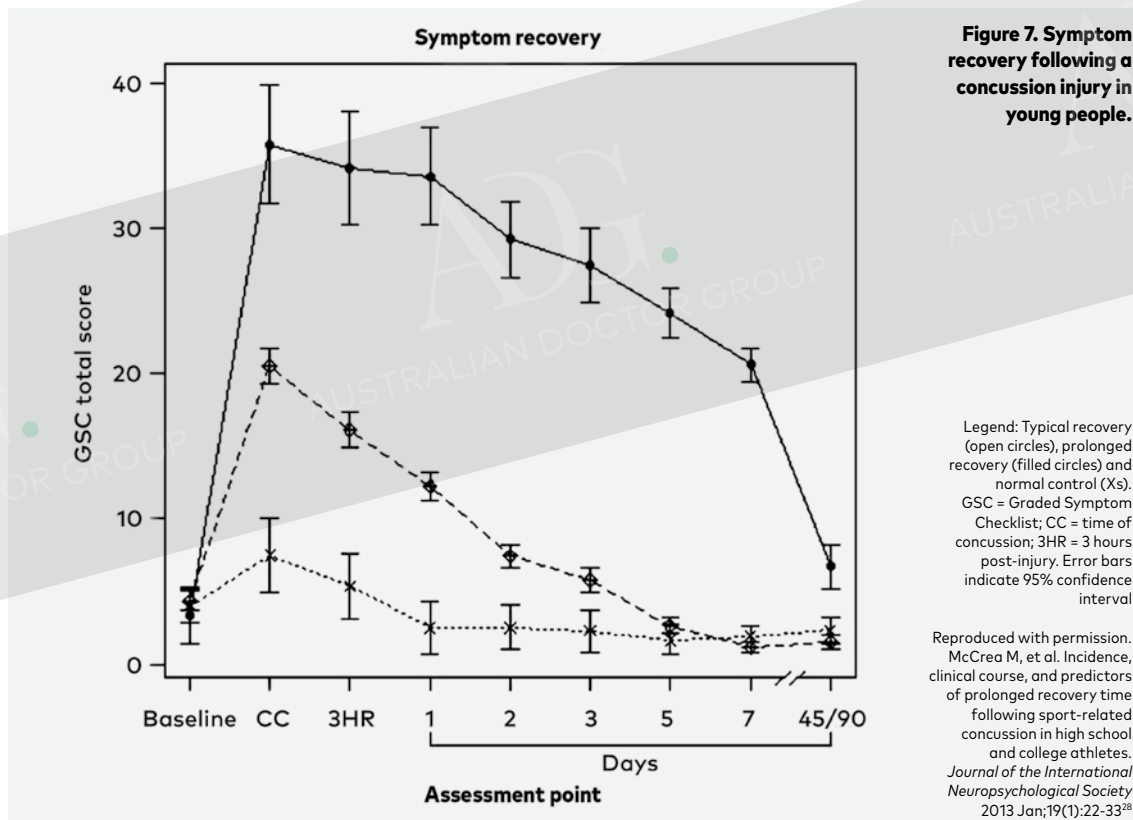


Figure 7. Symptom recovery following a concussion injury in young people.

Legend: Typical recovery (open circles), prolonged recovery (filled circles) and normal control (Xs). GSC = Graded Symptom Checklist; CC = time of concussion; 3HR = 3 hours post-injury. Error bars indicate 95% confidence interval

Reproduced with permission. McCreary M, et al. Incidence, clinical course, and predictors of prolonged recovery time following sport-related concussion in high school and college athletes. *Journal of the International Neuropsychological Society* 2013 Jan;19(1):22-33²⁸

Table 3. Exertional testing in the clinic

Test	Method	Interpretation
Kasch pulse recovery step test	<ul style="list-style-type: none"> • You will require a step (approximately 30cm high) a stopwatch, and a metronome (metronomeonline.com). A heart rate monitor is optional • Record the patient's baseline physical symptoms (see table 1) using a 10-point visual analogue scale • Set the metronome to 96bpm and instruct the patient to step up onto the step (right foot then left), and then step back down (right foot then left). Each step should synchronise with one click of the metronome. • At 1.5 minutes, ask the patient to swap and lead with the left foot for both the up and down phases • After three minutes, ask the patient to stop and sit down, record their symptom score, rating of perceived exertion, and heart rate 	<p>Stop the test if the patient asks to stop or displays significant balance or co-ordination impairment</p> <p>This indicates that they are not yet ready to start graded activity and should continue in the 'relative rest' zone</p> <p>If the patient completes the test but it provokes symptoms, they can engage in progressive activity within their level of symptom tolerance and the test should be repeated in the next few days</p> <p>Completion of the test with no symptom provocation indicates that the patient can likely progress rapidly through the Concussion Action Plan, but should not engage in contact activity until medically cleared</p>

Step testing requires minimal equipment and can provide guidance on readiness to return to physical activity.²⁹

activity within an acceptable time frame is the challenge-recovery model using the CAP. This model, starting with 'relative rest', allows the patient to progress through pre-determined activity zones. Each activity

zone provides the patient with progressive challenges involving controlled activity to improve symptom tolerance. Once the patient is recovering well and tolerant of the pre-scribed activities, in terms of little to

no symptom exacerbation, they are ready to progress to the next zone. The clinician carefully monitors the patient and facilitates their progress and that of their family through these steps. If this is not possible, then refer

«PAGE 18 are reports suggesting that high-school-aged athletes may experience more cognitive problems if they have previous history of concussion compared with those with no prior concussion history, other studies report no significant cognitive differences when controlling for education level.^{33,34} It is hypothesised, however, that at a certain point the effect of repetitive concussion or sub-concussive impacts may accumulate, leading to a ‘dose-response’ effect; however, further investigation into this area is required, particularly in children and adolescents.³⁵ Emerging evidence points to repetitive concussions as a contributing factor for neurodegenerative conditions such as chronic traumatic encephalopathy, post-traumatic stress disorder, substance abuse, anxiety and depression.³⁶ In primary care, the best prevention for concussion is following the principles of good concussion care.

THE FUTURE

CONCUSSION research has grown in leaps and bounds because of growing concern for athletes and the long-term repercussions of repeated head impacts. It is important to ensure that clinical care keeps up with emerging research to optimise the management of individuals who have sustained a concussion. This means removing and superseding outdated models of care such as strict rest until reaching asymptomatic status.

There are multiple avenues being explored that hope to revolutionise the way concussion is diagnosed and managed in both clinical and non-clinical settings.

The Kids Concussion Service has developed, and is currently beta-testing, a mobile phone application called Neurocover which will integrate multimodal assessment with the CAP. This will provide first responders with reliable and up-to-date information, and then translate management practice into the hands of the injured individual.

The ‘holy grail’ of research into diagnosis is a clear and reliable biomarker which can rapidly provide a yes or no answer as to whether a concussion has been sustained. Such a breakthrough would eliminate the over-reliance of subjective symptom reporting and provide greater clarity regarding expected recovery trajectory and physiological brain recovery.

Tools that target one or more of the affected clinical domains are being explored but are not yet at the stage of being able to address all potential areas of dysfunction with one ‘magic formula’.

Ultimately, no matter the novel research solutions, their benefit is limited by people’s awareness of the signs to look for and steps to take. This highlights the important, and often neglected, aspect of education.

CASE STUDIES

Case study one

CALLUM, a 13-year-old basketballer, is jumping for a rebound when his feet are swept from under him and he hits the ground, landing directly onto the side of his head. He tries to stand up, but immediately stumbles and sits back down. He is helped off the court and looks around in confusion.

The next day Callum vomits and is taken to his local ED where he reports having a headache, photophobia and

The Children’s Hospital at Westmead - Institute of Sports Medicine

For parents

Have your child complete the following zone and stepwise program. Seek urgent medical attention if your child’s symptoms worsen or if other symptoms appear (see the HEAD BUMPS symptoms list overleaf).

(Date started: _____)

REST PERIOD: Days 1 and 2 following injury:

Rest your child from any physical or cognitive activity.

Supportive care

- Encourage good sleep patterns. Rest your child with no TV, phone or disruptions.
- Provide regular meals and a minimum of 2L of water per day.
- Use over the counter headache medication as needed.
- Complete the Symptoms Log Sheet, monitoring your child’s symptoms and signs. Continue using the sheet until your child reaches 14 days without symptoms.
- Encourage your child to have a positive mental attitude towards their recovery.

Move on to the next zone when your child is symptom free.

Use the Symptoms Log Sheet to record any symptoms that your child develops. If your child develops symptoms during an activity, stop the activity and let your child rest. When the symptoms are gone, have your child try the activity again.

(Date started: _____)

RELATIVE REST PERIOD: Days 3, 4 and 5 following injury:

Recommendations for days 3, 4 and 5 following injury:

- Start low level physical and cognitive activity. Your child can now move around more freely.

Activities may include:

5-10 minutes walking balance exercises like single leg stands and heel-toe walking cognitive tasks like crosswords or reading

Supportive care

- Try to reduce and/or stop headache medication once your child is more physically/mentally active.
- Should sleep pattern remain a problem, then further assessment and possible treatment with Melatonin may be considered. This will require medical supervision and is best discussed with your local GP.

See your GP to check that your child may progress to the next zone. Your child must be symptom free before moving on to Step 1.

Use the Symptoms Log Sheet to record any symptoms that your child develops. If your child develops symptoms during an activity, stop the activity and let your child rest. When the symptoms are gone, have your child try the activity again.

(Date started: _____)

GRADED RETURN TO ACTIVITY

Step 1 – Light cognitive and physical activity

- Progress toward 30 minutes of cognitive exertion.
- Your child can perform 10-15 minutes of light aerobic activity.

Progress to the next step if your child is symptom free for 24 hours.

Step 2 – Moderate cognitive and physical activity

- Part time school with accommodations (rest breaks, minimal homework, no exams) until able to handle 60 minutes or more of cognitive exertion.
- Specific skills and moderate aerobic activity for 20-30 minutes.

Progress to the next step if your child is symptom free for 24 hours.

Step 3 – Extended activity

- Progress towards full time school with minimal accommodations.
- More intense aerobic and skill-based activity on a more regular basis.

Progress to the next step if your child is symptom free for 24 hours.

Use the Symptoms Log Sheet to record any symptoms that your child develops. If your child develops symptoms during an activity, stop the activity and let your child rest. When the symptoms are gone, have your child try the activity again.

(Date started: _____)

RETURNING TO PRE-INJURY ACTIVITY

Once your child is performing regular cognitive and physical activity without symptoms, they are ready to progress as follows:

Step 4 – Pre-injury activity (without contact)

- Full time school with minimal accommodations progressing when able to handle all classroom activities.
- Attend sport practice, however with no contact or collision activities.

Step 5 – Reconditioning (without contact)

- Full school.
- Progressively return to non-contact sports over the next few weeks (e.g. 10 minutes → half game → full game).
- Prepare for return to play with extra aerobic and (if relevant) resistance training. Your child must have 14 days symptom free before returning to contact sport.

Your child must be symptom free for 14 days before moving on to Step 6. If clearance is needed for your child’s school or sporting club, see your GP to obtain the sign off below.

Doctor’s name: _____ Signature: _____ Date: _____

Step 6 – Full activity (with contact)

- Once your child has been symptom free for 14 days, return to all activities without restriction, including contact and collision sports.

Figure 8. Concussion Action Plan.

neck pain. A CT of his head and spine are performed, and both are reported as normal. Callum is told to rest and not return to school or exercise for two weeks. A referral to a specialist concussion clinic is provided and he is sent home.

Callum is reviewed at a tertiary concussion service at 17 days post-injury and records a Post-Concussion Symptom Scale (PCSS) score of 25 out of 132. His major symptoms are headache, difficulty concentrating, neck pain and fatigue. He has not returned to school or any form of physical activity since his injury; he stays home and regularly naps throughout the day.

Neurocognitive testing identifies

a reduction in visual memory, processing speed and reaction time. Vestibular/ocular and balance testing are both abnormal, with unstable single leg stance and tandem gait, and dizziness provoked by saccades and vestibulo-ocular reflex testing. Callum reaches 7.5 minutes on graded exercise testing before dizziness becomes intolerable and he asks to stop. Once he has sat down, the dizziness rapidly dissipates.

Callum is provided with a CAP, starting on the orange zone with advice to progress to the yellow zone in 2-3 days. A letter is provided to Callum’s school advising that he should return slowly (starting at three half-days), may not engage in any exams

or receive any homework, and that he be permitted to rest throughout the day if his symptoms become severe. Callum’s current school sport is soccer, which carries the potential risk of collision; therefore, he is advised not to engage in matches, heading the ball, or tackling, but he may participate in other training drills within his level of symptom tolerance. Callum is given balance and vestibular rehabilitation exercises and some neck exercises based on the Kids Health ‘Balance’ and ‘Neck Strength’ after-care programs. Callum is told that he can engage in regular activities of daily living, including light aerobic activity and some basketball skills training (shooting hoops, dribbling),

following the CAP.

Callum is seen again two weeks after his initial consult at the concussion clinic. He records a PCSS score of 15, with minor headache and fatigue. He is now attending three full and two half-days of school and his neurocognitive, balance and vestibular/ocular testing have all almost normalised. His graded exercise test time is 10.5 minutes. Callum is cleared to return to full school and basketball training and will be seen in another two weeks to review for full return to competition.

Case study two

Jasmine, a 15-year-old soccer player, presents to the GP with a

◀PAGE 20 three-month history of constant fatigue and daily headaches. She feels dizzy on standing up and has not been to school or participated in any physical activity for weeks, with significant impact on her mental wellbeing.

Three months earlier she was knocked to the ground after an opposing player's shoulder hit her in the jaw. She got up and continued to play, seeing out the rest of the half. At half-time she reported blurred vision and a worsening headache, and her parents took her to ED. In ED she reported having no memory of the collision or of continuing to play afterwards and was diagnosed with concussion.

The ED staff provided Jasmine with guidelines for gradual return to school and sport, but she ignored these and re-engaged with full school and soccer immediately. During a game two weeks later, she felt dazed while jumping up to head the ball but finished the game.

The GP diagnoses Jasmine with post-concussion syndrome, and upon review, recognises signs that Jasmine may require specialist intervention, including a high PCSS score (88/132) and previous diagnosis of depression, for which she was formerly seeing a psychologist. The GP refers Jasmine to a tertiary concussion service for management.

At the concussion clinic, Jasmine scores 96 on the PCSS, selecting all 22 symptoms on the scale. Jasmine reports she has been feeling much more emotional and irritable lately, and that she is anxious about missing out on schoolwork. Based on this and Jasmine's affect during the consultation, the clinician suspects a severe mood disorder. Blood pressure and



Figure 9. Step testing.

heart rate are measured while Jasmine is seated and standing; blood pressure is stable, but her heart rate increases by 42 beats per minute. Balance, vestibular/ocular and neurocognitive testing are normal. Jasmine reports having a headache and feeling drowsy after her neurocognitive test. She performs a graded exercise test on a treadmill, reaching four minutes before asking to stop because of

dizziness.

Jasmine is diagnosed with post-concussion syndrome and suspected postural orthostatic tachycardia syndrome (POTS), confounded by mental health issues.

Jasmine is referred to a psychologist to help deal with her depression and anxiety, and provided with a recumbent exercise program, including floor-based exercises, that she can

perform from home on alternate days. The regimen is floor based because of the suspected POTS.

Jasmine is given a letter for school asking that she be provided with schoolwork that can be completed at home for 1-2 weeks, with a plan to progress to one period at school a week.

She is seen again at the concussion clinic three weeks later. While she is

still fatigued, Jasmine is now able to tolerate her headaches and engage in two half-days of school a week. She only gets dizziness on standing when it is very hot or when she has been sitting for extended periods. Jasmine has found that getting into more of a routine is helpful, and she is coping better with her symptoms. Her PCSS score has reduced to 32 and she reaches eight minutes on the treadmill.

CONCLUSION

CONCUSSION continues to concern many parents, whose children nonchalantly take to the sporting field every week, putting their heads and bodies on the line. As our understanding of concussive injury continues to evolve, it is important that we update clinical procedures to ensure we follow best practice.

Good GP care of a patient with concussion is the best prevention of adverse outcomes. The ability of the GP to appropriately determine when to treat and when to refer is an important agent for change in this field.

FURTHER READING

- McCrory P, Meeuwisse W, Dvorak J, et al. Consensus statement on concussion in sport – the 5th international conference on concussion in sport held in Berlin, October 2016. *Br J Sports Med* 2017 Jun;51(11):838-47. bit.ly/3ta7nrH
- Raj SR, Guzman JC, Harvey P, Richer L, et al. Canadian cardiovascular society position statement on postural orthostatic tachycardia syndrome (POTS) and related disorders of chronic orthostatic intolerance. *Can J Cardiol* 2020 Mar;36(3):357-72. bit.ly/3t5l36p

RESOURCES

- The Children's Hospital at Westmead Concussion Action Plan and after care instructions bit.ly/2VBEpo4
- Child Sport Concussion Assessment Tool – 5th edition (Child SCAT5) bit.ly/3yyqtKj
- Sport Concussion Assessment Tool – 5th edition (SCAT5) bit.ly/3xyubIR
- Vestibular/Oculomotor Motor Screening (VOMS) bit.ly/3CxPUOf
- Post-Concussion Symptom Scale (PCSS) bit.ly/3DEXTtz
- Abbreviated Westmead Post-Traumatic Amnesia Score (A-WPTAS) bit.ly/3jKu6HN
- Modified Balance Error Scoring System (mBESS) bit.ly/3jKKVCp
- Immediate Post-Concussion Assessment and Cognitive Test (ImPACT) bit.ly/38Gsd8H

Conflict statement

The Kids Concussion Service is sponsored by Bio Island.

The parents of the children shown in this How to Treat have provided permission for the use of their photographs.

References

Available on request from howtotreat@adg.com.au

How to Treat Quiz.

SPORTS CONCUSSION IN CHILDREN AND ADOLESCENTS

GO ONLINE TO COMPLETE THE QUIZ ausdoc.com.au/howtotreat

- Which THREE statements regarding concussion are correct?
 - Concussion is characterised by a combination of physical, emotional, cognitive and sleep-related symptoms.
 - Sporting injuries are overall the most common mechanism of injury.
 - Recovery from concussion can be more prolonged in children and adolescents.
 - Early detection, proper evaluation and appropriate guidelines for return-to-activity may influence the trajectory of recovery.
- Which ONE symptom domain is NOT usually affected by a concussion?
 - Physical.
 - Cognitive.
 - Social.
 - Sleep-related.
- Which THREE criteria are used to diagnose a concussion?
 - A viable mechanism of injury.
 - Typical signs and symptoms that follow in a sequential and predictable pattern.
 - Loss of consciousness.
 - No other plausible reason for the symptoms.

- Which TWO statements regarding the presentation of concussion are correct?
 - Loss of consciousness and impact seizure are indicative of a more serious injury.
 - Amnesia of the traumatic event may occur.
 - Male adolescents are more susceptible to a prolonged recovery.
 - If a concussion is suspected, the player should be removed and not allowed to return on the same day.
- Which THREE form part of the initial management after a head impact?
 - Immediate transfer to ED for all head impacts.
 - Exclude the presence of other significant structural trauma.
 - A sideline concussion examination to determine whether the player must leave the field.
 - Monitoring for the development of symptoms that

- Which THREE are part of the HEAD BUMPS signs and symptoms indicating further attention is warranted?
 - Headache.
 - Dizziness.
 - Poor concentration.
 - Mood changes.
- Which TWO concussion assessments are suitable for initial use in general practice?
 - Buffalo Concussion Treadmill Test.
 - Post-Concussion Symptom Scale.
 - Vestibular/Ocular Motor Screening.
 - Immediate Post-concussion Assessment and Cognitive Test.
- Which THREE statements regarding the management of concussion are correct?
 - In most cases, recovery from a

require urgent medical attention.

typical concussion occurs in a predictable fashion.

- Advise review and self-pacing within symptom tolerance in the first week after concussion.
 - A prescriptive recovery plan offers simple and clear direction on how to progress treatment.
 - Long periods of rest initially improve long-term outcomes.
- Which TWO are possible signs of atypical concussive injury?
 - A-WPTAS score of 18/18.
 - Delayed onset of symptoms.
 - Hospital admission.
 - Repeated injury or recurrent sub-concussive impacts.
 - Which THREE statements regarding the long-term risk after concussion are correct?
 - Sport-related concussions may be under-reported.
 - Athletes who have recovered from a concussion are at higher risk of sustaining another.
 - It is hypothesised that at a certain point the effects of repetitive concussion may accumulate, leading to a 'dose-response' effect.
 - Repetitive concussions may be a contributing factor for neurodegenerative conditions.



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- Each article has been allocated 2 RACGP CPD points and 1 ACRRM point.
- RACGP points are uploaded every six weeks and ACRRM points quarterly.