Australian and Aotearoa New Zealand Clinical Practice Guideline for the assessment and management of mild traumatic brain injury/concussion and persisting post-concussion symptoms in adults and children

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Summary

Mild traumatic brain injury affects 210,000 people in Australia and Aotearoa New Zealand, and 50-60 million people worldwide every year.[1] Concussions are a form of mild traumatic brain injury (mTBI), however the term "mild" is a misnomer when 20-50% of people experience longer term problems that may last months or years after their injury. There is increasing recognition of the significant long-term symptoms and functional impairments following mild traumatic brain injury/concussion. Indeed, studies in Australia, Aotearoa New Zealand and worldwide have shown that care along the journey from injury to recovery is highly variable, advice from health care professionals is often inconsistent, and management may be uncoordinated and incongruent with expert recommendations, compounding poor outcomes.

The 2023 Report to the Australian Senate on concussions and repeated head trauma in contact sports is evidence of the increasing public concern about mTBI/concussion.[2] Sport is the most recognised cause, especially due to the propensity for repeated injury, however, many mTBI/concussions are also due to falls (most common), road traffic accidents, assault/domestic violence, and military activities. Like sport, family violence often has the propensity for repeated injury. Mild TBI/concussion observes no social or economic boundaries and can occur in anyone; children, young adults, older people and Indigenous peoples are most frequently affected. This Guideline addresses some of the key recommendations from the Senate Inquiry by facilitating the evidence-based management of mTBI/concussion through increasing the knowledge among health professionals, providing up-to-date management recommendations, offering key tools to support care, and ultimately aiming to standardise practice across Australia and Aotearoa New Zealand.

Over the last decade, there have been significant advances in the approach to mTBI/concussion and associated symptoms, yet management continues to significantly lag behind the medical evidence. Indeed, Australians are concerned that health care professionals have significant knowledge gaps in this area.[3] Clinical practice guidelines are key tools to bridge knowledge gaps, improve outcomes and optimise resource utilisation.[4] Key factors demonstrated to improve outcomes in mTBI/concussion management are early recognition, avoidance of repeat injury, education, and an early, appropriate, graduated return to activities that is tailored to the individual. Although most people will have an uncomplicated recovery, a significant number will experience symptoms that persist for longer and remit more slowly; some requiring input from multiple medical and allied health disciplines in a coordinated approach.

There are several evidence-based clinical practice guidelines to help guide the management of mTBI/concussion across specific populations[5-9] yet none address all sectors of the population nor take into account the varied Australia and Aotearoa New Zealand health care settings. This Guideline was developed using a meta-guideline approach, closely aligned to the ADAPTE approach,[10] a pragmatic process to expedite guideline development through analysis, synthesis and expansion of multiple existing high-quality national and international guidelines. Where possible recommendations are evidence-based, otherwise recommendations are based on consensus of experts and consumers and tailored to be applicable to the majority of Australia and Aotearoa New Zealand. Consumers and health care professionals called for consistency and clarity especially in regard to returning to play. Validated questionnaires and screening tools aiming to support patient assessment are provided throughout the Guideline.

For practical purposes, we have structured the Guideline into five sections based on phases of recovery: Recognition and early assessment (day 1-3), Early symptom management, Return to activities (day 3-28), Assessment and management of persisting post-concussion symptoms (>4 weeks), Management of specific symptoms, and Repetitive injuries and long-term effect. The way in which different health care professionals use this Guideline will vary depending on their knowledge, skills and role, as well as the setting in which care is provided. Whatever the setting and circumstances, mTBI/concussion care should be tailored to the individual and their symptoms, taking into account their previous medical history, and be culturally responsive. It should involve collaborative decision-making. Health professionals providing care should have appropriate training and skills and should work together to provide continuity of care following mTBI/concussion.

Summary of recommendations and practice points

The table below lists the recommendations and practice points included in this Guideline. Four types of guidance are included:

- *evidence-based recommendations* (EBR) — a recommendation formulated after a systematic review of the evidence, with a clear linkage from the evidence base to the recommendation using GRADE methods and classified either as:
  - 'strong' (EBR^{S}) – implies that most/all individuals will be best served by the recommended course of action; used when confident that desirable effects clearly outweigh undesirable effects or, conversely, when confident that undesirable effects clearly outweigh desirable effects (shaded in blue) or
  - 'conditional' (EBR^{C}) – implies that not all individuals will be best served by the recommended course of action; used when desirable effects probably outweigh undesirable effects; used when undesirable effects probably outweigh desirable effects (shaded in turquoise)
- *consensus-based recommendation* (CBR) — a recommendation formulated in the absence of quality evidence, after a systematic review of the evidence was conducted and failed to identify sufficient admissible evidence on the clinical question (shaded in mauve)
- *practice point* (PP) — advice on a subject that is outside the scope of the search strategy for the systematic evidence review, based on expert opinion and formulated by a consensus process (shaded in green).

Table 1 Recommendations and practice points

RECOGNISE AND ASSESS

Initial diagnosis and assessment

1	Suspected mTBI/concussion should be recognised as soon as possible.	EBR	1.1.1
2	Adults and children with suspected mTBI/concussion should be referred to a medical doctor for confirmation of diagnosis.	CBR	1.1.1
3	People with mTBI/concussion should be assessed in a hospital setting if the mechanism of injury was severe or if they develop any of the following signs or symptoms within 72 hours of injury: • seizure or convulsion • loss of consciousness • deteriorating level of consciousness • confusion • not acting normally, including abnormal drowsiness, increasing agitation, restlessness or combativeness • double vision, ataxia, clumsiness or gait abnormality • weakness and tingling in arms or legs • vomiting[2] • presumed skull fracture (palpable fracture, 'raccoon eyes' or Battle's signs, cerebrospinal fluid leak, otorrhea, rhinorrhoea) • severe headache (children 2-18 years) • occipital or parietal or temporal scalp haematoma (in children aged less than 2 years only).	CBR	1.1.2

4	Children with head injuries do not need to attend hospital for assessment and can be safely managed in primary care or at home if all of the following apply: • the injury was sustained from ground-level falls or walking or running into stationary objects • there is no loss of consciousness • GCS score is 15 • there are no signs or symptoms of head trauma other than abrasions.	CBR	1.1.2
5	Special consideration needs to be made for older people (see Glossary) who: • had a fall/head trauma (witnessed or unwitnessed) or explicit significant injury • are on anticoagulation/antiplatelet therapy with the above incidents. Further assessment and CT of the brain should be considered.	CBR	1.1.2
6	A medical doctor should conduct a review of every person who has sustained mTBI/concussion to confirm diagnosis.	EBR^{S}	1.1.3
7	Initial medical management of a person with mTBI/concussion should be based on a thorough history and physical examination, and concurrent potential contributing factors, such as co-morbid medical conditions and mental health conditions	EBR^{C}	1.1.4
8	Consideration should be given to use of an age-appropriate standardised concussion symptom inventory tool.	EBR^{C}	1.1.4
9	Neuroimaging should not be routinely used for the purpose of diagnosing mTBI/concussion.	EBR^{C}	1.1.5
10	In children with mTBI/concussion who have one or more risk factors for a brain injury, qualified health care professionals should take into account the number, severity and persistence of signs and symptoms (see Figure 1), and family factors (e.g. distance from hospital and social context) when choosing between structured observation and a head CT.	EBR^{C}	1.1.5
11	The need for neuroimaging of adults with mTBI/concussion on acute presentation (within 24-48 hours post-injury) should be determined according to the Canadian CT rule (see Figure 2), noting that people who are anticoagulated or who have bleeding disorders require extra consideration.	EBR^{C}	1.1.5
12	Plain skull x-rays are not recommended for the purpose of diagnosing mTBI/concussion.	CBR	1.1.5
13	Qualified health care professionals should not use single-photon emission CT (SPECT) or quantitative electroencephalogram in the acute evaluation of suspected or diagnosed mTBI/concussion.	CBR	1.1.5
14	If, in an acute care setting, CT head is indicated and no abnormality is identified, neurological deterioration should prompt urgent reappraisal, with consideration of an immediate repeat head CT and consultation with a neurosurgical service.	EBR^{S}	1.1.5

15	People who are being observed after a normal initial head CT who have not achieved a GCS score of 15 after up to 6 hours observation from the time of injury, should have senior clinical review for consideration of a further head CT or MRI and/or consultation with a neurosurgical service. The differential diagnosis of neurological deterioration or lack of improvement should take account of other injuries, drug or alcohol intoxication and non-traumatic aetiologies.	EBR[S]	1.1.5
16	Consultation with a neurosurgical service should occur in all cases with an intracranial injury shown on a head CT, other than in infants and children with an isolated, non-displaced, linear skull fracture on a head CT without intracranial injury and a GCS score of 15.	CBR	1.1.6
17	Consultation with a neurosurgical service should occur in all adults with a base of skull fracture, or skull fracture and confusion, decreased conscious level, or neurological symptoms or signs.	CBR	1.1.6
a	Where structured observation is undertaken, observation period should be 4 hours or greater and should include amnesia and orientation assessment.	PP	1.1.7
b	If the GCS does not return to 15, repeat assessment should be performed.	PP	1.1.7
c	Discharge criteria (see Section 1.1.3) should be met, even if there is a normal head CT.	PP	1.1.7

Complicating factors

d	Consider the possibility of abusive head trauma in all presentations of mTBI/concussion.	PP	1.2.1
e	In people with a ventricular shunt and mTBI/concussion, if there are local signs of shunt disconnection, shunt fracture (e.g. palpable disruption or swelling), or signs of shunt malfunction, consider obtaining a shunt series, and consultation with a neurosurgical service.	PP	1.2.2
18	For people with congenital or acquired bleeding disorders who have experienced mTBI/concussion, consider structured observation over immediate head CT if there are no risk factors for more serious forms of traumatic brain injury (see Figure 1 and Figure 2) and no symptoms consistent with intracranial bleeding. If there is a risk factor for intracranial injury, a head CT should be performed. If there is a deterioration in neurological status, a head CT should be performed urgently.	EBR[C]	1.2.3
f	For people with a coagulation factor deficiency (e.g. haemophilia) who have experienced mTBI/concussion that results in presentation to an acute care setting, neuroimaging should not delay the urgent administration of replacement factor, with guidance from a haematologist sought as required.	PP	1.2.3
g	For children with a bleeding disorder or on anticoagulant or antiplatelet therapy who have experienced mTBI/concussion that results in presentation to an acute care setting, health professionals should urgently seek advice from a haematologist.	PP	1.2.3

h	In adults on anticoagulant or antiplatelet therapy or who have known bleeding disorders, CT should be strongly considered. Qualified health care professionals should follow local protocols and guidelines for management of anticoagulation agents in trauma patients.	PP	1.2.3
19	It is unclear whether people with neurodevelopmental disorders have a different background risk for intracranial injury following mTBI/concussion. Consider performing a period of structured observation or a head CT because these people may be difficult to assess. Shared decision making with caregivers and the clinical team that knows the person is particularly important.	CBR	1.2.4
20	In people who are intoxicated with drugs or alcohol who have experienced mTBI/concussion, treat as if the neurological findings are due to the mTBI/concussion. A low threshold should be used to recommend head CT.	CBR	1.2.5

Initial management

21	Provide patient/parent/support person with clear, age-appropriate verbal and written advice including: • reassurance that most people recover fully • natural history of early symptoms • possibility of persisting symptoms • advice on early symptom management • advice on return to activities/school/work • follow-up with qualified heath care professional if symptoms persist • discharge letter (for people seen in the emergency department).	EBR[S]	1.3.1
22	All people discharged from medical care after presenting with a mTBI/concussion should be given clear, age appropriate, written and verbal advice on when to return to the emergency department; this includes worsening symptoms (e.g. headache, confusion, irritability, or persistent or prolonged vomiting), a decreased level of consciousness or seizures.	EBR[S]	1.3.1
23	All people discharged from medical care after presenting with mTBI/concussion, should be given contact information for the emergency department, telephone advice line or other local providers of advice.	EBR[S]	1.3.1
24	Advise people who have experienced mTBI/concussion to avoid alcohol and other recreational drugs while symptoms persist.	CBR	1.3.1
25	Provide people who have experienced mTBI/concussion with guidance on fatigue management and age-appropriate sleep hygiene methods.	CBR	1.3.1
26	Over-the-counter medications such as paracetamol and ibuprofen may be recommended to treat acute headache in people with mTBI/concussion. Use paracetamol in those who are also taking anticoagulants or antiplatelet medication.	EBR[C]	1.3.2

27	People presenting with acute mTBI/concussion can be safely discharged for home observation in the care of a responsible adult if they meet all of the following clinical criteria: • normal neurological examination and mental status (alertness/behaviour/cognition) • no clinical risk factors indicating the need for head CT (or a normal head CT if performed due to presence of risk factors) • absence of risk factors warranting hospital admission (e.g. other injuries, clinical concerns [e.g. persistent vomiting], drug or alcohol intoxication, social factors, underlying medical conditions such as bleeding disorders or possible abusive head trauma).	EBR[C]	1.3.3

Follow-up

28	All people discharged from hospital after presenting with mTBI/concussion should be advised to follow up with their primary health professional (e.g. general practitioner) within 1 to 2 weeks for assessment of post-concussive symptoms and monitoring of clinical status.	EBR[C]	1.4.1
i	People (or their parents or carers) should be reassured that most post-concussive symptoms are not clinical indicators for imaging.	PP	1.4.2
29	For people at high risk of persisting symptoms (see Box A), qualified health care professionals should consider earlier referral to specialist services for post-concussive symptom management.	EBR[C]	1.4.3

Prognosis

j	For people presenting with mTBI/concussion, qualified health care professionals should consider factors known to be associated with an increased risk of developing post-concussive symptoms (see Box A).	PP	1.5.1
k	Qualified health care professionals should counsel people with mTBI/concussion and their families that, although some factors predict an increased or decreased risk for persisting symptoms, each person's recovery from mTBI/concussion is unique and will follow its own trajectory.	PP	1.5.2

RETURN TO ACTIVITY

General activity

30	Strict rest until the complete resolution of mTBI/concussion-related symptoms is not beneficial and not recommended.	EBR[S]	2.1.1
31	Relative (not strict) rest is recommended for 24-48 hours after mTBI/concussion. Most activities of daily living can resume immediately.	EBR[S]	2.1.1
32	Following mTBI/concussion, physical activity should be started between 24 and 48 hours post injury, gradually increasing from low to moderate physical activity, provided that it is at a level that does not result in significant exacerbation of post-concussive symptoms. A small increase in symptoms (i.e. 20% increase in symptoms) is acceptable. Physical activities that pose no or low risk of sustaining another mTBI/concussion (e.g. walking or stationary cycling) are advisable.	EBR[S]	2.1.1

33	Individuals should be advised to avoid the risk of re-injury (i.e. fall, contact or collision) until a qualified health care professional determines it is safe for higher risk activities.	CBR	2.1.2
34	Explain that transient symptom worsening with increased activity is common.	EBR[C]	2.1.2
l	Where a fall was the cause of mTBI/concussion in an older person, early resumption of daily activities should be encouraged. It is important to provide information on falls prevention strategies.	PP	2.1.2
35	Reduced screen use in the first 48 hours after mTBI/concussion is warranted but may not be effective beyond that time.	EBR[S]	2.1.3
m	Parents and carers should be aware of general recommendations for screen use in children aged over 5 years; that is, promote that children get adequate sleep (8–12 hours, depending on age), recommend that children not sleep with devices in their bedrooms (including televisions, computers and smartphones) and avoid exposure to devices or screens for 1 hour before bedtime.	PP	2.1.3

Return to driving/operating machinery

36	People who have experienced mTBI/concussion should be advised to avoid driving or operating heavy machinery during the first 24 hours.	CBR	2.2
37	People returning to driving should be advised that symptoms such as blurred vision, dizziness, fatigue, impaired cognition, headache and neck pain or stiffness may affect their ability to drive or operate heavy machinery.	CBR	2.2

Return to work

38	Encourage people to return to some form of work, so long as work does not place the person at high risk of reinjury. Facilitate identification of necessary modifications (to decrease the risk of reinjury) and appropriate accommodations by clearly identifying exacerbators of symptoms and functional limitations (physical, cognitive and emotional).	EBR[C]	2.3
39	Students should have returned to school full-time before commencing extra-curricular work (unless part of educational activity).	EBR[C]	2.3
40	When persisting post-concussive symptoms pose a barrier to return to pre-injury employment, introduction of other meaningful activities that facilitate recovery should be considered. Other employment (full-time or part-time), educational activities, community roles, and activities that promote community integration (e.g. volunteer work) may be considered as an alternative focus for meaningful activities.	CBR	2.3

Return to school/learning

41	To minimise academic and social disruptions following mTBI/concussion, qualified health care professionals should not recommend complete rest and isolation, even for the initial 24–48 hours, and instead recommend a period of relative rest.	CBR	2.4.1

42	Complete absence from the school / education environment for more than one week is not generally recommended. Children/adolescents should receive temporary academic accommodations (e.g. modifications to schedule, classroom environment and workload) to support a return to the school environment in some capacity as soon as possible.	CBR	2.4.1
43	A child or adolescent should return to their school environment as soon as they are able to tolerate engaging in cognitive activities without overly exacerbating their symptoms, even if they are still experiencing symptoms. Return-to-school protocols should be customised based on the severity of post-concussion symptoms as determined jointly by health-care and school-based teams and be modified based on ongoing assessment of symptoms.	CBR	2.4.1
44	In consultation with educators, and accounting for social determinants of health, some students may be offered temporary academic supports to promote return to learning including: • environmental adjustments, such as modified school attendance, frequent rest breaks from cognitive/thinking/deskwork tasks throughout the day and/or limited screen time on electronic devices • physical adjustments to avoid any activities at risk of contact, collision or falls, such as contact sports or game play during physical education classes or after-school activities, while allowing for safe non-contact physical activity (e.g. walking) • curriculum adjustments, such as extra time to complete assignments/homework and/or preprinted class notes • testing adjustments, such as delaying tests/quizzes and/or permitting additional time to complete them.	CBR	2.4.2
45	Return-to-school is a priority in children and adolescents, and while full return to learn is recommended before unrestricted return to sport, the two strategies can occur in parallel.	EBR[C]	2.4.3
46	For students who experience prolonged symptoms and academic difficulties despite an active treatment approach, qualified health care professionals should refer the child for a formal evaluation by a specialist in paediatric mTBI/concussion, or a interdisciplinary concussion team where available.	EBR[C]	2.4.4

Return to sport

47	Return to sport strategies should be individualised, follow the recommended guidelines, and be monitored by a qualified health care professional.	CBR	2.5
48	People who experience mTBI/concussion should gradually progress through return-to-learn and the return-to-sport stages (specific steps are outline in Table 2, Table 3 and Figure 3 in Aotearoa New Zealand), ensuring a minimum time away from play of 21 days from injury.	CBR	2.5

ASSESSMENT AND MANAGEMENT OF PERSISTING SYMPTOMS

Assessing persisting symptoms

49	The assessment and management of an individual with persisting mTBI/concussion-related symptoms should be directed towards specific symptoms identified and monitored with a symptom checklist. The person's most prominent symptoms or impairments should be directly assessed, including: • headache (including neck pain), migraine • mood (i.e. depression), anxiety, post-traumatic stress disorder, somatisation and other trauma and stressor-related disorders • sleep • dizziness, balance and visual problems • cognitive symptoms (memory loss, attention) • fatigue • screening for medication/substances that may mask or modify the symptoms.	EBR[C]	3.1
50	Physical examination should be conducted and include: • vital signs (resting heart rate and blood pressure) • complete neurological examination (cranial nerve, motor, sensory, reflex, cerebellar, gait, balance testing) • cervical spine examination (palpation, range of motion, provocative cervical spine tests) • mental state examination including cognitive screening • further examination of the individual should be based on symptoms. Assessments may need to be conducted over a number of appointments.	EBR[C]	3.1
51	The assessment of persisting symptoms should include a review of currently prescribed medications (and adherence), and non-prescribed medications/supplements and substance use, including but not limited to alcohol, cannabis and other drugs.	CBR	3.1
52	Repeat medical assessment is advisable for people with concerning or worsening post-concussion symptoms at 1-2 weeks following acute injury and then at 4 weeks in people with persisting symptoms.	CBR	3.1
53	When neck pain is present, careful and thorough clinical examination is required. Investigation (i.e. imaging) should only be conducted according to established imaging guidelines (e.g. NEXUS, Canadian Canadian C-spine rule).	EBR[S]	3.1
n	For people with persisting symptoms following mTBI/concussion, clinical assessment including identification of factors that may suggest an alternative diagnosis is recommended.	PP	3.1
54	Careful and thorough differential diagnoses should be considered as similar symptoms are common in chronic pain, depression, anxiety disorders, sleep disorders and other medical and psychiatric disorders (see Box B).	EBR[S]	3.1.1

Managing persisting symptoms

55	Individuals with symptoms that persist after 4 weeks should be informed and reassured that a symptom-based approach will facilitate recovery and that symptom resolution is achieved by most people. This information should be provided in written, verbal and/or pictorial formats and should also outline mental health considerations, and non-pharmacological strategies to minimise symptoms including: • activity modifications • limiting triggers • managing fatigue • sleep hygiene • the importance of social interaction • activities of daily living • graduated return to cognitive and physical activity • working with the school team to facilitate school/work success.	EBR[C]	3.2
56	For people with persisting symptoms, a slower progression in return to normal activity should be implemented if symptom worsening is more than mild or is prolonged.	EBR[C]	3.2
57	The use of hyperbaric oxygen to treat symptoms post- mTBI/concussion is not recommended.	EBR[S]	3.2
58	Treatment for specific symptoms or concerns should be initiated while waiting for a referral to an interdisciplinary concussion team or sub-specialist.	CBR	3.2
59	Encourage people with persisting symptoms to engage in cognitive activity and low-risk physical activity while staying below their symptom-exacerbation threshold. Activities that pose no/low risk of sustaining a mTBI/concussion (no risk of contact, collision, or falling) should be resumed even if mild residual symptoms are present or whenever acute symptoms improve sufficiently to permit activity.	CBR	3.2.1
60	Referral to interdisciplinary concussion team or subspecialist (where available) should be considered for people who have persisting symptoms.	CBR	3.2.2

ASSESSMENT AND MANAGEMENT OF SPECIFIC SYMPTOMS

Headache

61	Identification of the headache phenotype can inform management.	EBR[C]	4.1.1
62	A qualified health care professional should take a comprehensive headache history (see Box C) to identify the headache phenotype(s) that most closely resemble(s) the person's symptoms.	EBR[C]	4.1.1
63	Personal, environmental, work-related, school-related, and physical factors such as neck pain should be identified and addressed as potential headache contributors.	EBR[C]	4.1.1
64	Establish the degree of headache-related disability (taking a biopsychosocial approach) to assist in preparing a treatment approach (i.e. non-pharmacological and/or pharmacological).	EBR[C]	4.1.1

65	The qualified health care professionals treating post-traumatic headaches should perform neurological and musculoskeletal examinations, including blood pressure and heart rate monitoring (both lying and standing), cervical spine and vestibulo-ocular system examination.	CBR	4.1.1
66	People older than 5 years with post-traumatic headache should be encouraged to maintain an accurate headache and medication diary (see Box D) and to bring it to every follow-up visit with their treating health care professional.	CBR	4.1.2
67	Although most people with post-traumatic headache do not require imaging, brain or cervical spine imaging (MRI or brain CT) is a consideration when neurologic signs or symptoms are suggestive of possible intracranial pathology or significant cervical spine injury.	CBR	4.1.2
68	Education should be provided to the person with post-traumatic headache on the lifestyle strategies useful for potentially minimising headache occurrence and/or decreasing the impact of headaches when they occur.	CBR	4.1.3
69	Over the counter analgesics (e.g. paracetamol, ibuprofen, aspirin, naproxen) should be used less than 15 days per month.	CBR	4.1.4
70	Combination analgesics (i.e. with caffeine or codeine) should be used less than 10 days per month.	CBR	4.1.4
71	Migraine-specific acute therapies should be trialled when non-specific acute therapies are incompletely effective. Triptans can be used for migrainous-type headaches less than 10 days per month.	CBR	4.1.4
72	When headaches are too frequent (e.g. more than 10 days per month) or disabling, prophylactic therapy should be considered	CBR	4.1.4
o	Prophylactic therapy should be guided by headache phenotype.	PP	4.1.4
73	Post-traumatic headaches may be unresponsive to conventional treatments. If headaches remain inadequately controlled, referral to a neurologist, headache specialist, paediatrician, or interdisciplinary concussion team is recommended.	CBR	4.1.5

Sleep disturbances

74	A repeat medical assessment should be performed for all people presenting with sleep disturbances 1-2 weeks following acute mTBI/concussion .	CBR	4.2.1
75	People with post-concussion symptoms should be routinely screened for sleep-related problems (i.e. sleep disturbances). For those screening positive, sleep should be evaluated using a validated assessment tool, particularly for insomnia	CBR	4.2.1
76	When criteria are met for chronic insomnia, sleep should be monitored for improvement over time using validated person-reported outcome measures or sleep monitoring devices.	CBR	4.2.2

77	Other pre-existing sleep-wake disturbances and medical conditions that influence sleep should be screened for and treated. Medications that influence sleep (including supplements, herbal medicines or steroid medications) should be noted and their use monitored.	CBR	4.2.2
78	Education and treatment of sleep disturbances (including sleep apnoea) should be prioritised (along with headache and mood), given their significant impact and interaction with other functionally limiting symptoms.	EBR[C]	4.2.3
79	Education on sleep disturbances should be provided in written, verbal and/or pictorial formats.	CBR	4.2.3
80	People with insomnia should be given advice on sleep hygiene (see Box E) and self-management strategies or programs.	CBR	4.2.4
81	Advise people with post-concussive insomnia to use melatonin (2-5 mg two hours before bedtime).	EBR[S]	4.2.4
82	Advise on reduced evening light exposure and consider bright light exposure or blue light therapy in the morning.	EBR[C]	4.2.4
83	Refer people with prolonged post-concussive insomnia for cognitive behavioural therapy (CBT) specifically for sleep or to a sleep physician (where accessible).	EBR[C]	4.2.4
p	Maintain a high index of suspicion for sleep problems.	PP	4.2.4
q	Screen for obstructive sleep apnoea and depression as causes of poor sleep	PP	4.2.4
r	Assess sleep using a sleep diary over 2–3 weeks.	PP	4.2.4
s	Encourage physical activity.	PP	4.2.4
t	Avoid using benzodiazepines.	PP	4.2.4
84	If non-pharmacological treatment options have not been effective in treating sleep disturbances that persist beyond 4 weeks, medications could be considered to facilitate sleep. The following principles must be considered: • avoid medications that may lead to dependency or sleep disturbances • avoid benzodiazepines • aim for a short duration of use • recognise potential adverse effects/interactions of medications • avoid polypharmacy where possible • prescribe medications that may manage multiple co-occurring symptoms e.g. Amitriptyline for headache and sleep disturbances • start at a low dose and gradually increase as tolerated	CBR	4.2.5
85	If sleep problems emerge or continue despite appropriate sleep hygiene measures, qualified health care professionals may consider referral of people with mTBI/concussion to a sleep disorder specialist or an interdisciplinary concussion team.	EBR[C]	4.2.6

Fatigue

86	Characterise the dimensions of fatigue (e.g. physical, mental, impact on motivation) and consider alternative or contributing causes that may not be directly related to the injury (see Table 4 for useful assessment tools).	EBR[C]	4.3.1
87	People with significant symptoms of fatigue should be given information about management of contributing factors (see Table 4).	EBR[S]	4.3.2
88	Advise people with fatigue resulting from disturbed sleep to use melatonin (2-5 mg two hours before bedtime).	EBR[C]	4.3.3
89	Cognitive behavioural therapy and mindfulness-based stress reduction should be considered when managing fatigue.	EBR[C]	4.3.3
90	Blue light therapy may be considered to reduce symptoms of fatigue and excessive daytime sleepiness.	CBR	4.3.3
91	Referral to interdisciplinary concussion team or a qualified health care professional should be considered if fatigue causing functional impairment persisting for more than 4 weeks .	EBR[C]	4.3.4

Mental health disorders, mood and behaviour symptoms

92	Qualified health care professionals should routinely monitor for and manage depression and anxiety in people with a recent mTBI/concussion.	EBR[C]	4.4.1
93	In assessing mental health symptoms following mTBI/concussion, use a structured clinical interview, self-report questionnaires, and behavioural observation to determine whether the symptoms meet criteria for a mental health disorder (see Box F).	EBR[S]	4.4.2
94	If a mental health disorder is identified, existing practice guidelines for the treatment of the diagnosed condition should be followed.	EBR[S]	4.4.3
95	Cognitive behavioural therapy (CBT) and other psychotherapeutic modalities delivered by an qualified health care professional should be recommended for people with mental health conditions following mTBI/concussion.	EBR[C]	4.4.3
96	Mindfulness-based stress reduction may be recommended to help manage chronic symptoms following mTBI/concussion.	EBR[C]	4.4.3
u	If pharmacological treatment of mental health disorders, mood and behaviour symptoms in people following mTBI/concussion is considered, a qualified health care professional with experience in managing mental health should be involved.	PP	4.4.3
97	Treat mental health conditions or consider referral to a mental health specialist, especially where there is a lack of response to treatment.	CBR	4.4.4

Cognitive difficulties

98	Qualified health care professionals should attempt to determine the aetiology of cognitive dysfunction within the context of other mTBI symptoms.	CBR	4.5.1

v	Cognitive change in an older person could be a symptom of dementia. An early assessment to exclude intracranial pathology is recommended in older people with mTBI/concussion. After exclusion of other organic pathology, consider referral of older people with cognitive difficulties for further assessment (e.g. to a geriatrician, neurologist).	PP	4.5.1
99	People with pre-existing conditions and comorbid symptoms (e.g. anxiety, mood disorders, posttraumatic stress disorder, attention-deficit/hyperactivity disorder, sleep disturbances, fatigue, pain) should be provided with education highlighting that these pre-existing conditions may contribute to having an increased risk of more severe and prolonged cognitive symptoms.	EBR[C]	4.5.2
100	Manage cognitive symptoms that interfere with daily functioning which may include self-directed compensatory strategies (i.e. internal, external, environmental). If cognitive difficulties persist for more than 4 weeks, consider specialist assessment, preferably by a neuropsychologist or interdisciplinary concussion team.	EBR[C]	4.5.3
101	Referral for specialised cognitive assessment (e.g. neuropsychological assessment) may be considered in the following circumstances: • there is functionally limiting cognitive impairment • comorbidities potentially impacting cognition have been optimally managed • there is no ongoing cognitive symptom improvement • cognitive symptoms are prolonged (i.e.. Beyond 1 month)	CBR	4.5.4
102	Older people with cognitive symptoms should be referred to a geriatrician, neurologist, memory clinic or cognitive medical specialist for evaluation.	CBR	4.5.4
103	If cognitive symptoms are persisting beyond 3 months, then review, modify, and extend work/school accommodations as appropriate. These accommodations must be assessed and reviewed by the medical team and adjusted to individual needs as required.	CBR	4.5.4

Sensory sensitivity

104	For people with noise, light and other sensory sensitivities, a graduated exposure program is recommended. People should receive education about sensory tolerance levels and be encouraged to gradually increase exposure to these stimuli. Specifically, they should recognise the point at which mild symptoms have onset and push to the point that does not result in a significant or prolonged exacerbation of symptoms to promote desensitisation.	CBR	4.6

Balance, dizziness and visual dysfunction

105	If vestibular, vision, balance and coordination symptoms are endorsed, they should be screened for and monitored at follow-up appointments. A validated screening tool can be useful.	EBR[C]	4.7

106	If changes in vision are reported, a detailed history, including visual history, should be taken and assessments performed of visual acuity, pupillary function, visual fields, fundoscopy, binocular vergence, and extra-ocular movements.	EBR[C]	4.7.1
w	An eye examination should be undertaken to rule out ocular injuries and/or pre-existing disease that may impact vision.	PP	4.7.1
107	Perform oculomotor and vestibulo-ocular examinations including: • assessment of convergence, accommodation, saccades and smooth pursuits • assessment of the vestibulo-ocular reflex such as the head thrust test and/or dynamic visual acuity (may require involvement of a vestibular rehabilitation physiotherapist) • age-appropriate assessment of postural stability and balance (e.g. standing balance test or Balance Error Scoring System).	EBR[C]	4.7.2
108	Screen for benign paroxysmal positional vertigo (BPPV) if the person reports vertigo or dizziness that occurs for seconds following position changes and consider targeted particle re-positioning manoeuvres.	CBR	4.7.3
x	After completing a neurological screen and clearing the cervical spine to move into the test position, perform the Dix-Hallpike Test. If positive for BPPV (i.e. reproduction of vertigo, typically for seconds, in addition to a characteristic pattern of nystagmus for the canal that is being assessed), a Particle Repositioning Manoeuvre may be appropriate (e.g. the Epley manoeuvre).	PP	4.7.3
109	If the Dix-Hallpike manoeuvre reproduces vertigo, and there is no evidence of nystagmus, a Roll test should be performed, and other differential diagnoses or referral should be considered. The Epley manoeuvre should still be considered for treatment.	CBR	4.7.3
110	Screen for and consider underlying psychosocial factors that may exacerbate symptoms of vestibular, vision, and oculomotor dysfunction.	CBR	4.7.4
111	Provide general post-concussion education that outlines symptoms of mTBI/concussion, and provide suggestions regarding accommodations to manage visual, vestibular and oculomotor symptoms.	CBR	4.7.5
112	When the Dix-Hallpike manoeuvre is positive, the Epley/canalith repositioning manoeuvre should be used to treat benign paroxysmal positional vertigo.	EBR[C]	4.7.6
113	If BPPV does not resolve within 1-3 treatments, consider referral to an otolaryngologist or qualified health care professional certified in vestibular rehabilitation.	CBR	4.7.6
114	Consider referral to an interdisciplinary concussion team or physiotherapist with competency-based training.	EBR[C]	4.7.6
115	Vestibular rehabilitation therapy is recommended for people experiencing functionally limiting dizziness.	EBR[S]	4.7.7

116	When a person with mTBI/concussion identifies a problem with hearing (i.e. intolerance to everyday sounds, hearing loss, tinnitus), a detailed history (including auditory history) should be taken, otologic examination (including otoscopy) performed, and referral for audiological assessment and/or ENT opinion if no apparent cause is found.	EBR[C]	4.7.8
117	Consider referral to an ENT specialist for people with either unilateral tinnitus or persistent tinnitus that has not responded to self-management strategies.	CBR	4.7.9
118	If vestibular, vision, balance and coordination symptoms remain functionally limiting, further assessment to identify potential causes of symptoms to direct treatment is required. Referral to a qualified health care professional with specialised training in the vision or vestibular system is recommended, where available.	CBR	4.7.10

Autonomic nervous system

y	Autonomic dysfunction can occur following mTBI/concussion and may contribute to persisting symptoms.	PP	4.8

REPEAT CONCUSSION AND LONG-TERM EFFECTS

Repeat concussion

119	People diagnosed with a repeat concussion soon after the index injury (within 3 months) or after multiple repeat episodes are at increased risk of persisting post-concussive symptoms.	CBR	5.1.1
z	When returning to sport, people with repeat mTBI/concussions within the season are likely to require a more conservative approach and may require input from an interdisciplinary concussion team.	PP	5.1.1
aa	People who are concerned about possible long term effects of repetitive head injuries should be encouraged to seek medical assessment and advice. Symptoms that cause concern are more likely to be due to other medical conditions that can be managed effectively.	PP	5.1.1

Introduction

Mild traumatic brain injury (mTBI) and concussion are important health care issues that present an opportunity for improved care. While many people recover quickly and uneventfully, a proportion of children and adults have ongoing symptoms that may significantly impair function and quality of life. Mild traumatic brain injury and concussion account for 80-90% of all traumatic brain injuries, estimated to occur in 749 per 100,000 person-years globally (i.e. approximately 180,000 cases in Australia, and 40,000 cases in Aotearoa New Zealand, every year).[1, 11, 12] They occur most commonly in children, affecting 20% of children under 16 years of age,[13, 14] and adults who are older than 75 years. The incidence is three times higher in Indigenous Australians, and 20% more common in Aotearoa New Zealand Māori and Pasifika populations compared to the non-Indigenous population.[11, 15, 16] The most common causes are falls, mechanical forces, motor vehicle accidents, assault/family violence, and blast-related injury (military personnel).[11] Additionally, individuals sustaining a mTBI/concussion are at increased risk of repeated mTBI/concussion, which often results in more severe and protracted symptoms.[17-19]

The diagnostic criteria for mild traumatic brain injury were revised in 2023.[20] In brief, firstly, there should be a biomechanically plausible mechanism of injury. In addition, there should be one or more of the following: i) an acute physiological disruption of brain function as manifested by loss of consciousness, alteration in mental status, complete or partial amnesia following the event, or other neurological sign/s; ii) two or more acute symptoms (e.g. subjective altered mental status, physical, cognitive or emotional) *and* clinical (e.g. cognitive, balance, oculomotor, vestibular-oculomotor signs on examination) or laboratory findings (e.g. blood biomarker indicative of intracranial injury); and iii) neuroimaging evidence of TBI. Lastly, symptoms and signs must not be fully accounted for by an alternative diagnosis or a more severe form of TBI. The term "concussion" can be used interchangeably with mTBI when there is no structural injury on conventional CT or MRI brain.[20, 21] In these guidelines, we use the term mTBI/concussion to avoid confusion.

People with mTBI/concussion are often significantly debilitated after their injury. Symptoms that follow a mTBI/concussion are collectively known as post-concussion symptoms and persisting post-concussion symptoms when lasting for longer than 4 weeks. Symptoms are categorised in four symptom domains: physical (e.g. headaches, dizziness, visual disturbance), cognitive (e.g. problems with attention/concentration, memory difficulties), behavioural (e.g. mood disturbance, anxiety), and sleep/fatigue problems.[22, 23] Children and youth are often thought to have slower recovery rates, 30–40% have post-concussion symptoms for longer than 4 weeks after injury.[24] There is increasing evidence, however, that as many as 20–50% of adults also have delayed recovery.[25, 26] Good acute management including patient education, avoidance of repeat injury, and early follow-up can reduce the risk of persisting post-concussion symptoms and the significant emotional and financial burden.[27, 28] However, between 40-80% of people leave the emergency department without education or discharge instructions and without a clear follow-up plan.[17-19]

The management of mTBI/concussion is highly variable across health professionals[3, 29] and there is a lack of knowledge about the best practice and care of people with mTBI/concussion and persisting symptoms. Clinical practice guidelines can help to improve outcomes, optimise resource utilisation, and increase cost-effectiveness.[4] There are several evidence-based clinical practice guidelines to help guide the management of mTBI/concussion, however, these have focused on specific populations i.e. children,[5-7] and sport-related concussion,[8] or are for use in specific settings e.g. the emergency department.[7, 9] However, there are few guidelines that guide the management from injury to recovery, and none that have been adapted for use across the Australian and Aotearoa New Zealand (ANZ) healthcare systems.

Development of the Guideline

The guideline development process commenced with a scoping review to assess the potential for using existing national and international mTBI/concussion clinical practice guidelines as source guidelines. To assess the suitability for use of the potential source guidelines, the scope, methods, transparency in reporting and applicability of the guidelines to the ANZ health care settings were explored.

The scoping review found there was no existing single clinical practice guideline whose coverage completely aligned with that proposed for the ANZ guideline. In addition, most guidelines were developed internationally with applicability concerns for the ANZ context. Therefore, using a single source guideline for the development of the ANZ guideline was not appropriate. The scoping review was also used to inform the scope of the guideline in terms of the topics to be addressed.

Due to the breadth of topics to be addressed by the Guideline, the traditional guideline approach of developing research questions and associated eligibility criteria (usually in Population, Intervention, Comparator, Outcome [PICO] format), and *de novo* evidence reviews to answer the research questions was not feasible. Instead, the guideline was developed using the following main methodologies:

- meta-guideline approach, closely aligned to the ADAPTE approach:[10] a pragmatic process to expedite guideline development through analysis, synthesis and expansion of multiple existing high-quality national and international guidelines
- *de novo* evidence reviews for topics within the scope of the ANZ mTBI/Concussion Guideline, but outside the scope of existing high-quality clinical practice guidelines.

The meta-guideline approach identified the following source guidelines:

- *Living concussion guidelines: Guideline for concussion and prolonged symptoms for adults 18 years or older 2023*[30]
- Paediatric Research in Emergency Departments International Collaborative (PREDICT) 2021 *Australian and New Zealand guideline for mild to moderate head injuries in children – Full guideline*[7]
- *Living guideline for pediatric concussion care* 2023[31]
- *Centers for Disease Control and Prevention guideline on the diagnosis and management of mild traumatic brain injury among children*[5]
- *Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport-Amsterdam, October 2022*.[32]

Guideline Development Group and other groups informing guideline development

A multidisciplinary group of medical and allied health professionals, who work with people who experience mTBI/concussion, came together to form the Guideline Development Group (GDG; see Appendix A). The GDG included medical specialists (general practice, neurology, neurosurgery, sports medicine, rehabilitation medicine, emergency medicine, geriatrics, rural medicine), allied health (physiotherapy, sport and exercise science, vestibular physiotherapy, neuropsychology), guideline development experts, and academic researchers, across paediatric, adult and older populations. The GDG also involved consumer representation and advocates for Aboriginal and Torres Strait Islanders, Māori and Pacifica populations, and people living with disability.

Additionally, a Consumer Working Group (CWG) informed the GDG across scope, lived experience, and areas of need (see Appendix A). This group was composed of Australians and New Zealanders who have experienced or cared for a family member with mTBI/concussion, and included Aboriginal and Māori peoples.

The GDG was also informed by a subgroup of physiotherapists and occupational therapists who were consulted in areas specific to their expertise (see Appendix A). Relevant advice was also sought from subspecialists such as ethicists, haematologists, and geriatricians.

Public consultation

The guideline was released for public consultation for 30 days. Feedback was welcomed and received from a variety of individuals and groups from across Australia and Aotearoa New Zealand. Submissions were received from members of the general public, medical groups, individual medical professionals, sporting associations, and community groups. The draft guideline was also provided for comment to the colleges and ministries of health. This feedback addressed many different topics and provided valuable input to the guideline. The feedback is provided in the *supplementary materials*.

Aim and scope of the Guideline

The guideline addresses the care of individuals of all age groups who incur a mTBI/concussion (due to any cause), from injury to recovery and community re-integration.

It is anticipated that availability of a guideline relevant to all people with mTBI/concussion will help to improve outcomes, limit the impact of persisting symptoms, reduce inequalities in mTBI/concussion treatment, and give health professionals confidence to deliver consistent best-practice care. It will provide a framework of contextual recommendations that can be easily and cost-effectively implemented by health professionals as they assess and manage people with mTBI/concussion in their journey from injury to recovery.

In providing these guidelines, the GDG acknowledges that:

- in general ANZ societies have become more inclusive and there are greater levels of participation of people with disabilities in the workforce and in community-based sport and recreation settings; with the Paralympic Games now the third largest multi-sport event in the world
- greater involvement of people with a wide range of disabilities, particularly in active sport and recreation settings, increases the likelihood of mTBI/concussion and related contact in the health system
- in general, the strength of the recommendations we make are reduced when applied to community dwelling people with certain types of disabilities because the effects of that disability may interact with the effects of mTBI/concussion in ways that are unpredictable and/or make accurate / complete assessment impossible/difficult/invalid. For example:
  - people living with moderate or severe traumatic brain injury
  - neurodiverse people
  - people with intellectual disabilities
  - people with poor oro-motor function or other communication difficulties
  - people with sensory impairments (vision, hearing).

In other instances (e.g. limb deficiency, short stature) the strength of the recommendations will be unaffected.

Intended audience

It is expected that the primary users of this guideline will be health care professionals who may play a role in the assessment and management of people with mTBI/concussion and post-concussive symptoms. This is likely to include health care professionals across a wide variety of settings from general practice, emergency departments, medical/surgical settings, and radiology to a range of rehabilitation and sports medicine clinicians in community offices or hospitals in metropolitan, regional, remote and very remote settings.

Terminology used in the Guideline

A “mild traumatic brain injury” is an injury to the brain that occurs following a biomechanical insult to the head or body leading to neurological dysfunction. Neurological dysfunction can be manifested in a variety of signs (such as loss of consciousness, alteration of mental status immediately following the injury, amnesia, and/or other neurological signs) and symptoms (such as confusion, disorientation, headache, balance problems, dizziness, difficulty concentrating and/or emotional symptoms) with or without trauma-related changes on brain imaging. The symptoms and signs of mTBI/concussion should not be better accounted for by another condition/diagnosis or effects of drugs/alcohol/medications and should not meet criteria for more severe forms of TBI. Moderate and severe forms of TBI can be diagnosed when the conscious level is more severely impaired (loss of consciousness for more than 30 minutes, Glasgow Coma Score of less than 13) or the length of post-traumatic amnesia is longer than 24 hours.

The criteria for mTBI were revised by the American Congress of Rehabilitation using a Delphi consensus in 2023 to improve diagnostic clarity and aid clinical care.[20] In brief, firstly, there should be a biomechanically plausible mechanism of injury. In addition, there should be one or more of the following: i) an acute

physiological disruption of brain function as manifested by loss of consciousness, alteration in mental status, complete or partial amnesia following the event, or other neurological sign/s; ii) two or more acute symptoms (e.g. subjective altered mental status, physical, cognitive or emotional) *and* clinical (e.g. cognitive, balance, oculomotor, vestibular-oculomotor signs on examination) or laboratory findings (e.g. blood biomarker indicative of intracranial injury); and iii) neuroimaging evidence of TBI. Lastly, symptoms and signs must not be fully accounted for by an alternative diagnosis or a more severe form of TBI. Currently, there is insufficient evidence for the use of biomarkers as a routine tool for the diagnosis/management of mTBI/concussion. The term "concussion" can be used interchangeably with mTBI when there is no structural injury on conventional CT or MRI brain.[20, 21] In these guidelines, we use the term mTBI/concussion to avoid confusion.

Any impact to the head causing injury is considered a "head injury" but does not necessarily mean there has been a brain injury. When communicating that an injury to the brain has occurred, we suggest refraining from using terms such as "head knocks", "head dings", "trivial head injury", or "blow to the head" and that the terms "mild traumatic brain injury" or "concussion" are used instead.

"Physical activity" is any bodily movement produced by skeletal muscles that requires energy expenditure. Exercise is a form of physical activity that is planned, structured, and repetitive and aims to improve physical fitness. Sport refers to a human activity that involves physical exertion and skill as its primary focus, often involving competition or social participation.

In this document, a child is a person less than 18 years of age. Older people is used to refer to individuals who are 65 years or older, except in Aboriginal and Torres Strait Islander people where it refers to people who are 50 years or older, due to the decreased life expectancy in this population. While life expectancy among Māori is also lower than in the general Aotearoa New Zealand population,[33] no age range has been specified as "older people" in this group.

There are select communities and large geographical regions in Australia and Aotearoa New Zealand where access to health care is more limited. The term "qualified health care professional" is used to indicate a licensed health care professional (not necessarily a doctor) whose scope of practice, education, experience, training and accreditation are appropriate for the situation or condition of the patient who is the subject of the consultation or referral. These individuals have a wide range of professional backgrounds and include medical doctors, psychologists, allied health professionals, and indigenous health workers

Consensus agreement

There were two topics in particular that produced extensive debate within the GDG. These were 'Return to sport' and 'Chronic traumatic encephalopathy'. Over the last year, there has been a shift internationally towards a minimum time away from sport. The recommendations from national bodies such as New Zealand Accident Compensation Corporation (ACC),[34] UK government (non-elite sports),[35] and sporting organisations such as World Rugby[36] were reviewed. The GDG also reviewed the protocols across the sporting codes in Australia and Aotearoa New Zealand, most of which did not have a common 'return to play' strategy. The evidence guiding return to play decisions was reviewed, noting that delaying return to play decreases the risk of repeat injury and improves recovery time but also the lack of evidence supporting optimal timing of return to play. The research demonstrating ongoing changes in brain microstructure even when the person has clinically recovered was also discussed including whether these changes were an indication of ongoing recovery or compensatory changes. The GDG was unable to reach unanimous consensus. All agreed that return to play should be individualised. Most members were concerned about the variability in number days away from sport across the sporting codes, that they are not based on evidence, and the potential conflict between timing of return based on the next game day versus player health. The majority of members advised that the lack of a common protocol creates confusion in the community and endorsed a minimum time away from play. A few members did not agree with a minimum time away from sport, the danger that as a result players may not report concussions setting the field back, and that return should be based on the International Conference on Concussion in Sport 2023 alone.

To resolve this issue, a Delphi poll was conducted. In addition to minimum time away from play, the GDG was asked to consider if recommendations should differ between children and adults, all sports versus contact sport, and community versus elite sport. 87% agreed on a fixed time away from contact sport; 66% felt this should apply to all sports (including community sport, 75%); and 86% recommended 21 days away from play (as opposed to 14 or 28 days) in adults and children alike. All agreed that the graduated return to activity paths should be followed to guide recovery as an overriding principle. It was acknowledged that elite athletes were likely to have increased access to specialised medical care to guide recovery when compared to the general community. All agreed that increased community resources will be necessary to facilitate recovery of individuals with concussion/mTBI. This consensus was reached independently, before the recommendations of the Australian Institute of Sport (AIS)[37] were released. However, the agreed timeframe reflects that recommended by the AIS.

Chronic Traumatic Encephalopathy: There is increasing public concern about the potential link between concussion/mTBI and neurodegenerative disease later in life. The GDG reviewed the evidence, including recent systematic reviews, about whether repetitive head injuries are associated with increased risk of dementia, and neurological problems. A summary of the evidence can be found in Section 5. As yet, there is no conclusive data to support this risk and so the GDG was unable to develop a recommendation around this. The GDG agreed that the focus of guidance should be on assessment, differential diagnoses and managing treatable symptoms such as mental health issues and practice points were created.

Tools

Throughout the guidelines, “Further guidance” sections provide links to contextualised tools and resources. Note that these have not been validated in specific population groups and may not be applicable in all cases.

Implementation and review

In addition to engaging stakeholders, following NHMRC guidelines, and ensuring trustworthiness, it is anticipated that implementability of these guidelines will be increased by understanding local contexts obtained by performing a contextual framework analysis identifying factors that need to be considered in final recommendations and any potential barriers and facilitators for its use, including consideration of the:

- needs of Aboriginal and Torres Strait Islander peoples and of Māori and Pasifika peoples, especially given their high incidence rate of TBI, and increased risk factors for poor outcome
- difficulties related to accessing services when living in rural and remote areas
- commonly co-occurring problems (e.g. alcohol and/or drug dependency, domestic violence, homelessness)
- consideration of culturally and linguistically diverse populations
- dissemination of the guidelines in different formats (e.g. web-based platforms, Wiki format, open-access publication in medical journals, downloadable files).

It is anticipated that a review of the guideline recommendations will be undertaken in 5 years.

Funding is being sought to change these Guidelines to “Living Guidelines” in the future.

1 Recognition and early assessment

1.1 Recognise and assess

Diagnosis of mTBI/concussion is the critical first step in successful management, leading to improved outcomes and prevention of further injury.[30] This requires a high index of suspicion in situations of increased risk of mTBI/concussion such as when assessing people after a fall, victims of assault or those involved in traffic incidents or multitrauma, as well as those playing contact sport. In the latter context, any person suspected of a possible mTBI/concussion should be removed from play to avoid the risk of re-injury.

The initial medical assessment aims to establish a diagnosis of mTBI/concussion by ruling out other conditions with similar symptom profiles, such as more severe forms of traumatic brain injury, cervical spine injuries and some medical and neurological and mental health conditions.[38] Assessment should be as soon as possible after the injury. Although it is recommended that a medical doctor confirm the diagnosis of concussion, this may be difficult in rural and remote regions. In these circumstances, virtual consultations in collaboration with another appropriately qualified health care professionals is warranted.

Following diagnosis of concussion, individuals and their support person(s) should be given written, verbal and/or pictorial education about management and prognosis. Plans need to be made to monitor progress and ensure that symptoms are improving as expected.[30] Ideally, this information should be provided to their usual treating health care professional (e.g. general practitioner [GP], Aboriginal health team etc).

1.1.1 Recognition

Not all people who experience mTBI/concussion will present to the emergency department, with many presenting to primary care. Regardless of setting, assessment should be carried out by a qualified health care professional. Although it is recommended that a medical doctor confirm the diagnosis of concussion, this may be difficult in rural and remote regions. In these circumstances, virtual consultations and/or consultation with another qualified health care professional may be necessary.

Recommendation for children and adults[39-41]	**Strong**
1. Suspected mTBI/concussion should be recognised as soon as possible.	Adapted[7,30]

Recommendation for children and adults[39-42]	**Consensus-based**
2. Adults and children with suspected mTBI/concussion should be referred to a medical doctor for confirmation of diagnosis.	Adapted[30]

Further guidance and tools

Tools to guide identification of mTBI/concussion include the Concussion Recognition Tool, Sport Concussion Assessment Tool (SCAT6), and the Child Sport Concussion Assessment Tool (Child SCAT6). Tools to identify neck injury that requires investigation in adults include the NEXUS tool for neck assessment and the Canadian C Spine Rule. The PECARN clinical decision rule can be used as a prediction tools for cervical spine imaging in children

1.1.2 When to be assessed in hospital

In light of the limited evidence on pre-hospital tools that specifically determine the need for assessment in the acute hospital setting following mTBI/concussion, the following consensus-based recommendations for adults and children were informed by the Canadian CT Head Rule and the Pediatric Emergency Care Applied Research Network study.[43] These are identified as “red flags” in concussion recognition tools. Additional considerations apply for older people (see Glossary) due to the likely presence of comorbidities.

Recommendation for children and adults[44-48]	Consensus-based
3. People with mTBI/concussion should be assessed in a hospital setting if the mechanism of injury was severe[1] or if they develop any of the following signs or symptoms within 72 hours of injury: • seizure or convulsion • loss of consciousness • deteriorating level of consciousness • confusion • not acting normally, including abnormal drowsiness, increasing agitation, restlessness or combativeness • double vision, ataxia, clumsiness or gait abnormality • weakness and tingling in arms or legs • vomiting[2] • presumed skull fracture (palpable fracture, 'raccoon eyes' or Battle's signs, cerebrospinal fluid leak, otorrhea, rhinorrhoea) • severe headache (children 2-18 years) • occipital or parietal or temporal scalp haematoma (in children aged less than 2 years only).	Adapted[7]

Notes:

1 Severe mechanism of injury: motor vehicle accident with patient ejection, death of another passenger or rollover; pedestrian or bicyclist without helmet struck by motorised vehicle; falls of 1 metre or more for children aged less than 2 years, and more than 1.5 m for children aged 2 years or older; or head struck by a high-impact object.

2 A case of a single isolated vomit can be assessed in general practice.

Recommendation for children[43]	Consensus-based
4. Children with head injuries do not need to attend hospital for assessment and can be safely managed in primary care or at home if all of the following apply: • the injury was sustained from ground-level falls or walking or running into stationary objects • there is no loss of consciousness • GCS score is 15 • there are no signs or symptoms of head trauma other than abrasions.	Adapted[7]

Recommendation for elderly adults	Consensus-based
5. Special consideration needs to be made for older people (see Glossary) who: • had a fall/head trauma (witnessed or unwitnessed) or explicit significant injury • are on anticoagulation/antiplatelet therapy with the above incidents. Further assessment and CT of the brain should be considered.	New

Further guidance and tools

Tools to guide identification of mTBI/concussion include the Concussion Recognition Tool (CRT 6), Brain Injury Screening Tool (BIST, used in NZ), Sport Concussion Assessment Tool (SCAT6), and the Sport Concussion Office Assessment Tool (SCOAT). Tools to identify neck injury that requires investigation include the NEXUS tool for neck assessment, the PECARN clinical decision rule and the Canadian C Spine Rule

1.1.3 Clinical evaluation of a person with mTBI/concussion

Physical examination looks for objective signs of disorientation, amnesia or other dysfunction following mTBI/concussion and examines for other potential diagnoses.[49, 50] Mental health status should also be reviewed

as there is evidence that pre-injury psychiatric history or disorder is a predictor of persisting post-concussion symptoms and disability following mTBI/concussion.[51]

Recommendation for children and adults[40, 41, 52-61]	Strong	
6. A medical doctor should conduct a review of every person who has sustained mTBI/concussion to confirm diagnosis.		Adapted[30]

1.1.4 Clinical history, physical examination and assessment tools

A thorough assessment of a person with mTBI/concussion should be carried out by medical doctor to both assess the condition and to exclude potential neurosurgical or medical complications. The examination should include:[30]

- pre-injury history (e.g. prior concussion(s), premorbid conditions and medications)
- concurrent potential factors that could exacerbate symptoms or prolong recovery (e.g. comorbid medical conditions, Attention-deficit/hyperactivity disorder [ADHD], mental health difficulties, impact of associated concurrent injuries), migraine
- evaluation of current signs and symptoms
- consideration of all available diagnostic tests (if performed) evaluation of potential associated physical injuries through examination (e.g. neck injury).

The use of a standardised tool with concussion-specific measures allows for consistent and standardised assessment, with the ability to follow and monitor the progression of recovery.

Recommendation for children and adults[49, 62-71]	Conditional	
7. Initial medical management of a person with mTBI/concussion should be based on a thorough history and physical examination, and concurrent potential contributing factors, such as co-morbid medical conditions and mental health conditions.		Adapted[30]

Recommendation for children and adults[40, 41, 52-61, 72-75]	Conditional	
8. Consideration should be given to use of an age-appropriate standardised concussion symptom inventory tool.		Adapted[30]

1.1.5 Neuroimaging

Need for neuroimaging

Computed tomography (CT) scanning is an appropriate investigation for the exclusion of neurosurgically significant lesions (e.g. haemorrhage) in the acute phase (≤48 hours after injury) but not in the post-acute phase (>48 hours after injury).

People with bleeding disorders or who are taking direct oral anticoagulant treatment or a vitamin K antagonist require extra attention as they have an increased risk of haemorrhage.[76-78] People with neurodevelopmental disabilities sustain more injuries than those without and also require special consideration as neurological deterioration can be harder to assess.

Imaging protocols are beyond the scope of this guideline. For guidance on imaging for children, please see PREDICT recommendations 24, 25 and 26.

Recommendations for children and adults[76, 78-82]	Conditional	
9. Neuroimaging should not be routinely used for the purpose of diagnosing mTBI/concussion.		Adapted[30]

Recommendation for children[83-87]	Conditional	
10. In children with mTBI/concussion who have one or more risk factors for a brain injury, qualified health care professionals should take into account the number, severity and persistence of signs and symptoms (see Figure 1), and family factors (e.g. distance from hospital and social context) when choosing between structured observation and a head CT.		Adopted[31]
Recommendations for adults[76, 78-82]	**Conditional**	
11. The need for neuroimaging of adults with mTBI/concussion on acute presentation (within 24-48 hours post-injury) should be determined according to the Canadian CT Head rule (see Figure 2), noting that people who are anticoagulated or who have bleeding disorders require extra consideration.		Adapted[30]
Recommendations for children and adults[80, 82, 88, 89]	**Consensus-based**	
12. Plain skull x-rays are not recommended for the purpose of diagnosing mTBI/concussion.		Adapted[30, 31]
13. Qualified health care professionals should not use single-photon emission CT (SPECT) or quantitative electroencephalogram in the acute evaluation of suspected or diagnosed mTBI/concussion.		Adopted[5]

Figure 1 Pediatric Emergency Care Applied Research Network (PECARN) Head Injury Decision Rule

Risk factors for intracranial injury		
All children	**Age <2 years**	**Age >2 years**
GCS 14 or other signs of altered mental status Abnormal neurological examination Severe mechanism of injury* Post-traumatic seizures	Palpable skull fracture Non-frontal scalp haematoma History of loss of consciousness ≥5 seconds Acting abnormally per parent	Signs of base of skull fracture History of loss of consciousness History of vomiting** Severe headache

Any risk factors: Recommended observation period is up to 4 hours post injury including 1 hour return to normal

High risk = imaging	Intermediate risk = consider imaging or structured observation	Low risk	Very low risk
Palpable skull fracture **OR** Signs of base of skull fracture **OR** Worsening signs or symptoms **OR** Persistent GCS 14 **OR** Persistent signs of altered mental status	≥ 2 risk factors **OR** Post-traumatic seizure(s) **OR** Persistent severe headache or persistent vomiting >4 hours post injury	Not intermediate or high risk **AND** improving signs and symptoms: GCS 15, acting normally, no current signs of altered mental status, vomiting has stopped, severe headache resolved	No risk factors

Notes:

* Struck by a motor vehicle, occupant ejected from a motor vehicle or death of another passenger, motor vehicle rollover; bicyclist without helmet struck by motorised vehicle; falls of 1 m or more for children aged less than 2 years and more than 1.5 m for children aged 2 years or older; or head struck by a high-impact object).

** Isolated vomiting, without any other risk factors, is an uncommon presentation of more severe forms of traumatic brain injury. Vomiting, regardless of the number of vomits or persistence of vomiting, in association with other risk factors increases concern for more severe forms of traumatic brain injury.

Source: Adapted from PREDICT and Kuppermann N, Holmes JF, Dayan PS, Hoyle JD, Jr., Atabaki SM, Holubkov R, et al. Identification of Children at Very Low Risk of Clinically-Important Brain Injuries after Head Trauma: A Prospective Cohort Study. Lancet. 2009;374(9696):1160–70.

Figure 2 The Canadian CT Head rule for adults with mTBI/concussion

* **Signs of basal skull fracture** Haemotympanum, 'racoon' eyes, CSF otorrhoea/rhinorrhoea, Battle's sign ** **Dangerous mechanism** Pedestrian struck by vehicle Occupant ejected from motor vehicle Fall from elevation ≥3 metres or 5 stairs	**CT head is only required for people with minor head injury with any one of these findings:** **High risk (for neurological intervention)** 1. GCS score <15 at 2 hours after injury 2. Suspected open or depressed skull fracture 3. Any sign of basal skull fracture* 4. Vomiting ≥2 episodes 5. Age ≥65 years **Medium risk (for brain injury on CT)** 6. Amnesia before impact ≥30 min 7. Dangerous mechanism **	**Rule not applicable if:** Non-trauma cases GCS <13 Age <16 years Anticoagulants or bleeding disorder Obvious open skull fracture

Source: Stiell IG, Wells GA, Vandemheen K, Clement C, Lesiuk H, Laupacis A, et al. The Canadian CT Head Rule for patients with minor head injury. Lancet. 2001;357(9266):1391-6. doi: 10.1016/s0140-6736(00)04561-x.[90]

Further guidance

For information regarding the need for neuroimaging in children who present to the emergency department in the Australia and Aotearoa New Zealand, please refer to the PREDICT guidelines.

The GDG endorses PREDICT guideline recommendations 7, 27, PP D, PP C, 22, PP N, 19, 20, 21.

Repeat imaging

Evidence from a study conducted among children suggests a 1% prevalence of new intracranial lesions on repeat neuroimaging in children with GCS of 14 and 0.5% prevalence of new intracranial lesions in those with GCS 15.[91] Data in adults suggest that for mTBI patients with intracranial haemorrhage on initial head CT, who subsequently undergo clinical observation and repeat head CT with stable or improved clinical examinations and CT findings, the probability of death is low.[92] Other studies have found that routine repeat head CT is not warranted in people with mTBI/concussion, even in people at higher risk of intracranial haemorrhage progression.[93, 94]

Recommendation for children and adults[91, 95]	**Strong**
14. If, in an acute care setting, CT head is indicated and no abnormality is identified, neurological deterioration should prompt urgent reappraisal, with consideration of an immediate repeat head CT and consultation with a neurosurgical service.	Adapted[7]
15. People who are being observed after a normal initial head CT[1] who have not achieved a GCS score of 15[2] after up to 6 hours observation from the time of injury, should have senior clinical review for consideration of a further head CT or MRI and/or consultation with a neurosurgical service. The differential diagnosis of neurological deterioration or lack of improvement should take account of other injuries, drug or alcohol intoxication and non-traumatic aetiologies.	Adapted[7]

Notes:

1 The initial head CT should be interpreted by a radiologist to ensure no injuries were missed.

2 Measured using an age-appropriate GCS, consider post-traumatic amnesia assessment for those that remain amnesic.

1.1.6 Neurosurgical consultation

Simple linear skull fractures do not require specific intervention if a head CT reveals no underlying injury. A meta-analysis and four retrospective studies found a very low risk of adverse outcomes in children with isolated, non-displaced, linear skull fractures.[96-100] Evidence on the level of risk for adverse outcomes in people aged >12 with mTBI (GCS 13–15) and injuries identified by head CT is limited, but 27.7% may require hospital admission and 13% neurosurgery, intensive care admission or intubation.[101] Risk factors for deterioration include anticoagulation, GCS<15, abnormal neurological examination, and significant extracranial injury.[101] Evidence of intracranial injury or intracranial haemorrhage on head CT requires urgent neurosurgical consultation.

Recommendations for children and adults[96-100, 102]	Consensus-based
16. Consultation with a neurosurgical service should occur in all cases with an intracranial injury shown on a head CT, other than in infants and children with an isolated, non-displaced, linear skull fracture on a head CT without intracranial injury and a GCS score of 15.[1]	Adopted[7]
17. Consultation with a neurosurgical service should occur in all adults with a base of skull fracture, or skull fracture and confusion, decreased conscious level, or neurological symptoms or signs.	Adapted[7]

Notes: Measured using an age-appropriate GCS e.g. for infants and non-verbal people.

1.1.7 Observation

People with a simple linear skull fracture on head CT should be observed for 4 to 6 hours in hospital or the emergency department. People are admitted for observation if there is any suspicion or clinical evidence of a more severe brain injury. Structured observation (see Glossary) is appropriate in people who do not fulfil criteria for routinely available imaging and necessary in those requiring transfer to access appropriate imaging.

Practice points for children and adults	
a. Where structured observation is undertaken, observation period should be 4 hours or greater and should include amnesia and orientation assessment.	Adapted[7]
b. If the GCS does not return to 15, repeat assessment should be performed.	Adapted[7]
c. Discharge criteria should be met, even if there is a normal head CT.	Adapted[7]

Further guidance

The PREDICT guidelines provide advice about the observation of childhood mild and moderate head injuries in the emergency department in the 'Triage' section.

1.2 Complicating factors

1.2.1 Abusive head trauma

Family violence is a significant cause of brain injury, due to mTBI/concussion, hypoxia, and/or strangulation.[103] It is important to recognise symptoms of abuse and violence and explore with sensitivity and empathic listening.[104] Although family violence is common it is underrecognised; when present, it is usually repeated.[105] Local and national guidelines should be used to guide the assessment and management.[104]

Mandatory reporting of child abuse is required throughout Australia and New Zealand. Some regions also mandate reporting in vulnerable adults.

Practice point for children and adults	
d. Consider the possibility of abusive head trauma in all presentations of mTBI/concussion.	Adapted[7]

Further guidance

Further advice is available from:

- Royal Australian College of General Practitioners guideline "Abuse and violence – working with our patients in general practice"
- Health New Zealand Te Whatu Ora "Family violence guidelines."
- PREDICT guidelines for the management of childhood abusive head trauma in the emergency department.

1.2.2 Ventricular shunts

Practice point for children and adults	
e. In people with a ventricular shunt and mTBI/concussion, if there are local signs of shunt disconnection, shunt fracture (e.g. palpable disruption or swelling), or signs of shunt malfunction, consider obtaining a shunt series, and consultation with a neurosurgical service.	Adapted[7]

1.2.3 Anticoagulant or antiplatelet therapy, and known bleeding disorders

Adults taking anticoagulant or antiplatelet therapies who have a mild head injury are at an increased risk of intracranial haemorrhage and delayed neurological deterioration (up to 6 hours).[106-109] People without symptoms and a GCS of 15 may not need a head CT and instead undergo structured observation.[110] However, people over 60 years are at higher risk of intracranial haemorrhage and have a higher mortality,[108, 109] thus older people on anticoagulant or antiplatelet therapy should be considered for a CT scan. Evidence on the risk of important intracranial injuries in children with bleeding disorders compared to those without bleeding disorders is limited. It is likely that the risk of intracranial haemorrhage differs between types of bleeding disorders and types of anticoagulant or antiplatelet therapy.[111]

Urgent anticoagulant reversal should be considered for people with acute intracranial haemorrhage, as ongoing bleeding and haemorrhage enlargement can cause neurologic deterioration, elevation in intracranial pressure, and poor functional outcome or death.[112] Urgent reversal may not be necessary for a clinically stable person with a small, chronic subdural haemorrhage and no evidence of elevated intracranial pressure. Here, the potential benefit of reversing anticoagulation must be weighed against the risk of thrombosis/stopping the anticoagulation.

Recommendation for children and adults[111, 113] **Conditional**	
18. For people with congenital or acquired bleeding disorders who have experienced mTBI/concussion, consider structured observation over immediate head CT if there are no risk factors for more serious forms of traumatic brain injury (see Figure 1 and Figure 2) and no symptoms consistent with intracranial bleeding. If there is a risk factor for intracranial injury, a head CT should be performed. If there is a deterioration in neurological status, a head CT should be performed urgently.	Adapted[7]

Practice point for children and adults	
f. For people with a coagulation factor deficiency (e.g. haemophilia) who have experienced mTBI/concussion that results in presentation to an acute care setting, neuroimaging should not delay the urgent administration of replacement factor, with guidance from a haematologist sought as required.	Adapted[7]

Practice points for children and adolescents	
g. For children with a bleeding disorder or on anticoagulant or antiplatelet therapy who have experienced mTBI/concussion that results in presentation to an acute care setting, health professionals should urgently seek advice from a haematologist.	Adapted[7]

Practice point for adults[114-116]	
h. In adults on anticoagulant or antiplatelet therapy or who have known bleeding disorders, CT should be strongly considered. Qualified health care professionals should follow local protocols and guidelines for management of anticoagulation agents in trauma patients.	New

Further guidance

For guidance on the assessment of children with immune thrombocytopenia or on anticoagulant therapy or other anticoagulants (e.g. direct oral anticoagulants) or antiplatelet therapy, please see the PREDICT guidelines.

1.2.4 Neurodevelopmental disorders

Neurodevelopmental disorders, such as attention deficit/hyperactivity disorder (ADHD) and specific learning disorder (LD) may increase the risk of bodily injury, including mTBI/concussion, over the lifetime in both males and females.[117]

Recommendation for children and adults	Consensus-based
19. It is unclear whether people with neurodevelopmental disorders have a different background risk for intracranial injury following mTBI/concussion. Consider performing a period of structured observation or a head CT because these people may be difficult to assess. Shared decision making with caregivers and the clinical team that knows the person is particularly important.	Adapted[7]

1.2.5 Intoxication

People with intoxication were excluded from studies exploring the requirement for neuroimaging in mTBI/concussion. Therefore, brain imaging decision rules may not have adequate sensitivity for people who present who are intoxicated.

Recommendation for children and adults	Consensus-based
20. In people who are intoxicated with drugs or alcohol who have experienced mTBI/concussion, treat as if the neurological findings are due to the mTBI/concussion. A low threshold should be used to recommend head CT.	Adapted[7]

1.3 Initial management

1.3.1 Education and advice

There is evidence that providing information about expected symptoms, their likely time course, and suggested coping strategies minimises stress and anxiety and optimises early management among adults and children who experience mTBI/concussion.[28, 118]

Recommendations for children and adults[24, 119-123]	Strong
21. Provide patient/parent/support person with clear, age-appropriate verbal and written advice including: • reassurance that most people recover fully • natural history of early symptoms • possibility of persisting symptoms • advice on early symptom management • advice on return to activities/school/work • follow-up with a qualified health care professional if symptoms persist • discharge letter (for people seen in the emergency department).	Adapted[7, 30]

Education and advice before sending the person home

Recommendation for children and adults[27, 28, 95, 120, 121, 124-127]	Strong
22. All people discharged from medical care after presenting with a mTBI/concussion should be given clear, age appropriate, written and verbal advice on when to return to the emergency department; this includes worsening symptoms (e.g. headache, confusion, irritability, or persistent or prolonged vomiting), a decreased level of consciousness or seizures.	Adapted[7]
23. All people discharged from medical care after presenting with mTBI/concussion, should be given contact information for the emergency department, telephone advice line or other local providers of advice.	Adapted[7]

Alcohol and drug use post-concussion

Alcohol and recreational drugs may have a negative effect on mTBI/concussion recovery. Avoiding alcohol or drugs prevents people from self-medicating and resorting to drugs to relieve symptoms. Impaired judgement after a mTBI/concussion could lead to risky behaviour that causes further harm and may delay the identification of complications.

Recommendation for children and adults	Consensus-based
24. Advise people who have experienced mTBI/concussion to avoid alcohol and other recreational drugs while symptoms persist.	Adapted[31]

Further guidance

The Model Systems Knowledge Translation Center provides fact sheets on alcohol use after traumatic brain injury.

Sleep

Receiving adequate sleep has been shown to facilitate health[128] and, when not adequate, adversely affects medical conditions, including mTBI/concussion.[129-131] Although there is limited evidence to recommend for sleep hygiene in children with mTBI/concussion, evidence in adults mTBI indicates benefits, suggesting that the maintenance of appropriate sleep and the management of disrupted sleep may be a critical target for treatment in both adults and children with mTBI/concussion.[132-134] Following mTBI/concussion that has been assessed by a qualified health care professional, there is no need to keep a person awake.

Recommendation for children and adults[135, 136]	Consensus-based
25. Provide people who have experienced mTBI/concussion with guidance on fatigue management and age-appropriate sleep hygiene methods.	Adapted[5]

1.3.2 Early symptom management

Pain management in the first 2 weeks after mTBI/concussion may involve paracetamol or ibuprofen. After 2 weeks, use of these should be limited to < 3/week or 15/month due to the risk of medication-associated headache. Non-steroidal anti-inflammatory medications (e.g. ibuprofen, naproxen) are not suitable for people taking anticoagulants or who have a bleeding disorder unless under the direction of their regular physician.

Recommendation for children and adults[137-139]	Conditional
26. Over-the-counter medications such as paracetamol and ibuprofen may be recommended to treat acute headache in people with mTBI/concussion. Use paracetamol in those who are also taking anticoagulants or antiplatelet medication.	Adapted[31]

1.3.3 Discharge criteria

Persisting amnesia (e.g. >24 hours) and/or abnormal neurological findings can indicate a moderate/severe TBI or alternative diagnosis and require different management. People should have a normal neurological examination before being discharged; this should include an examination for persisting amnesia, using a validated tool (e.g. the Abbreviated Westmead Post-traumatic Amnesia Scale), if possible, to ensure safe discharge. Normal mental status should be specifically assessed to ensure safe discharge.

Clinical factors such as persistent abnormal GCS, focal neurological deficit, vomiting/severe headache, presence of coagulopathy, persistent drug or alcohol intoxication, presence of multi-system injuries, presence of concurrent medical problems, or age (<2years; >65 years; or >50 years in Aboriginal or Torres Strait Islander peoples) may indicate clinical risk factors warranting continued hospital observation.[39, 58, 79, 80]

Recommendation for children and adults[39, 58, 79, 80]	Conditional
27. People presenting with acute mTBI/concussion can be safely discharged for home observation in the care of a responsible adult if they meet all of the following clinical criteria: • normal neurological examination and mental status (alertness/behaviour/cognition) • no clinical risk factors indicating the need for head CT (or a normal head CT if performed due to presence of risk factors) • absence of risk factors warranting hospital admission (e.g. other injuries, clinical concerns [e.g. persistent vomiting], drug or alcohol intoxication, social factors, underlying medical conditions such as bleeding disorders or possible abusive head trauma).	Adopted[30]

1.4 Follow-up

Follow-up provides the opportunity for healthcare professionals to identify persisting post-concussive symptoms, which occur in 30-40% of children,[140] and are also prevalent in adults[141] and older people.[142, 143]

CT head is not indicated in people with mTBI/concussion presenting to the GP *unless* they have unexplained focal neurology, symptoms suggestive of raised intracranial pressure, or fulfills criteria for CT head (as indicated by the Canadian CT head injury/trauma rule, Nexus head CT instrument or PREDICT). If this is the case, refer to the emergency department.

1.4.1 Follow-up from the emergency department (for post-concussive symptoms)

Recommendation for children and adults[119, 120, 144-148]	Conditional
28. All people discharged from hospital after presenting with mTBI/concussion should be advised to follow up with their primary health professional (e.g. general practitioner) within 1 to 2 weeks for assessment of post-concussive symptoms and monitoring of clinical status.	Adapted[7, 30, 31]

1.4.2 Follow-up for post-concussive symptoms

Practice point for children and adults	
i. People (or their parents or carers) should be reassured that most post-concussive symptoms are not clinical indicators for imaging.	New

1.4.3 Referral of people with poor prognosis following mTBI/concussion

Recommendation for children and adults[119, 120, 144]	Conditional
29. For people at high risk of persisting symptoms (see Box A), qualified health care professionals should consider earlier referral to specialist services for post-concussive symptom management.	Adapted[7]

1.5 Prognosis

The symptoms experienced by most people with mTBI/concussion resolve within 1 to 3 months of the injury[24, 149, 150] but some people experience persisting symptoms and delayed recovery. People with mTBI/concussion who are at high risk for persisting symptoms or delayed recovery are more likely to require intervention than those at low risk.[5] Early identification of these factors and their treatment may facilitate recovery.

1.5.1 Predicting risk of persisting symptoms

A range of factors affect the severity and duration of persisting post-concussive symptoms.[143] These include concurrent factors such as pain, anxiety, depression, post-traumatic stress and litigation.[143] Pre-injury variables, including psychopathology, substance misuse, and other forms of acquired brain injury, can also affect

recovery.[143] Repetitive head trauma and greater severity of symptoms at initial presentation have been associated with symptoms persisting for more than one month, although the vast majority of these patients recover by three months.[151]

Practice point for children and adults[49, 62-71, 144, 145, 148, 152, 153]

j.	For people presenting with mTBI/concussion, qualified health care professionals should consider factors known to be associated with an increased risk of developing post-concussive symptoms (see Box A).	Adapted[7, 30, 31]

Box A: Modifiers that may delay recovery

Children	Adults
– Previous concussion/mTBI with delayed recovery – High pre-injury symptom burden – High symptom burden at initial presentation – Clinical evidence of vestibular or oculomotor dysfunction – Personal and family history of migraines – History of learning or behavioural difficulties – Personal and family history of poor mental health – Low family socioeconomic status/education	– High symptom burden at initial presentation – Neck pain – History of migraine or headache – Previous concussion/mTBI with delayed recovery – Injury obtained during traumatic circumstances, e.g. assault/fatal car crash – Previous mTBI/concussion – Mental health problems, depression, and/or anxiety pre-injury – Litigation

1.5.2 Counselling of prognosis/advice regarding prognosis

Practice point for children and adults[24, 28, 126, 154-158]

k.	Qualified health care professionals should counsel people with mTBI/concussion and their families that, although some factors predict an increased or decreased risk for persisting symptoms, each person's recovery from mTBI/concussion is unique and will follow its own trajectory.	Adapted[5]

Further guidance

Tools for assessing the risk of symptoms persisting are available from 5P study: Predicting and Preventing Post-concussive Problems in Pediatrics and the AUT Traumatic Brain Injury Network.

2 Return to activity

2.1 General activity

Evidence suggests that people with mTBI/concussion can safely and gradually resume normal activity (activities of daily living, work, school, duty, leisure) as early as 24 hours post-injury. Strict rest until symptom resolution is *not* effective for recovery from mTBI/concussion. Light physical activity that does not exacerbate symptoms during the 48 hours after injury facilitates recovery.[159]

Transient symptoms refer to a temporal onset of symptoms related to activity that typically resolve or improve in less than 24 hours. The onset of transient symptoms during a gradual return to activity is common and safe so long as these do not impair functional abilities beyond a short time frame and no new or further injury is caused. Exacerbation of symptoms lasting greater than 24 hours indicate that tolerance thresholds have been exceeded, and activity should be adjusted accordingly. Where progress is not seen, or is very slow, a reassessment by a healthcare professional is warranted.

2.1.1 Initial education and advice on return to physical activity

This section is relevant to return to physical activity (i.e. exercise), defined as any activity that gets the body moving, makes a person breathe faster and speeds up his or her heart rate.[160] Return to sport (defined as activity where physical exertion and skill are a primary focus, with elements of competition or social participation[161]) is discussed in Section 2.5.

Strict rest until symptom resolution is not effective for recovery from mTBI/concussion. Light physical activity that does not exacerbate symptoms during the 48 hours after injury facilitates recovery.[159]

Recommendations for children and adults[159, 162, 163]	**Strong**
30. Strict rest until the complete resolution of mTBI/concussion-related symptoms is not beneficial and not recommended.	Adapted[32]
31. Relative (not strict) rest is recommended for 24-48 hours after mTBI/concussion. Most activities of daily living can resume immediately.	Adapted[32]

Recommendation for children and adults[124, 159, 164, 165]	**Strong**
32. Following mTBI/concussion, physical activity should be started between 24 and 48 hours post injury, gradually increasing from low to moderate physical activity, provided that it is at a level that does not result in significant exacerbation of post-concussive symptoms. A small increase in symptoms (i.e. 20% increase in symptoms) is acceptable. Physical activities that pose no or low risk of sustaining another mTBI/concussion (e.g. walking or stationary cycling) are advisable.	Adapted[7, 32]

2.1.2 General recommendations

Recommendation for children and adults[159]	**Consensus-based**
33. Individuals should be advised to avoid the risk of re-injury (i.e. fall, contact or collision) until a qualified health care professional determines it is safe for higher risk activities.	Adopted[32]

Recommendations for children and adults[166-168]	**Conditional**
34. Explain that transient symptom worsening with increased activity is common.	Adapted[30]

Practice point for older people	
l. Where a fall was the cause of mTBI/concussion in an older person (see Glossary), early resumption of daily activities should be encouraged. It is important to provide information on falls prevention strategies.	New

Further guidance

Refer to the RACGP Falls Prevention in Older Adults website or World falls guidelines 2022[169] for further details on assessing and managing falls risk.

2.1.3 Screen time

Recommendation for children and adults[170]	Strong
35. Reduced screen use in the first 48 hours after mTBI/concussion is warranted but may not be effective beyond that time.	Adopted[32]

Practice point for children	
m. Parents and carers should be aware of general recommendations for screen use in children aged over 5 years; that is, promote that children get adequate sleep (8–12 hours, depending on age), recommend that children not sleep with devices in their bedrooms (including televisions, computers and smartphones) and avoid exposure to devices or screens for 1 hour before bedtime.	Adopted[7]

2.2 Return to driving/operating machinery

Considerations when a person returns to driving following mTBI/concussion include avoiding driving if there is potential for symptoms to affect the ability to drive safely, initially returning to driving with someone else in the car, starting with short, local trips, choosing not to drive at night, and reducing any additional demands or distractions when driving.

Recommendation for children and adults[171-173]	Consensus-based
36. People who have experienced mTBI/concussion should be advised to avoid driving or operating heavy machinery during the first 24 hours.	Adapted[30]
37. People returning to driving should be advised that symptoms such as blurred vision, dizziness, fatigue, impaired cognition, headache and neck pain or stiffness may affect their ability to drive or operate heavy machinery.	Adapted[30]

Further guidance

Guidance on assessing medical fitness to drive is available in Australia and New Zealand.

2.3 Return to work

Evidence indicates that encouraging people to gradually and progressively (hours and duties) return to some form of meaningful work (paid or unpaid) provides the opportunity for the individual to establish and maintain routine and structure to their day and their sleep schedule, to gradually build tolerance to environmental stimuli, to gradually build tolerance for physical and/or cognitive activities, and to provide a purpose for the day. Returning to meaningful activities earlier helps to promote both physical and mental recovery and results in higher likelihood of success.[174] For individuals who experience prolonged symptoms and workplace difficulties despite an active treatment approach, health professionals should refer the individual for a formal evaluation by a specialist, vocational occupational therapist or an interdisciplinary concussion team where available.

Recommendation for adolescents and adults[175-177]	Conditional
38. Encourage people to return to some form of work, so long as work does not place the person at high risk of reinjury. Facilitate identification of necessary modifications (to decrease the risk of reinjury) and appropriate accommodations by clearly identifying exacerbators of symptoms and functional limitations (physical, cognitive and emotional).	Adapted[30]
39. Students should have returned to school full-time before commencing extra-curricular work (unless part of educational activity).	Adapted[30]

In situations where persisting symptoms were not successfully managed with an individualised treatment or rehabilitation plan, a broad variety of meaningful activities that promote recovery or provide a sense of purpose may be a consideration.

Recommendation for adults[178]	Consensus-based
40. When persisting post-concussive symptoms pose a barrier to return to pre-injury employment, introduction of other meaningful activities that facilitate recovery should be considered. Other employment (full-time or part-time), educational activities, community roles, and activities that promote community integration (e.g. volunteer work) may be considered as an alternative focus for meaningful activities.	Adopted[30]

2.4 Return to school/learning

The transition back to school/university and learning following mTBI/concussion is an important consideration for children, adolescents and young adults. A systematic review revealed that most athletes (93%) of all ages have a full return to learning with no additional academic support by 10 days.[179] The process of quickly returning to learning may be more challenging for students with specific considerations (e.g. high acute symptom severity, a prior learning disability) that may affect recovery.[179]

Children and adolescents, especially those studying at high school or university, may have different requirements due to the increased demands of home work and exams.[180] Educational accommodations should be based on resolution of symptoms (physical, cognitive, emotional and sleep/fatigue) and age/school level of the child/youth. Accommodations may include part-time school, rest breaks, low-noise contexts, reduction in subject load, as well as the extra time in exams. These accommodations may need to extend past symptom resolution for a short period to allow the student to "catch-up" on what they have missed while coping with the demands of current learning tasks.[181] The young person and family should work with the school to arrange accommodations. Most educational systems will accept recommendations from medical, allied health, and/or psychology professionals for formal process such as reasonable accommodations for exams.

2.4.1 Timing of return to school/learning

Recommendations for children and adults[178, 179, 182-184]	Consensus-based
41. To minimise academic and social disruptions following mTBI/concussion, qualified health care professionals should not recommend complete rest and isolation, even for the initial 24–48 hours, and instead recommend a period of relative rest.	Adopted[32]
42. Complete absence from the school / education environment for more than one week is not generally recommended. Children/adolescents should receive temporary academic accommodations (e.g. modifications to schedule, classroom environment and workload) to support a return to the school environment in some capacity as soon as possible.	Adapted[31]

Recommendation for children and adolescents[73, 185-189]	Consensus-based
43. A child or adolescent should return to their school environment as soon as they are able to tolerate engaging in cognitive activities without overly exacerbating their symptoms, even if they are still experiencing symptoms. Return-to-school protocols should be personalised, gradually increased based on the symptom severity, guided jointly by health-care and school-based teams, and be modified based on ongoing assessment of symptoms.	Adapted[5, 31]

Table 2 Return to learn strategy

Step	Mental activity	Activity at each step	Goal
1	Daily activities that do not result in more than a mild exacerbation of symptoms	Typical activities during the day (e.g. reading) while minimising screen time. Start with 5–15 min at a time and increase gradually	Gradual return to typical activities
2	School activities	Homework, reading or other cognitive activities outside the classroom	Increase tolerance to cognitive work
3	Return to school part-time	Gradual introduction of schoolwork. May need to start with a partial school day or with greater access to rest breaks during the day	Increase academic activities
4	Return to school full-time	Gradually progress in school activities until a full day can be tolerated without more than mild symptom exacerbation	Return to full academic activities and catch up on missed work

Source: Patricios JS, Schneider KJ, Dvorak J, Ahmed OH, Blauwet C, Cantu RC, et al. Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport-Amsterdam, October 2022. British Journal of Sports Medicine. 2023;57(11):695-711. doi: 10.1136/bjsports-2023-106898.

Notes: *Mild and brief exacerbation of symptoms can occur during a graded return to learn/education. Begin at Step 1 (i.e. within 24-48 hours of injury) with progression through each subsequent step. Several days at each step may be required and should be guided by symptoms, ideally with the involvement of the health care practitioner and/or school/educator. Where return is problematic, a review by a health care practitioner is warranted and a referral to a health care practitioner experienced in concussion management, neuropsychologist, or interdisciplinary concussion clinic may be required.

2.4.2 Supports/accommodations for return to learning

Recommendation for children and adolescents	Consensus-based
44. In consultation with educators, and accounting for social determinants of health, some students may be offered temporary academic supports to promote return to learning including: • environmental adjustments, such as modified school attendance, frequent rest breaks from cognitive/thinking/deskwork tasks throughout the day and/or limited screen time on electronic devices • physical adjustments to avoid any activities at risk of contact, collision or falls, such as contact sports or game play during physical education classes or after-school activities, while allowing for safe non-contact physical activity (e.g. walking) • curriculum adjustments, such as extra time to complete assignments/homework and/or preprinted class notes • testing adjustments, such as delaying tests/quizzes and/or permitting additional time to complete them.	Adapted[32]

2.4.3 Prioritisation of return to school/learning

Recommendations for children and adolescents[179]	Conditional
45. Return-to-school is a priority in children and adolescents, and while full return to learn is recommended before unrestricted return to sport, the two strategies can occur in parallel.	Adapted[31, 32]

2.4.4 Ongoing supports for school difficulties

The type of accommodations and their duration should be determined based on resolution of symptoms across all domains (physical, cognitive, emotional, sleep/fatigue) and the age/school level of the child/young person. Sufficient support should be put in place to allow the student to catch up on work missed and any non-essential assignments to be waived or modified. Regular contact between the student (and family) and the school about their recovery improves communication and understanding, ideally with a sense of partnership between the school and family.

For most students, accommodations are short term. Students requiring accommodations for more than 3-6 months should be referred to specialized concussion services or providers with experience in learning and mental health such as psychologist, educational psychologist, or neuropsychologist. The purpose is to investigate the barriers to recovery, assess any underlying learning or mental health problems, and determine the best supportive strategies.

Recommendation for children and adolescents[187, 190-193]	Conditional
46. For students who experience prolonged symptoms and academic difficulties despite an active treatment approach, qualified health care professionals should refer the child for a formal evaluation by a specialist in paediatric mTBI/concussion, or an interdisciplinary concussion team where available.	Adapted[5]

Please refer to Section 4.5 'Assessment and management of specific systems- Cognitive difficulties' for further guidance.

Further guidance

Online information about educational support (right to education) for students for each state or territory is available: Australian Capital Territory, New South Wales, the Northern Territory, Queensland, South Australia, Tasmania, Victoria, and Western Australia.

2.5 Return to sport

Deferring return to sport decreases the likelihood of repeat mTBI/concussion.[179] Avoidance of repeated head injury decreases time to recovery and decreases length of persisting symptoms.[179] The graduated return to play should be individualised based on symptoms, with return to sport occurring only when symptom-free in the context of all activities including school/work. While a minimum period between injury and return to sport is controversial, consultation on the matter has shown that health professionals and consumers want consistent advice across sports that is feasible to implement into current practice across Australia and Aotearoa New Zealand.

To develop a recommendation, the GDG looked at different concussion protocols across different sporting codes in Australia and Aotearoa New Zealand, most of which did not have a common 'return to play' strategy. The group also looked at national and international guidelines, in particular recommendations from national bodies such as the New Zealand Accident Compensation Corporation (ACC), UK government on non-elite sports, and sporting organisations such as World Rugby and AFL community guidelines.

The following consensus-based recommendations are based on the results of a Delphi poll undertaken to reach consensus among the GDG. The recommendations relate to **community sports** and follows similar recommendations from national bodies such as the AIS, NZ ACC, UK government on non-elite sports and sporting organisations such as World Rugby and AFL community guidelines.

See Section 5 for returning to sport in the context of repeated injury.

Recommendation for children and adults[32]	Consensus-based
47. Return to sport strategies should be individualised, follow the recommended guidelines, and be monitored by a qualified health care professional.	New
48. People who experience mTBI/concussion should gradually progress through return-to-learn and return-to-sport stages (specific steps are outlined in Table 2, Table 3 and Figure 3 in Aotearoa New Zealand), ensuring a minimum time away from play of 21 days from injury.	New

Table 3 Return-to-sport strategy

Each step typically takes a minimum of 24 hours			
Step	**Exercise strategy**	**Activity at each step**	**Goal**
1	Symptom-limited activity	Daily activities that do not exacerbate symptoms (e.g. walking).	Gradual reintroduction of work/school
2	Aerobic exercise **2A—Light** (up to approximately 55% maxHR) **then** **2B—Moderate** (up to approximately 70% maxHR)	Stationary cycling or walking at slow to medium pace. May start light resistance training that does not result in more than mild and brief exacerbation* of concussion symptoms.	Increase heart rate
3	Individual sport-specific exercise Note: If sport-specific training involves any risk of inadvertent head impact, medical clearance should occur prior to Step 3	Sport-specific training away from the team environment (e.g. running, change of direction and/or individual training drills away from the team environment). No activities at risk of head impact.	Add movement, change of direction
Steps 4–6 should begin after the resolution of any symptoms, abnormalities in cognitive function and any other clinical findings related to the current concussion, including with and after physical exertion.			
4	Non-contact training drills	Exercise to high intensity including more challenging training drills (e.g. passing drills, multiplayer training) can integrate into a team environment.	Resume usual intensity of exercise, coordination and increased thinking
5	Full contact practice	Participate in normal training activities.	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play.	

Notes: *Mild and brief exacerbation of symptoms (i.e. an increase of no more than 2 points on a 0–10 point scale for less than an hour when compared with the baseline value reported prior to physical activity). Athletes may begin Step 1 (i.e. symptom-limited activity) within 24 hours of injury, with progression through each subsequent step typically taking a minimum of 24 hours, noting that the entire RTS process is subject to a minimum duration of 21 days. If more than mild exacerbation of symptoms (i.e. more than 2 points on a 0–10 scale) occurs during Steps 1–3, the athlete should stop and attempt to exercise the next day. Athletes experiencing concussion-related symptoms during Steps 4–6 should return to Step 3 to establish full resolution of symptoms with exertion before engaging in at-risk activities. A minimum of 21 days away from play following injury should be adhered to before returning to normal game play. Written determination of readiness to RTS should be provided by a health care professional before unrestricted RTS as directed by local laws and/or sporting regulations.

maxHR=predicted maximal heart rate according to age (i.e. 220-age).

Source: Patricios JS, Schneider KJ, Dvorak J, Ahmed OH, Blauwet C, Cantu RC, et al. Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport-Amsterdam, October 2022. British Journal of Sports Medicine. 2023;57(11):695-711. doi: 10.1136/bjsports-2023-106898.

Figure 3 New Zealand Accident Commission Corporation guidelines on graduated return to education, work and sport

Day 0 = Day of the injury/concussion

GRADUATED RETURN TO EDUCATION/WORK AND SPORT PROTOCOL			
Stage 1	**Day 1–2**		Relative rest for 24–48 hours (i.e. light activities of daily living that do not provoke symptoms are ok) • Minimise screen time • Gentle exercise (i.e. walking around the house)
Stage 2	**Day 2–13**	Minimum of 24 hours between stages before progressing	Gradually introduce daily activities • Activities away from school/work (introduce TV, increase reading, games etc) • Exercise – light physical activity (e.g. short walks outside)
Stage 3		Symptoms should be progressively improving	Increase tolerance for mental and exercise activities • Increase study/work-related activities with rest periods • Increase intensity of exercise guided by symptoms
Stage 4		If symptoms worsen drop back a stage	Return to work/study and sport training • Part time return to work/education • Start training activity without risk of head impact
Stage 5	**Earliest Day 14**		Return to normal work/study and sport-specific training • Completion of Stages 1–4 **AND** • Fully integrated into work or school **AND** • **Symptom free** • **And ≥ Day 14 post-injury** ➔ reintegration into full sport-specific training can occur
Stage 6	**Earliest Day 21**		Return to sports competition • Completion of Stage 5 **AND** • **Symptom free during sports training** • **AND ≥ Day 21 post-injury** • **AND** the (player) has received medical clearance from a qualified medical professional (from a general practice or primary care team).

Source: NZ Accident Compensation Corporation. *Sport concussion in New Zealand: National guidelines*. 2024. NZ ACC: Wellington.

3 Assessment and management of persisting symptoms

Symptoms attributed to mTBI/concussion are non-specific, commonly also reported by healthy individuals and those with conditions other than mTBI/concussion, and can be exacerbated by biopsychosocial factors aside from mTBI/concussion.[32] Other problems may exist prior to injury but can be exacerbated by a mTBI/concussion, co-occur with persisting symptoms or mimic persisting symptoms but may not arise from mTBI/concussion.[32]

The rate of recovery from a mTBI/concussion is influenced by a range of factors, including previous medical conditions, pre-injury mood and anxiety disturbances, learning difficulties, attention deficit disorders, and the mechanism and setting for the initial injury.[30] While related symptoms usually resolve within a few weeks of the injury, they may continue for longer than 4 weeks. These are considered as 'persisting symptoms' and occur in 30–40% of children and as many as 20–50% of adults.[25, 26]

A coordinated approach to the assessment and management of persisting symptoms facilitates symptom improvement and potential recovery.[30] Validated assessment and monitoring tools may assist this approach.[30] Common considerations in the context of persisting symptoms include headache disorders and migraine; sleep disturbance and fatigue; mental health issues; learning or attention difficulties; visual, oculomotor, cervical and vestibular problems; dysautonomia, including orthostatic intolerance and postural orthostatic tachycardia syndrome; and pain.[32]

Referral to specialised services such as an interdisciplinary concussion team where available, or a coordination of care via a GP, especially where symptoms show no improvement or only slow improvement, can facilitate this coordinated approach.[144]

3.1 Assessing persisting symptoms

Symptoms that are considered the most debilitating and that are therefore prioritised for assessment and management are headache, mood, fatigue and insomnia.[194] These symptoms frequently impede the ability to administer active rehabilitation interventions.[194]

Review of a person's current medication and substance use has the potential to identify the use of those that may exacerbate symptoms and those where lack of adherence to prescribed dosing can effect recovery.[195] Another concern is the potential for commonly encountered complications such as medication-overuse headache with the use of simple analgesics.[196]

Pain can be a factor in maintaining persisting symptoms and/or can overlap with or exacerbate symptoms of mTBI/concussion.[197] Neck injury and pain is a common comorbid condition following mTBI/concussion and can impede recovery.[197] There is significant overlap in symptoms of a neck injury and mTBI/concussion (e.g. headache, dizziness and visual disturbances) and the neck should be considered as a potential source of symptoms post mTBI/concussion.[198, 199]

Recommendation for children and adults[194, 200-209]	**Conditional**
49. The assessment and management of an individual with persisting mTBI/concussion-related symptoms should be directed towards specific symptoms identified and monitored with a symptom checklist. The person's most prominent symptoms or impairments should be directly assessed, including: • headache (including neck pain), migraine • mood (i.e. depression), anxiety, post-traumatic stress disorder, somatisation and other trauma and stressor-related disorders • sleep • dizziness, balance and visual problems • cognitive symptoms (memory loss, attention) • fatigue • screening for medication/substances that may mask or modify the symptoms.	Adapted[30]
50. Physical examination should be conducted and include: • vital signs (resting heart rate and blood pressure) • complete neurological examination (cranial nerve, motor, sensory, reflex, cerebellar, gait, balance testing) • cervical spine examination (palpation, range of motion, provocative cervical spine tests) • mental state examination including cognitive screening • further examination of the individual should be based on symptoms. Assessments may need to be conducted over a number of appointments.	Adapted [31]

Recommendations for children and adults[195]	**Consensus-based**
51. The assessment of persisting symptoms should include a review of currently prescribed medications (and adherence), and non-prescribed medications/supplements and substance use, including but not limited to alcohol, cannabis and other drugs.	Adapted[30]
52. Repeat medical assessment is advisable for people with concerning or worsening post-concussion symptoms at 1-2 weeks following acute injury and then at 4 weeks in people with persisting symptoms.	Adapted [31]

Further guidance

Standardised tools for the assessment of mTBI/concussion-related symptoms include the SCOAT6, BIST, PC-PTSD-5, PCL-5 and VOMS.

Recommendation for children and adults[197, 210]	**Strong**
53. When neck pain is present, careful and thorough clinical examination is required. Investigation (i.e. imaging) should only be conducted according to established imaging guidelines (e.g. NEXUS, Canadian C-spine rule)	Adapted[30]

Practice point for children and adults

n.	For people with persisting symptoms following mTBI/concussion, clinical assessment including identification of factors that may suggest an alternative diagnosis is recommended.	New

3.1.1 Differential diagnosis of persisting symptoms

Prolonged physical, cognitive, and/or psychological symptoms following mTBI/concussion can be non-specific and may overlap with other conditions, diagnoses, comorbidities, and premorbid diagnoses.[8, 211] The medical professional should continue to consider alternative diagnoses or factors which may be preventing or delaying symptom resolution and seek medical advice.

Functional neurological disorder should be considered early, especially where symptoms are progressive, atypical, fail to improve, last longer than three months, and/or follow biomechanically implausible injury, to ensure patients access more appropriate care pathways and avoid unnecessary investigations and incorrect treatments.

Further guidance

Further resources on functional neurological disorder are available online.

Post-traumatic stress symptoms or disorder (PTSD) can also overlap with persisting post-concussion symptoms. Here, memories revisiting the trauma trigger subconscious neurobiological responses and heightened emotional reactions. PTSD should be considered when minor provocations lead to exaggerated emotional responses and/or minor challenges cause the patient to freeze or become helpless. Complex PTSD (cPTSD) can occur in adults and children who have experienced repeated or prolonged psychological trauma. PTSD and cPTSD requires specialized management by psychologists experienced in this area and not usually offered within an interdisciplinary concussion team.

Recommendation for children and adults[197, 200-204]	**Strong**	
54.	Careful and thorough differential diagnoses should be considered as similar symptoms are common in chronic pain, depression, anxiety disorders, sleep disorders, functional neurological disorder, and other medical and psychiatric disorders (see Box B).	Adapted[30]

Box B: Differential diagnoses related to mTBI/concussion

- Major depressive disorder
- Generalised anxiety disorder
- Post-traumatic stress disorder
- Chronic pain syndrome
- Cervical strain/whiplash associated disorder
- Somatic syndrome disorder
- Functional neurological disorder
- Malingering
- Fibromyalgia syndrome (secondary)
- Primary sleep disorder (e.g. obstructive sleep apnoea)

Source: Marshall S, Lithopoulos A, Curran D, Fischer L, Velikonja D, Bayley M. Living concussion guidelines: Guideline for concussion and prolonged symptoms for adults 18 years or older 2023.

Further guidance

Differential diagnoses related to mTBI/concussion are defined by ICD-10.

3.2 Managing persisting symptoms

There are several potential causes of persisting symptoms post-concussion including vestibular, ocular, physiological and the cervical spine. Adjustment problems and new or pre-existing psychological disorders commonly play a role when persisting symptoms extend beyond 3 months. Strategies for management include symptom reduction strategies, targeted treatments to the causes of the symptoms,

psychological support, and strategies for graduated return to activities of daily living, learning, and work. Care should be taken to avoid medication overuse.

Early re-introduction of usual daily activities should occur within the first few days of injury. Gradual reintroduction to activity is recommended,[212] as opposed to returning to full participation once individuals are symptom free at rest, as a recurrence of symptoms with exercise may indicate incomplete recovery from a concussion.[213, 214]

Targeted treatments combined with accessible and comprehensible education about mTBI/concussion aim to resolve symptoms, with the goal of return to baseline function.[26, 144, 194, 215, 216] Since symptoms are often interrelated and impact one another, ideally the delivery of these treatments should be integrated, with communication amongst health professionals delivering them to optimise outcomes.

Recommendation for children and adults[125, 217-224]	**Conditional**
55. Individuals with symptoms that persist after 4 weeks should be informed and reassured that a symptom-based approach will facilitate recovery and that symptom resolution is achieved by most people. This information should be provided in written, verbal and/or pictorial formats and should also outline mental health considerations, and non-pharmacological strategies to minimise symptoms including: • activity modifications • limiting triggers • managing fatigue • sleep hygiene • the importance of social interaction • activities of daily living • graduated return to cognitive and physical activity • working with the school team/employer to facilitate school/work success.	Adapted[30, 31]

Recommendations for children and adults[166-168]	**Conditional**
56. For people with persisting symptoms, a slower progression in return to normal activity should be implemented if symptom worsening is more than mild or is prolonged.	Adapted[30]

Recommendations for children and adults[225-233]	**Strong**
57. The use of hyperbaric oxygen to treat symptoms post- mTBI/concussion is <u>not</u> recommended.	Adapted[30]

Recommendation for children and adults	**Consensus-based**
58. Treatment for specific symptoms or concerns should be initiated while waiting for a referral to an interdisciplinary concussion team or sub-specialist.	Adapted[31]

3.2.1 Return to activity with persisting symptoms

Recommendation for children and adults[159]	**Consensus-based**
59. Encourage people with persisting symptoms to engage in cognitive activity and low-risk physical activity while staying below their symptom-exacerbation threshold. Activities that pose no/low risk of sustaining a mTBI/concussion (no risk of contact, collision, or falling) should be resumed even if mild residual symptoms are present or whenever acute symptoms improve sufficiently to permit activity.	Adapted[31]

3.2.2 Follow-up and referral for people with persisting symptoms

An interdisciplinary concussion team (see Glossary) is defined as a location or network where people with mTBI/concussion are assessed by a physician with experience in concussion management and an allied team of interdisciplinary practitioners.[234] Management by an interdisciplinary concussion team includes specific assessment and treatment recommendations, and may include a period of follow-up. As the individual's regular doctor is an important part of this team, communication and ongoing follow-up with the GP is recommended. In rural and remote areas access to such services can be difficult, here GP or alternative local health care professional monitoring together with telehealth services can be used to organise assessments, optimise local services, and plan more specialised services where needed.

Recommendation for children and adults[177, 219, 235-237]	**Consensus-based**
60. Referral to interdisciplinary concussion team or subspecialist (where available) should be considered for people who have persisting symptoms.	Adapted[30]

4 Assessment and management of specific symptoms

4.1 Headache

Headaches are the most common symptom following mTBI/concussion.[238] The pathophysiology of post-traumatic headaches is not well understood.[239] While most people with post-traumatic headache improve within days or weeks, headaches may persist beyond this time frame, up to months or years in some individuals.[240] The International Classification of Headache Disorders (ICHD-III) includes diagnostic criteria for both acute and persistent post-traumatic headache following mTBI.[241] In most people, headaches can be well managed using simple analgesics (NSAIDS and paracetamol). Some people, however, have significant morbidity due to post-traumatic headache.[242] Identifying the headache phenotype, can inform management. Post-traumatic headache with migraine-like phenotype often lasts longer and has a worse outcome than a tension-type phenotype.[243]

In addition to the trigeminal system, the upper cervical nerve roots and upper cervical cord play and important role in headache.[244] Careful examination of the cervical spine as well as the head and neck can help to identify factors commonly associated with headache after mTBI/concussion such as facet joint injury and occipital neuralgia. When identified occipital nerve blocks, peripheral nerve blocks, and/or cervical physiotherapy can lead to rapid improvements in headache.

Although physical activity has been demonstrated to increase the rate of recovery following mTBI/concussion and in migraine,[159, 245] the evidence for its effectiveness in post-traumatic headache is limited. Regardless, gradual introduction of exercise is recommended.[212] As worsening of headache is commonly reported with exercise, headache can impede graded return to activity.[181] Here, the involvement of a physiotherapist or exercise physiologist can help graded introduction of exercise working with the medical specialist. Sometimes, there is significant fear and anxiety about the effect of activity on a patient's headaches or other post-concussive symptoms which limits recovery. This can lead to avoidance of physical activity (kinesiophobia), cognitive activity (cogniphobia),[214] and sensory stimuli (such as noise and light). As this is often associated with significantly increased disability, the involvement of a psychologist or behavioural occupational therapist can be helpful.[214]

Caution should be taken to avoid medication overuse (defined as 15 days a month or more use of simple analgesics or 10 days a month or more of combination analgesics or triptans), which can contribute to persistent post-traumatic headaches.[246] The evidence to support spinal manipulation as part of headache management is limited, and is not recommended for infants or following trauma[247, 248]. Pharmacotherapy is usually guided by the headache phenotype as well as effective management of comorbidities i.e. amitriptyline can be useful for headache as well as insomnia.

4.1.1 Diagnosis

Headache subtypes typically include migraine-like and tension types but other considerations are occipital neuralgia, medication-overuse headache and cervicogenic headache.[249, 250] Identification of headache subtypes can help to guide management. Specialist assessment of headache should be considered in children less than 5 years of age and in people whose cognitive disability may impede assessment.

Recommendation for children and adults[250, 251]	**Conditional**
61. Identification of the headache phenotype can inform management.	Adapted[30]
62. A qualified health care professional should take a comprehensive headache history (see Box C) to identify the headache phenotype(s) that most closely resemble(s) the person's symptoms.	Adapted[30]

Box C: Important components to include in the focussed headache history

– Headache frequency – Headache duration – Headache location – Headache intensity – Quality of the pain (pressure, throbbing, stabbing)	– Associated symptoms (e.g. nausea/vomiting) – Precipitating/provoking factors – Alleviating factors – Previous treatment experiences and responses to date (including benefits and side-effects) – Previous headache history

Source: Marshall S, Lithopoulos A, Curran D, Fischer L, Velikonja D, Bayley M. Living concussion guidelines: Guideline for concussion and prolonged symptoms for adults 18 years or older 2023 [Available from: https://concussionsontario.org.

Recommendations for children and adults[249, 250, 252-254]	**Conditional**
63. Personal, environmental, work-related, school-related, and physical factors such as neck pain should be identified and addressed as potential headache contributors.	Adopted[30]
64. Establish the degree of headache-related disability (taking a biopsychosocial approach) to assist in preparing a treatment approach (i.e. non-pharmacological and/or pharmacological).	Adopted[30]

Recommendation for children and adults	**Consensus-based**
65. The qualified health care professionals treating post-traumatic headaches should perform neurological and musculoskeletal examinations, including blood pressure and heart rate monitoring (both lying and standing), cervical spine and vestibulo-ocular system examination.	Adapted[30]

4.1.2 Assessment of headache

A headache diary is a tool that aims to:

- help people with post-traumatic headache and their treating health care professional to identify the frequency, duration, and severity of the headaches
- aid in identifying the type, frequency, and amount of acute headache medications used
- help to recognise potential headache triggers
- guide treatment decisions and evaluate response to treatment
- help the qualified health care professional identify possible medication overuse headache.

In children under 5 years of age, a headache diary is not helpful and behavioural observations such as irritability may be the main indicator of headache.[255, 256]

Recommendation for children and adults	**Consensus-based**
66. People older than 5 years with post-traumatic headache should be encouraged to maintain an accurate headache and medication diary (see Box D) and to bring it to every follow-up visit with their treating health care professional.	Adapted[30]

Box D: Components tracked in a headache diary

Date	Time (*start/finish*)	Preceding symptoms	Triggers	Medication (*and dosage*)	Relief (*complete/moderate/none*)

Source: Marshall S, Lithopoulos A, Curran D, Fischer L, Velikonja D, Bayley M. Living concussion guidelines: Guideline for concussion and prolonged symptoms for adults 18 years or older 2023

Further guidance

The Headache Impact Test (HIT6, adult) and Paediatric Migraine Disability Assessment Tool (PedMIDAS, children) may also assist in the assessment of headaches

A headache diary can be downloaded from Headache Australia

Recommendation for children and adults	Consensus-based
67. Although most people with post-traumatic headache do not require imaging, brain or cervical spine imaging (MRI or brain CT) is a consideration when neurologic signs or symptoms are suggestive of possible intracranial pathology or significant cervical spine injury.	Adopted[30]

4.1.3 Education

Maintaining consistent bedtime and wake time, moderating triggers (e.g. screen time, neck position when using screens), consuming consistent meals with no skipped or delayed meals, good hydration, regular low-intensity cardiovascular exercise, use of relaxation, stress-management, and mindfulness-based strategies may provide relief from post-traumatic headache.[30]

Recommendation for children and adults	Consensus-based
68. Education should be provided to the person with post-traumatic headache on the lifestyle strategies useful for potentially minimising headache occurrence and/or decreasing the impact of headaches when they occur.	Adapted[30]

Further guidance

People with post-traumatic headache may benefit from advice on additional self-regulated intervention and lifestyle strategies to minimise headache occurrence.

Additional information is available from Headache Australia.

4.1.4 Pharmacological treatment for headache

People may use acute headache medications to try to reduce the severity, duration, and disability associated with individual headache attacks. The use of these medications needs to be limited in frequency to minimise the potential for medication overuse (rebound) headache. Although the supporting evidence is limited, preventative headache therapy should be considered where headaches are frequent and/or disabling.[257, 258] The type of treatment is informed by the headache phenotype i.e. post-traumatic migraine-like headache is managed with a migraine-directed approach. Various treatment algorithms have been proposed,[259] although more research is needed to determine their effectiveness. Pharmacotherapy is often used in as part of a multidisciplinary approach, especially when headaches persist or are difficult to manage.

Recommendations for children and adults[259]	Consensus-based
69. Over the counter analgesics (e.g. paracetamol, ibuprofen, aspirin, naproxen) should be used less than 15 days per month.	Adopted[30]
70. Combination analgesics (i.e. with caffeine or codeine) should be used less than 10 days per month.	Adopted[30]
71. Migraine-specific acute therapies should be trialled when non-specific acute therapies are incompletely effective. Triptans can be used for migrainous-type headaches less than 10 days per month.	Adopted[30]

Recommendations for children and adults[259]	Consensus-based
72. When headaches are too frequent (e.g. more than 10 days per month) or disabling, prophylactic therapy should be considered	Adopted[30]

Practice point	
o. Prophylactic therapy should be guided by headache phenotype.	Adopted[30]

4.1.5 Follow-up and referral for headache

Recommendations for children and adults	Consensus-based
73. Post-traumatic headaches may be unresponsive to conventional treatments. If headaches remain inadequately controlled, referral to a neurologist, headache specialist, paediatrician, or interdisciplinary concussion team is recommended.	Adopted[30, 31]

4.2 Sleep disturbances

More than 50% of people report sleep disturbances following mTBI/concussion, specifically symptoms that may indicate insomnia, hypersomnia, obstructive sleep apnoea, poor sleep maintenance, poor sleep efficiency, early awakening, delayed sleep onset, or alterations in circadian cycle.[260-265] While the need for sleep may increase in the immediate acute stage of mTBI/concussion,[260] this decreases over time. The key is to recognise sleep disturbance and its cause.

Insomnia is the most common form of sleep disturbance reported in the subacute and chronic stages of mTBI/concussion, occurring in as many as 70% of people especially older adults and women.[266-270] Always check for the possibility of other sleep disorders such as obstructive sleep apnoea, restless legs syndrome and depression, treating as appropriate. Simple management strategies for insomnia can help including education about normal sleep and normal waking during sleep and by initiating sleep hygiene measures.

Relaxation techniques such as mindfulness, cognitive behavioural therapy, progressive muscle relaxation, meditation, and breathing techniques can help manage insomnia.[271]

Adolescents commonly report circadian rhythm problems such as delayed sleep phase disorder where sleep is delayed two or more hours from usual sleep patterns making it harder to wake in time for work or school. These need management strategies targeted for circadian rhythm disorders (including avoidance of long sleep-ins on the weekend; using light exposure after latest getting up time and moving this earlier every 3 days and adding in/increasing exercise according to return to activity guidelines). Melatonin has been shown to improve sleep following mTBI/concussion[272, 273]; this should occur in conjunction with sleep hygiene, insomnia, and circadian rhythm disorder management.

4.2.1 Diagnosis

Recommendation for children and adults[267]	Consensus-based
74. A repeat medical assessment should be performed for all people presenting with sleep disturbances 1-2 weeks following acute mTBI/concussion.	Adapted[31]
75. People with post-concussion symptoms should be routinely screened for sleep-related problems (i.e. sleep disturbances). For those screening positive, sleep should be evaluated using a validated assessment tool, particularly for insomnia.	Adopted[30]

Further guidance

The Australasian Sleep Association provides guidance on assessment and management of insomnia that is endorsed by the RACGP.

4.2.2 Assessment

Sleep monitoring devices such as a sleep diary, and technological solutions for monitoring sleep (e.g. smart watches) can help recognise patterns in sleep habits.[274] Sleep trackers (e.g. smart watches) don't measure sleep directly and this can only be done with a medical sleep study. When used with professional guidance, sleep trackers may aid in assessment of sleep quantity and the efficacy of current treatments in relation to the number of hours of sleep per night, the number of times one wakes up throughout the night, antecedents, and disturbances which may be impacting sleep.[274]

Recommendation for children and adults[274]	**Consensus-based**
76. When criteria are met for chronic insomnia, sleep should be monitored for improvement over time using validated person-reported outcome measures or sleep monitoring devices.	Adapted[30]
77. Other pre-existing sleep-wake disturbances and medical conditions that influence sleep should be screened for and treated. Medications that influence sleep (including supplements, herbal medicines or steroid medications) should be noted and their use monitored.	Adapted[30]

4.2.3 Education

Sleep disturbance is common following mTBI/concussion, with most people having mild symptoms and achieving full recovery with time.[267] While most sleep-related problems will resolve spontaneously, targeted intervention may be required to facilitate recovery.[267] Poor sleep may exacerbate other symptoms such as headache, fatigue, mood disturbances and cognitive problems possibly contributing to delayed recovery.[268, 275, 276] Targeted treatment of sleep disturbances, alongside other more disabling symptoms of headache, fatigue and mood is likely to improve overall recovery.

Evidence is lacking about when it is safe or appropriate to intervene earlier for sleep disturbances, and what is the appropriate treatment if earlier intervention is required. Further research on this question is required.

Recommendation for children and adults[201, 222, 264, 266, 270, 275, 277-284]	**Conditional**
78. Education and treatment of sleep disturbances (including sleep apnoea) should be prioritised (along with headache and mood), given their significant impact and interaction with other functionally limiting symptoms.	Adapted[30]

Recommendation for children and adults[267, 268, 275, 276]	**Consensus-based**
79. Education on sleep disturbances should be provided in written, verbal and/or pictorial formats.	Adapted[30]

4.2.4 Treatment

Melatonin

Melatonin is a natural hormone supplement that is used to adjust the body's internal clock, or circadian rhythm. It has been demonstrated to have efficacy in treating sleep problems in children with persisting post-concussion symptoms [285] and adults with traumatic brain injury.[286] Several supplements have been found useful to promote sleep. Magnesium can cause drowsiness, which can help people to fall asleep. Additionally, dietary zinc has been shown to help increase the amount of quality sleep.

Cognitive behavioural therapy (CBT) is the treatment of choice for sleep-wake disorders following mTBI/concussion.[287-289] If CBT provided by a licensed health care professional is not available, remote delivery of CBT and self-management strategies are also effective to reduce sleep wake disturbances. CBT for persistent insomnia incorporates:

- *sleep restriction*: limiting time spent in bed during the day

- *stimulus control*: build associations between the bedroom and sleep
- *relaxation*: e.g. deep breathing, progressive muscular relaxation
- *cognitive therapy*: address thoughts, beliefs, and attitudes related to sleep and consequences of sleep problems
- meditation

Recently, alternative psychotherapies such as Acceptance and Commitment Therapy (ACT) are showing promise in this area.

Recommendation for children and adults[287]	**Consensus-based**
80. People with insomnia should be given advice on sleep hygiene (see Box E) and self-management strategies or programs.	Adapted[30]

Box E: Sleep hygiene suggestions

- Get up at same time each day
- Go to bed only when sleepy
- Stay in bed only when asleep
- Do not nap during the day
- Limit caffeine/alcohol/cigarettes at night
- Exercise regularly

Source: HANDI RACGP

Recommendation for children and adults[273, 290-292]	**Strong**
81. Advise people with post-concussive insomnia to use melatonin (2-5 mg two hours before bedtime).	Adapted[30]

Recommendation for children and adults[290-294]	**Conditional**
82. Advise on reduced evening light exposure and consider bright light exposure or blue light therapy in the morning.	Adapted[30]

Cognitive behavioural therapy

Recommendation for children and adults[287, 288]	**Conditional**
83. Refer people with prolonged post-concussive insomnia for cognitive behavioural therapy (CBT) specifically for sleep or to a sleep physician (where accessible).	Adapted[30]

Practice points for sleep problems after mTBI/concussion	
p. Maintain a high index of suspicion for sleep problems.	New
q. Screen for obstructive sleep apnoea and depression as cause of poor sleep.	New
r. Assess sleep using a sleep diary over 2–3 weeks.	New
s. Encourage physical activity	New
t. Avoid using benzodiazepines	New

Further guidance

Additional resources are available from RACGP HANDI Interventions: Cognitive Behavioural Therapy-Chronic Insomnia; Sleep Therapy Australia; the Sleep Foundation and ThisWayUp.

4.2.5 Pharmacological treatment of sleep disturbances

Short-term pharmacological treatment options can be used in people with post-concussive sleep disturbances to establish a more routine sleep-wake pattern using agents with minimal risk of dependency and adverse effects. Medications with anti-cholinergic effects may worsen cognitive deficits, especially in older people.

Recommendation for children and adults	Consensus-based
84. If non-pharmacological treatment options have not been effective in treating sleep disturbances that persist beyond 4 weeks, medications could be considered to facilitate sleep. The following principles must be considered: • avoid medications that may lead to dependency or sleep disturbances • avoid benzodiazepines • aim for a short duration of use • recognise potential adverse effects/interactions of medications •avoid polypharmacy where possible • prescribe medications that may manage multiple co-occurring symptoms e.g. Amitriptyline for headache and sleep disturbances •start at a low dose and gradually increase as tolerated.	Adapted[30]

4.2.6 Follow-up and referral

Receiving adequate sleep has been shown to facilitate health[140] and, when not adequate, adversely affects medical conditions, including TBI.[129-131] Maintenance of appropriate sleep and the management of disrupted sleep may be a critical target of treatment for the people with mTBI/concussion.[132-134]

Recommendation for children and adults[129-134]	Conditional
85. If sleep problems emerge or continue despite appropriate sleep hygiene measures, qualified health care professionals may consider referral of people with mTBI/concussion to a sleep disorder specialist or a complex mTBI/concussion management team.	Adapted[5]

4.3 Fatigue

Fatigue may be perceived as a lack of mental or physical energy which may impair daily functional activities. A standardised scale is appropriate when symptoms of fatigue are suspected. Symptoms of fatigue following mTBI/concussion are common[295] and are associated with a constellation of disabling symptoms which may lead to poor outcomes post-injury.[296, 297 298] Acute fatigue can be associated with mTBI/concussion. Fatigue that lasts longer than 4 weeks requires further assessment for medical and psychological comorbidities. The management of acute fatigue or chronic fatigue where comorbidities have been excluded should include the management of insomnia, and encourage gradual return to activities of daily living, maintenance of interpersonal relationships, and return to school and work and activity. Exercise, mindfulness-based stress reduction, cognitive behavioural therapy and blue-light therapy may be helpful in treating fatigue.

4.3.1 Assessment

Due to the complex interplay of concurrent symptoms, fatigue may persist and be exacerbated by an array of other contributing factors. These may include mood disorders, sleep disturbances, post-traumatic migraine, metabolic diseases, endocrine disorders, cognitive slowing, electrolyte abnormalities,[299] consequences of adverse effects of medications and supplements,[300] polypharmacy, alcohol, substance use, and/or nutritional deficiencies.[30]

Recommendation for children and adults[222, 253, 301]	Conditional
86. Characterise the dimensions of fatigue (e.g. physical, mental, impact on motivation) and consider alternative or contributing causes that may not be directly related to the injury (see Table 4 for useful assessment tools).	Adapted[30]

Table 4 Fatigue: Assessment and management factors for consideration

Characteristics	• Frequency • Intensity • Time of day • Type of fatigue (i.e. physical or cognitive) • Aggravating factors (i.e. physical activity, cognitive load, social and environmental exposure
Assessment	• Focused history • Validated scale to assess fatigue (i.e., Fatigue Severity Scale) • Consider blood test screening if appropriate (CBC, TSH, electrolytes)
Contributing causes of fatigue	• Affective disorder, including depression, anxiety • Sleep disorder • Cognitive slowing and attentional problems • Autonomic dysfunction • Metabolic causes, including hypothyroidism, anaemia or chronic disease (e.g. rheumatoid arthritis) • Electrolyte abnormality (e.g. hyponatraemia, hypocalcaemia etc.) • Polypharmacy and medication adverse effect • Nutritional status

Source: Marshall S, Lithopoulos A, Curran D, Fischer L, Velikonja D, Bayley M. Living concussion guidelines: Guideline for concussion and prolonged symptoms for adults 18 years or older 2023 (*adapted*)

Further guidance

Additional information on assessment of fatigue is available from the RACGP and BMJ Best Practice.

4.3.2 Education

Various behavioural management strategies may be employed to reduce symptoms of fatigue in people with mTBI/concussion.[302] For example, distributing activities and breaks across the day may assist people to achieve more without exceeding tolerance levels.[298, 302] This may be facilitated with the use of a notebook or diary to plan and record activities. Self-monitoring and planning may also aid in identifying patterns of fatigue and contributing factors.[302] Good sleep management strategies, such as regular sleep-wake schedules and avoidance of stimulants and alcohol may also be of benefit (see Section 4.2).

Recommendation for children and adults[287, 302, 303]	Strong
87. People with significant symptoms of fatigue should be given information about management of contributing factors (see Table 4).	Adapted[30]

4.3.3 Treatment

Melatonin is a natural hormone supplement that is used to help regulate the body's internal clock, or circadian rhythm. Taking 2–5mg of melatonin 2 hours before bedtime can help restore sleep and improve daytime alertness.[303] Mindfulness-based stress reduction and cognitive behavioural therapy can be used successfully to address fatigue as well as sleep disturbance following traumatic brain injury.[289, 304] Daily

morning blue light therapy for 30 minutes over the course of 6 weeks may reduce daytime sleepiness following mTBI/concussion.[290, 294] A GP can guide this therapy.

Recommendation for children and adults[303, 305]	Conditional
88. Advise people with fatigue resulting from disturbed sleep to use melatonin (2-5 mg two hours before bedtime).	Adapted[30]
89. Cognitive behavioural therapy and mindfulness-based stress reduction should be considered when managing fatigue.	Adapted[30]

Recommendation for children and adults[290, 292, 294]	Consensus-based
90. Blue light therapy may be considered to reduce symptoms of fatigue and excessive daytime sleepiness.	Adopted[30]

4.3.4 Follow-up and referral

Interdisciplinary approaches to mTBI/concussion treatment may be effective. People with post-concussive fatigue may benefit from referral to an interdisciplinary mTBI/concussion team wherein practitioners from multiple disciplines coordinate care by providing diagnostic, educational, physical, cognitive, functional and emotional support.[177, 235-237] Interventions that may be effective in individuals with symptoms of fatigue include cognitive behavioural therapy, psychoeducation, psychotherapy, and exercise.[219]

Recommendation for children and adults[303]	Conditional
91. Referral to interdisciplinary concussion team or an appropriately qualified health care professional should be considered if fatigue causing functional impairment persisting for more than 4 weeks.	Adapted[30]

Further guidance

Additional resources to assist with sleep/fatigue include the "Four Ps", "strategies to promote good sleep and alertness" and "Sleep for Youth".

4.4 Mental health disorders, mood and behaviour symptoms

Pre-injury psychological history or diagnosis of a psychiatric disorder is a predictor of persistent symptoms following mTBI/concussion.[50, 51, 68, 70, 306] Additionally, people with high burden of adverse childhood experiences (ACE) (i.e. significant traumatic or stressful events) are more likely to experience mTBI/concussion and risk of mental health and mood problems which may affect recovery.[307]

People experiencing prolonged symptoms following mTBI/concussion are at an increased risk of developing new or worsening mental health symptoms. Psychological distress following mTBI/concussion can occur even without a premorbid psychological history. Psychological distress is associated with other complaints including subjective cognitive symptoms.[308]

The burden of mental health problems, whether caused by the mTBI/concussion or not, can be a barrier to recovery. Identification and treatment of mood and mental health problems (including patient education) facilitate recovery and return to work following a mTBI/concussion.[309, 310] Identification of a high burden of adverse childhood experiences or presence of attachment disorders has important treatment implications that may require more specialized psychological interventions when symptoms persist.

4.4.1 Diagnosis

Recommendation for children and adults[49, 62, 64, 66, 68]	Conditional
92. Qualified health care professionals should routinely monitor for and manage depression and anxiety in people with a recent mTBI/concussion.	Adapted[30]

4.4.2 Assessment

Disturbances in mood, cognition, and behaviour are commonly experienced following injury and may signal the presence of a mental health disorder. Pre-existing mental health conditions and symptoms with post-injury onset are predictive of persisting post-concussive symptomatology.[49, 50, 311, 312] Questionnaires and assessment tools facilitate assessment and are recommended but are not diagnostic.

Recommendation for adults[51, 62, 68, 203, 204, 312-325]	Strong
93. In assessing mental health symptoms following mTBI/concussion, use a structured clinical interview, self-report questionnaires, and behavioural observation to determine whether the symptoms meet criteria for a mental health disorder (see Box F).	Adapted[30]

Box F: Mental health disorders

- Adjustment disorders
- Behavioural changes (e.g. lability, irritability)
- Anxiety disorders
- Mood disorders
- Post-traumatic stress disorder and other trauma and stressor-related disorders
- Alcohol and substance use disorders
- Somatoform disorders

Source: Adapted from Marshall S, Lithopoulos A, Curran D, Fischer L, Velikonja D, Bayley M. Living concussion guidelines: Guideline for concussion and prolonged symptoms for adults 18 years or older 2023.

Further guidance

Assessment tools include:
Sport Concussion Office Assessment Tool
(contains screening tools for anxiety and depression)
Depression Anxiety Stress Scales (DASS-21)
Depression self-report questionnaire
Hamilton Depression Rating Scale
Beck Depression Inventory
Health of the Nation Outcomes Scales
Hospital Anxiety and Depression Scale
Self-report measure of anxiety GAD-7
Kessler Psychological Distress Scale (K10)
The PTSD checklist for DSM-5 (PCL-5)
International trauma questionnaire for PTSD
Bipolar self test

Tools for the assessment of children include:
Strength and difficulties questionnaire
Revised Children's Anxiety and Depression Scale
PROMIS measures of anxiety and depression included in the Child SCOAT6

Clinical Practice Guidelines
RANZCP Mood disorders
RANZCP Anxiety disorders
RANZCP Post-traumatic stress disorder

4.4.3 Treatment

There is no current evidence to indicate that the mental health problems of individuals who have suffered a mTBI/concussion should be treated any differently than mental health problems of other aetiologies. A mTBI/concussion diagnosis should not delay appropriate management and treatment. As such, pharmacological and nonpharmacological interventions including therapeutic interventions that have been found to be helpful in the general population should be considered for individuals who have developed mental health problems post-concussion.

Non-pharmacological treatments

Psychotherapeutic interventions are generally considered the first-line treatment for mood disorders of mild severity. Cognitive behavioural therapy (CBT) has well-established efficacy for the treatment of mood, anxiety, and trauma and stressor-related disorders.[326-331] It has been shown to be efficacious in individuals with TBI when both depression and anxiety are addressed together.[332] CBT has been shown to be effectively delivered across various modalities, such as telehealth virtual psychotherapy.[333, 334] Remote delivery of CBT may promote retention due to its accessibility and flexibility. Related psychotherapeutic modalities such as cognitive processing therapy, trauma-focused therapy and mindfulness-based interventions may also promote positive outcomes among people with mTBI/concussion.[305, 335]

Recommendation for children and adults[326]	**Strong**	
94. If a mental health disorder is identified, existing practice guidelines for the treatment of the diagnosed condition should be followed.		Adapted[30]

Recommendation for children and adults[223, 327, 328, 334-340]	**Conditional**	
95. Cognitive behavioural therapy (CBT) and other psychotherapeutic modalities delivered by a qualified health care professional should be recommended for people with mental health conditions following mTBI/concussion.		Adapted[30]

Recommendation for children and adults[305, 341]	Conditional	
96. Mindfulness-based stress reduction may be recommended to help manage chronic symptoms following mTBI/concussion.		Adopted[30]

Pharmacological treatments

Pharmacological treatment should commence if symptoms are persisting, rather than in the acute phase, as experiencing mental ill health may be reactionary following mTBI.

Practice point for children and adults	
u. If pharmacological treatment of mental health disorders, mood and behaviour symptoms in people following mTBI/concussion is considered, a qualified health care professional with experience in managing mental health should be involved.	New

4.4.4 Referral

Treatment of mental health conditions may be conducted in primary care or the person may be referred for more specialised mental health care if needed.

For children, referral to a local mental health professional with experience in the care of children or specialist with experience in paediatric mental health is a consideration if mental health symptoms are prolonged or urgent (presenting with a high risk of acute harm).

Prioritise treatment of mental health conditions early where concerns are identified.

Recommendation for children and adults	Consensus-based	
97. Treat mental health conditions or consider referral to a mental health specialist, especially where there is a lack of response to treatment.		Adapted[31]

Further guidance

Further Australian resources to aid the assessment and management of mental health conditions is available from beyondblue, the Black Dog Institute, Headspace and the RACGP. Links are also provided in Box F.

4.5 Cognitive difficulties

Symptoms of cognitive dysfunction are common after mTBI and include changes in speed of thinking and responses, attention, memory and learning, and aspects of executive functions.[74, 342-344]

Cognitive impairment may be directly related to the pathology of the brain injury but may also reflect secondary effects of other symptoms (e.g. ongoing headache pain, fatigue/low energy, sleep disturbance, visual disturbance, anxiety and/or depression) that may produce a disruption in cognitive processing[345]. Neuropsychological evaluations that also consider these factors can assist in determining the aetiology of cognitive impairment and directing treatment.[344]

Pre-injury factors such as ADHD, learning difficulties and PTSD may exacerbate symptoms.

Assessment has unique challenges in older people and culturally diverse populations including Aboriginal and Torres Strait Islander groups. When assessing impairments, normative data may not be appropriate for all ages, cultures, and neurodevelopmental disorders. Any assessments should be conducted by professionals who are culturally competent and aware of diverse cultural backgrounds. For Indigenous peoples, collaboration with local Indigenous Health Services/liaison officers can enhance the effectiveness of assessments.

It is important to document cognitive symptoms to characterise the nature of these symptoms and to track progress over time.

When cognitive dysfunction does not resolve with treatment of potentially contributing factors or if cognitive symptoms persist past 4 weeks, referral for further assessment should be considered[344]. Referral for psychology for CBT and/or to support them in identifying self-management strategies, address any contributing unhelpful cognitions or behaviours, and to reduce distress can be helpful.

4.5.1 Assessment

Recommendation for children and adults[344] **Consensus-based**	
98. Qualified health care professionals should attempt to determine the aetiology of cognitive dysfunction within the context of other mTBI symptoms.	Adapted[5]

Practice point for older people	
v. Cognitive change in an older person could be a symptom of dementia. An early assessment to exclude intracranial pathology is recommended in older people with mTBI/concussion. After exclusion of other organic pathology, consider referral of older people with cognitive difficulties for further assessment (e.g. to a geriatrician, neurologist).	New

4.5.2 Education

While return to school and work are encouraged, cognitive symptoms may limit successful return. The aim is to return to school or work with appropriate restrictions and accommodations (e.g. part-time attendance) in place to optimise reintegration. Individual workplaces and academic institutions may have resources available to facilitate reintegration.

Many people will recover from mTBI/concussion-related symptoms within the first few weeks following injury; however, a smaller percentage of individuals will experience prolonged symptoms. Providing early education about concussion symptoms and recovery to people with mTBI/concussion (and their families/significant others) has been demonstrated to positively influence recovery.[28, 118] Education should be offered in multiple formats to ensure information is accessible and comprehensible.

Persisting cognitive symptoms following mTBI/concussion (beyond 4 weeks) are often generated and exacerbated by other pre-existing and comorbid conditions such as headache, insomnia, visual disturbances, anxiety and disturbances in mood. If a person presents with persisting symptoms, they should be made aware that the presence of comorbidities may be interfering with recovery.[194, 346] People should be encouraged to pursue targeted interventions geared towards these comorbid conditions with the aim of facilitating the resolution of their cognitive symptoms.

Recommendation for children and adults[201, 210, 283, 317, 346-357] **Conditional**	
99. People with pre-existing conditions and comorbid symptoms (e.g. anxiety, mood disorders, posttraumatic stress disorder, attention-deficit/hyperactivity disorder, sleep disturbances, fatigue, pain) should be provided with education highlighting that these pre-existing conditions may contribute to having an increased risk of more severe and prolonged cognitive symptoms.	Adapted[5, 30]

4.5.3 Treatment

Manage factors that interfere with cognitive symptoms. Compensatory strategies can help people with symptoms of cognitive impairments following mTBI/concussion. These may include internal strategies, comprising of instructional (e.g. repeated practice, retrieval practice) and metacognitive methods (e.g. self-awareness and regulation).[358, 359] Additionally, external compensatory strategies such as the use of environmental supports and reminders (e.g. mobile/smartphones, notebooks) may also be employed.[334]

Recommendation for children and adults[305, 334, 358, 360-365]	Conditional	
100. Manage factors that interfere with cognitive symptoms that interfere with daily functioning which may include self-directed compensatory strategies (i.e. internal, external, environmental). If disabling cognitive difficulties persist for more than 4 weeks, consider specialist assessment, preferably by a neuropsychologist or interdisciplinary concussion team.		Adapted[30]

4.5.4 Referral for cognitive difficulties

For people with prolonged cognitive symptoms, it may be challenging to identify the contribution of multiple conditions and their impact on cognitive function. Psychological distress often plays a significant role in the subjective cognitive difficulties.[308] Specialised cognitive assessment may assist in clarifying diagnoses and appropriate treatment options based on individual characteristics and conditions. While neuropsychological assessment is the current gold standard for cognitive assessment, there are often barriers (i.e. financial or limited resource issues) preventing access to this type of assessment. Referral should only be considered after other comorbidities potentially impacting cognition have been managed.

Recommendation for children and adults	Consensus-based	
101. Referral for specialised cognitive assessment (e.g. neuropsychological assessment) may be considered in the following circumstances: • there is functionally limiting cognitive impairment • comorbidities potentially impacting cognition have been optimally managed • there is no ongoing cognitive symptom improvement • cognitive symptoms are prolonged (i.e. beyond 4 weeks).		Adapted[30]

Recommendation for older people	Consensus-based	
102. Older people (see Glossary) with cognitive symptoms should be referred to a geriatrician, neurologist, memory clinic or cognitive medical specialist for evaluation.		Adapted[30]

Recommendation for children and adults[178]	Consensus-based	
103. If cognitive symptoms are persisting beyond 3 months, then review, modify, and extend work/school accommodations as appropriate. These accommodations must be assessed and reviewed by the medical team and adjusted to individual needs as required.		Adapted[30]

4.6 Sensory sensitivity

Following an initial period of relative rest, people experiencing sensory sensitivity can be encouraged to gradually engage in activities that cause minimal worsening of symptoms (i.e. no more than 20% increase in symptoms), so long as the symptoms resolve shortly afterwards.[366] People with mTBI/concussion may consider *short-term* usage of noise cancelling headphones or reduced screen brightness when gradually returning to functional activities. Lingering symptoms should not prevent activities of daily living.[366]

Occupational therapists experienced in this area can help guide a graded desensitisation or graduated exposure program.

Persisting sensory sensitivity warrants further diagnostic consideration; see differential diagnoses of persisting symptoms in Box B. If present pre-injury, evaluation for social communication disorders such as autistic spectrum disorder may be warranted and appropriate referral.

Recommendation for children and adults[366]	Consensus-based
104. For people with noise, light and other sensory sensitivities, a graduated exposure program is recommended. People should receive education about sensory tolerance levels and be encouraged to gradually increase exposure to these stimuli. Specifically, they should recognise the point at which mild symptoms have onset and push to the point that does not result in a significant or prolonged exacerbation of symptoms to promote desensitisation.	Adapted[30]

4.7 Balance, dizziness and visual dysfunction

Balance, dizziness and vision dysfunction following mTBI/concussion are common. This is highlighted by the fact that approximately 60% of athletes report such symptoms following sport-related mTBI/concussion.[367] Acute vestibular and vision dysfunction may be associated with delayed recovery and return to activity. Examination may identify problems such as benign paroxysmal positional vertigo (BPPV), hearing deficits or vestibular migraine, which may require specific treatment.[367-370] A careful history may identify psychosocial factors that may impede recovery. The use of an objective screening tool can assist in decision-making regarding referral for further assessment for people not showing improvement. A validated and reliable screening tool is the Vestibular Ocular-Motor Screening (VOMS). Balance problems, dizziness, visual disturbance and tinnitus are associated with psychological distress, depression and anxiety, management strategies that include psychological treatment including cognitive behavioural therapy can be beneficial.

Recommendation for children and adults[367-370]	Conditional
105. If vestibular, vision, balance and coordination symptoms are endorsed, they should be screened for and monitored at follow-up appointments. A validated screening tool can be useful.	Adapted[30]

4.7.1 Assessment of vision

Symptoms affecting vision following mTBI/concussion include but are not limited to blurred vision, photosensitivity, double vision, headache, fatigue and difficulty reading. Symptoms may be exacerbated by bright lights or overwhelming visual environments.[371, 372]

Recommendation for children and adults[371, 372]	Conditional
106. If changes in vision are reported using a validated screening tool, a detailed history, including visual history, should be taken and assessments performed of visual acuity, pupillary function, visual fields, fundoscopy, binocular vergence, and extra-ocular movements.	Adapted[31]

Practice point for children and adults[371]	
w. An eye examination should be undertaken to rule out ocular injuries and/or pre-existing disease that may impact vision.	Adapted[30]

4.7.2 Assessment of balance

Visual reflexes, inner ear, musculoskeletal, nervous system or brain may contribute to dizziness, headaches, and balance problems. Vestibular rehabilitation and where appropriate, additional cervical spine therapy may improve balance and dizziness.[371, 372]

Recommendation for children and adults[371, 372]	Conditional
107. Perform oculomotor and vestibulo-ocular examination including: • assessment of convergence, accommodation, saccades and smooth pursuits • assessment of the vestibulo-ocular reflex such as the head impulse test and/or dynamic visual acuity (may require involvement of a vestibular rehabilitation physiotherapist) • age-appropriate assessment of postural stability and balance (e.g. standing balance test or Balance Error Scoring System.	Adapted[31]

4.7.3 Assessment for benign paroxysmal positional vertigo (BPPV)

In people who continue to experience prolonged vertigo or dizziness despite 3 particle repositioning manoeuvres, referral to an interdisciplinary concussion team or neuro-otologist or physiotherapist with competency-based training in vestibular rehabilitation may be a consideration[373].

Recommendation for children and adults	Consensus-based
108. Screen for benign paroxysmal positional vertigo (BPPV) if the person reports vertigo or dizziness that occurs for seconds following position changes and consider canalith repositioning manoeuvres.	Adopted[31]

Practice point for children and adults	
x. After completing a neurological screen and clearing the cervical spine to move into the test position, perform the Dix-Hallpike Test. If positive for BPPV (i.e. reproduction of vertigo, typically for seconds, in addition to a characteristic pattern of nystagmus for the canal that is being assessed), a Particle Repositioning Manoeuvre may be appropriate (e.g. the Epley manoeuvre).	Adopted[31]

Recommendation for children and adults	Consensus-based
109. If the Dix-Hallpike manoeuvre reproduces vertigo, and there is no evidence of nystagmus, a Roll test should be performed, and other differential diagnoses or referral should be considered. The Epley manoeuvre should still be considered for treatment.	Adapted[30]

4.7.4 Psychosocial assessment

Recommendation for children and adults	Consensus-based
110. Screen for and consider underlying psychosocial factors that may exacerbate symptoms of vestibular, vision, and oculomotor dysfunction.	Adapted[31]

4.7.5 Education

For people experiencing visual, vestibular and oculomotor symptoms, temporary modifications and accommodations may be helpful as they return to education. Reassure people that these symptoms are usually temporary and will resolve over time. Specific modifications depend on the severity and pervasiveness of symptoms and could include refraining from driving if visual disturbance is severe, breaking chores/assignments into smaller tasks, decreasing reading duration for shorter intervals or using

text to speech applications, taking frequent breaks, using caution where dizziness and balance is problematic when operating machinery or performing activities at height.

Recommendation for children and adults	Consensus-based
111. Provide general post-concussion education that outlines symptoms of mTBI/concussion, and provide suggestions regarding activity modification and includes academic accommodations to manage visual, vestibular and oculomotor symptoms.	Adapted[31]

4.7.6 Treatment of benign paroxysmal positional vertigo

The Epley Manoeuvre can be used to treat the anterior and posterior canals in the case of a canalithiasis. There are many subtypes of BPPV that may require further assessment or alternate canalith repositioning manoeuvres and referral to a qualified health care professional for treatment (usually a physiotherapist with competency-based training in vestibular rehabilitation)[373]. If severe symptoms are provoked by pressure (i.e. valsalva) or accompanied by a change in hearing, referral to an otolaryngologist or neuro-otologist is warranted.

Recommendation for children and adults[223, 374-377]	Conditional
112. When the Dix-Hallpike manoeuvre is positive, the Epley/canalith repositioning manoeuvre should be used to treat benign paroxysmal positional vertigo.	Adapted[30]

Recommendation for children and adults[223, 375]	Consensus-based
113. If BPPV does not resolve within 1-3 treatments, consider referral to an otolaryngologist or qualified health care professional certified in vestibular rehabilitation.	Adapted[30]

Recommendation for children and adults[371, 372]	Conditional
114. Consider referral to an interdisciplinary concussion team or physiotherapist with competency-based training.	Adapted[31]

Further guidance

Demonstrations of the Dix-Hallpike test and Epley manoeuvre are provided by the RACGP

4.7.7 Treatment of balance

Recommendation for children and adults[378-380]	Strong
115. Vestibular rehabilitation therapy is recommended for people experiencing functionally limiting dizziness.	Adapted[30]

4.7.8 Assessment of hearing

Hearing problems as a predominant post-concussion symptom are uncommon following mTBI/concussion, and should alert the health care professional to consider a possible alternative diagnosis. A detailed history can assist in ruling out common causes of hearing complications, which may include basilar skull fracture and excessive ear wax. Unilateral tinnitus is unusual in setting of mTBI/concussion and could indicate alternate diagnosis and requires an assessment by an ear nose throat (ENT) specialist.

Recommendation for children and adults[381, 382]	Conditional	
116. When a person with mTBI/concussion identifies a problem with hearing (i.e. intolerance to everyday sounds, hearing loss, tinnitus), a detailed history (including auditory history) should be taken, otologic examination (including otoscopy) performed, and referral for audiological assessment and/or ear nose throat (ENT) opinion if no apparent cause is found.		Adapted[30]

4.7.9 Management of hearing disturbance

Though there is no evidence for specific treatments for tinnitus (i.e. perception of sound that does not have an external source, so other people cannot hear it), clinical experience suggests that self-management strategies may aid with symptom coping. These can include earwax removal, white noise generators and hearing aids. Tinnitus is associated with psychological distress, depression and anxiety, management strategies that include psychological treatment including cognitive behavioural therapy can be beneficial.

Recommendation for children and adults[381]	Consensus-based	
117. Consider referral to an ENT specialist for people with either unilateral tinnitus or persistent tinnitus that has not responded to self-management strategies.		Adapted[30]

4.7.10 Referral

Prolonged symptoms post-concussion are often non-specific and may be attributed to multiple contributors. For example, clinical context suggests that prolonged vestibular, vision and balance symptoms may be influenced by factors such as mental health issues, neurological causes, uncorrected refractive error, binocular vision issues.

Recommendation for children and adults[383, 384]	Consensus-based	
118. If vestibular, vision, balance and coordination symptoms remain functionally limiting, further assessment to identify potential causes of symptoms to direct treatment is required. Referral to a qualified health care professional with specialised training in the vision or vestibular system is recommended, where available.		Adapted[30]

4.8 Autonomic nervous system

Symptoms of autonomic nervous system dysfunction are often non-specific and therefore a high index of suspicion is warranted. Common symptoms include dizziness, feeling faint (especially on standing), headaches, and gastrointestinal symptoms. Autonomic nervous system dysfunction leading to exercise intolerance and or orthostatic intolerance can occur after a mTBI/concussion and is associated with chronic disability when prolonged.[385, 386]

An orthostatic challenge measuring heart rate and blood pressure changes before and after standing from recumbency are relatively easy to perform and is a good screening tool. If symptoms are provoked and there is a change in heart rate of greater than 30 beats per minute in adults (or 40 beats per minute in children) without a change in blood pressure 5 minutes after standing this could indicate postural tachycardia syndrome and warrants further investigation. A decrease in systolic blood pressure of greater than 20mmHg indicates orthostatic hypotension and also warrants further investigation. Autonomic dysfunction is also one cause of exercise intolerance. An exercise tolerance test performed by a qualified health professional can help identify whether autonomic dysfunction is possibly contributing to post-concussion symptoms.

Autonomic dysfunction in the setting of mTBI/concussion often responds to graded subthreshold exercise program. Specialist referral and further investigation (e.g. Tilt Table testing) is warranted if symptoms do not resolve.

Practice point for children and adults

y.	Autonomic dysfunction can occur following mTBI/concussion and may contribute to persisting symptoms.	New

Further guidance

Further relevant investigations include an orthostatic challenge using the Active Standing Test (see the Sport Concussion Office Assessment Tool (SCOAT) – orthostatic vital signs), the Buffalo treadmill and bike test.

5 Repeat concussion and long term effects

5.1 Repeat concussion

People with a history of multiple concussions are at risk of persisting post-concussion symptoms.[387] People who have experienced multiple concussions, especially within a short time period such as a season of sport, should be managed more conservatively and may benefit from the involvement of a concussion interdisciplinary team.[37] Evaluation may reveal underlying causes or risk factors for repeated injury[388]. Advise on strategies to prevent concussion and the increased risks associated with certain activities should be given (i.e. contact sports, activities involving high speeds, equestrian show jumping). Currently, there is no evidence to support health care professionals in advising when people with multiple concussions should retire from sport. Referral to a specialist such as a sports medicine physician or concussion expert is recommended, especially where symptoms take a very long time to remit.

There is increasing concern about whether repetitive head injuries lead to a future increased risk of dementia and neurological problems. No source recommendations were identified on the prevalence or risk of long-term effects of mTBI, traumatic encephalopathy syndrome (TES) or chronic traumatic encephalopathy (CTE) as there are no conclusive data to support this risk or its management. Therefore, the GDG was unable to develop any recommendations.

Chronic traumatic encephalopathy is a pathological syndrome with degenerative changes that can only be diagnosed at autopsy (CTE-NC). CTE-NC is linked to repetitive head injuries. Evidence from pathological case series suggests that CTE-NC (i.e. the pathological changes) increases with increased exposure (years of play) in athletes e.g. those who have played for more than 14.5 years were 10 times as likely to have CTE pathology.[389]

The relationship between clinical symptoms and signs and the pathology CTE-NC is not clear. It is not known whether, or the extent to which, clinical signs and symptoms are caused directly or indirectly by CTE-NC. This becomes problematic for the management of people with prolonged exposure to repetitive head injury and concerns about their neurological function. The clinical syndrome that may accompany CTE-NC is referred to as traumatic encephalopathy syndrome (TES), a non-specific constellation of progressive cognitive, neurobehavioural, and motor impairments leading to loss of function and dementia. There are no clinical symptoms or signs that are specific to TES and all may be seen in other neurological or mental health conditions and community-dwelling adults.[390]

TES classification criteria have been developed in order to facilitate research helping understand how TES may or may not relate to CTE-NC and repetitive head injury.[391] The diagnosis of TES requires (1) substantial exposure to repetitive head impacts from contact sports (e.g. 5 or more years of American football, with at least 2 years at the high school level), military service, or other causes (2); core clinical features of cognitive impairment (in episodic memory and/or executive functioning), neurobehavioral dysregulation, or both (3); a progressive course; and (4) that the clinical features are not fully accounted for by any other neurologic, psychiatric, or medical conditions.[391] Psychiatric conditions such as depression, anxiety, suicide, or intermittent explosive condition are *not* core features, and there is controversy about whether they should be considered supportive features or not.[392]

Currently, there is no evidence for an increased risk of mental health or neurological conditions in amateur athletes with repetitive head injury, although there may be an increased risk in former professional athletes.[392] Other factors that may increase this risk of TES symptoms and/or CTE-NC include genetic, general health factors (e.g. obstructive sleep apnoea, cardiovascular disease, diabetes), social and lifestyle factors (e.g. alcohol use and substance use). As many of these factors are modifiable, healthy lifestyle practices and good medical care may ameliorate risks of TES in athletes.[393]

5.1.1 Management

Recommendation for children and adults[345, 388, 394]	Consensus-based
119. People diagnosed with a repeat concussion soon after the index injury (within 3 months) or after multiple repeat episodes are at increased risk of persisting post-concussive symptoms.	Adapted[7]

Practice points for children and adults

z.	When returning to sport, people with repeat mTBI/concussions within the season are likely to require a more conservative approach and may require input from an interdisciplinary concussion team.	New
aa.	People who are concerned about possible long term effects of repetitive head injuries should be encouraged to seek medical assessment and advice. Symptoms that cause concern are more likely to be due to other medical conditions that can be managed effectively.	New

6 Research gaps

These guidelines are based on the best available evidence to date. There are, however, significant gaps in the research evidence to support these recommendations.

Mild TBI is a very complex condition. It is made more challenging to study because the objective evidence for the severity of injury in the form of findings on brain scans is often not present. Although there may be neurological changes early after injury, these usually resolve quite rapidly. The diagnosis of persistent symptoms is reliant on subjective reporting of symptoms. These symptoms have been extensively documented, as have the factors associated with persistent symptoms. However, prediction in individual cases remains very challenging. How an individual reacts to the experience of symptoms after a mild TBI is impacted by so many factors – their psychological make-up, their expectations, the demands of their environment and the support they have, as well as the brain injury itself, which also varies considerably from one individual to another. Investigations of outcome predictors after mild TBI need to encompass all of these factors, in addition to biological factors. The validation and consistent use of measures to assess people with mild TBI will assist in the creation of large datasets to inform understanding of these complex relationships.

Research findings are now emerging to guide management of mild TBI; for example, evidence that prolonged rest results in worse outcomes than graduated return to activity. There is also evidence that early reassurance and provision of information about expected symptoms and suggested coping strategies may minimise symptom reporting and anxiety. There is a significant need for more research evaluating the efficacy of various interventions to address persistent post-concussion symptoms. This includes evaluation of effective elements of multi-disciplinary programs and identification of what works and for whom. Although the importance of physiotherapy to address vestibular and cervical problems is now recognised, more research evaluating treatments for specific post-concussion symptoms, including headache, fatigue, anxiety and depression, in individuals with mild TBI is paramount. Clinical trials to evaluate assessment procedures and recommendations to return to play in sport, return to school and return to work after mild TBI are important research goals as are continued work to understand the epidemiology, biology and treatment of long-term effects.

Finally, the successful implementation of these guidelines is crucial for ensuring consistent and high-quality patient care. Research into the implementation of these guidelines in the context of the differing geographical areas of Australia and Aotearoa New Zealand will be important to ensure adequate uptake and will include evaluation of efforts to build capacity (e.g. comprehensive training for GPs and other health care professionals, cost-effective patient monitoring approaches), integration into clinical workflows, and their continuous evaluation and evolution to ensure adherence. Studies have shown that effective implementation can significantly improve patient outcomes, enhance safety, and reduce variability in care practices. Ongoing research will help to refine these guidelines and implementation strategies, ensuring they remain relevant and effective in an ever-evolving healthcare landscape.

Glossary

Abusive head trauma	A head or neck injury from physical abuse. This includes trauma from transmitted force.
Anticoagulation	In the context of these guidelines, this refers to both anticoagulants and antiplatelet therapy.
Clinically important traumatic brain injury:	This is a traumatic brain injury where any of the following has occurred: death from traumatic brain injury, neurosurgical intervention for traumatic brain injury, intubation for more than 24 hours for traumatic brain injury, or hospital admission of 2 nights or more associated with traumatic brain injury on CT.[7]
Concussion:	A biomechanical alteration of brain function which includes one or more somatic, cognitive, or emotional symptoms, behavioural change, sleep disturbance, and/or transient physical signs (i.e. loss of consciousness, amnesia).[395] Concussion is a form of mild traumatic brain injury.
Exercise:	A form of physical activity that is planned, structured, and repetitive and aims to improve physical fitness.
Interdisciplinary concussion team	A team of health professionals from different disciplines working together to treat and manage a patient. The team does not need to be co-located but should be experienced in managing people with concussion and typically consists of three or more of the following disciplines: medical doctor (e.g. rehabilitation specialist, neurologist, paediatrician, sport medicine doctor), physiotherapist, vestibular physiotherapist, paediatric physiotherapist, occupation therapist, nurse specialist, psychologist and/or neuropsychologist.
Mild traumatic brain injury	A traumatically induced alteration of brain function where loss of consciousness, if present, is less than 30 minutes, the length of post-traumatic amnesia is less than 24 hours, and the Glasgow Coma Score is between 13 and 15.
Older people:	A person aged more than 65 years or more than 50 years in an Aboriginal and/or Torres Strait Islander person.
Persisting symptoms:	Symptoms that have persisted for more than 4 weeks following mTBI/concussion.
Physical activity:	Any bodily movement produced by skeletal muscles that requires energy expenditure.
Qualified health care professional	Depending on the context, this includes medical and/or allied health care professionals.
Sport:	A human activity involving physical exertion and skill as the primary focus of the activity, with elements of competition or social participation.[161]
Structured observation	Observation of a person in an outpatient, inpatient or emergency department setting, performed by a qualified medical doctor or nursing staff. This would take the form of repeated clinical assessments over a period of 4-6 hours.

Acronyms and abbreviations

ADHD	Attention deficit hyperactivity disorder
ANZ	Australia Aotearoa New Zealand
BPPV	Benign paroxysmal positional vertigo
CBT	Cognitive Behavioural Therapy
CSF	Cerebrospinal fluid
CT	Computed tomography
CTE	Chronic traumatic encephalopathy
CWG	Consumer working group
ENT	Ear nose throat (doctor)
GCS	Glasgow coma scale
GDG	Guideline development group
GFAP	Glial fibrillary acidic protein
GP	General practitioner
MRI	Magnetic resonance imaging
mTBI	Mild traumatic brain injury
NHMRC	National Health and Medical Research Council
PECARN	Pediatric Emergency Care Applied Research Network
PREDICT	Paediatric Research in Emergency Departments International Collaborative
PTSD	Post traumatic stress disorder
S100B	S100 calcium binding protein B
SCAT	Sport concussion assessment tool
SPECT	Single photon emission computed tomography
TBI	Traumatic brain injury
TES	Traumatic encephalopathy syndrome
VOMS	Vestibular Ocular-Motor Screening

Appendices

A Membership of the Steering Committee and Guideline Development Group

Steering committee

Name	Expertise	Institution	Location
Prof Karen Barlow (Chair)	Paediatric Neurologist Rehabilitation Specialist	University of Queensland; Queensland Children's Hospital	Brisbane, Queensland, Australia
Prof Franz Babl	Paediatric Emergency Physician	Murdoch Children's Research Institute; University of Melbourne; Royal Children's Hospital	Melbourne, Victoria, Australia
Mr David Cole	Consumer advocate		Brisbane, Queensland, Australia
Dr Gill Cowen	General Practitioner (FRACGP, MSportMed); Senior Lecturer Medicine; Senior Clinical Research Fellow	Curtin Medical School and Curtin Health Innovation Research Institute, Curtin University	Perth, Western Australia, Australia
Prof Rebecca Kimble	Professor of Obstetrics & Gynaecology Director, Queensland Clinical Guidelines	Clinical excellence Queensland; Royal Brisbane and Women's hospital; University of Queensland	Brisbane, Queensland, Australia
Prof Jennie Ponsford	Professor of Neuropsychology	Monash University; Monash-Epworth Rehabilitation Research Centre	Melbourne, Victoria, Australia
Prof Alice Theadom	Professor of Psychology and Neuroscience	Auckland University of technology	Auckland, Aotearoa New Zealand

Guideline Development Group

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Prof Stuart Dalziel	Paediatric emergency physician	University of Auckland; Starship Hospital	Auckland, Aotearoa New Zealand
Prof Gavin Davis	Neurosurgeon	Murdoch Children's Research Institute; Cabrini Health; Austin Health; Monash University; University of Notre Dame	Melbourne, Victoria, Australia
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Dr Howard Flavell	Rehabilitation medicine physician	Royal Darwin Hospital	Darwin, Northern Territory, Australia
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Name	Expertise	Institution	Location
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Consumer Working Group

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Kate Sawkins	Evidence review	Hereco
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Disclosures/Conflicts of interest

Steering committee

Member	Disclosure
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Prof Karen Barlow (Chair)	Institutional grants from MRFF Institutional grants from Motor Accident Insurance Commission Unpaid member of the advisory committee for Connectivity TBI Unpaid member of advisory committee for Concussion Australia Guideline Development Group for the PREDICT guideline
David Cole	Nil
Dr Gill Cowen	Institutional grants: AI MRFF stream 1 2021 TBI grant; CI MRFF Stream 1 2020 TBI Mission grant Unpaid roles: Chair WA Concussion Network; Advisor for WAFC; Gifts/rewards for services to WAFC presentations; Connectivity presentations From May 2024 is a member of the MRFF Expert Advisory Panel for TBI
Prof Rebecca Kimble	Nil
Prof Jennie Ponsford	Institutional grants from Transport Accident Commission and NHMRC; Payment for Medico-legal reports Book royalties from Informa Press
Prof Alice Theadon	Ministry of Business, Innovation and Employment -grant reviewer Australasian Society for the Study of Brain Impairment Received institutional grant from Rutherford Discovery Fellowship, Health Research Council Grants and Accident Compensation Corporation.

Guideline Development Group

Member	Disclosure
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Prof Gary Browne	Nil
Adj A/prof Jennifer Cullen	CEO of Synapse Australia Payment for advice to Disability Royal Commission paid to Synapse Member of the Independent Advisory Council for NDIS.
Prof Stuart Dalziel	Institutional grants from Cure Kids NZ and Health Research NZ Unpaid leadership positions on PREDICT and PERN One of the lead investigators on PREDICT guideline Receives institutional support from Cure Kids NZ Paid contract with Pharmac NZ
Prof Gavin Davis	Institutional grants for: (1) Study of Neck Injury Imaging in Children (SONIC): Improving the Diagnosis of Spinal Cord, Bone and Ligament Injuries in Children Compared With Current Practice. Franz Babl, Edward Oakley, Stuart Dalziel, Meredith Borland, Natalie Phillips, Susan Donath, Stacy Goergen, **Gavin Davis**, Geoffrey Askin. MRF1199748. Medical Research Future Fund (MRFF) - Clinical Trials Activity (Rare Cancers, Rare Diseases and Unmet Need) – 2019 Neurological Disorders Grant. 2020-2025. (2) Can predictive markers assist in early detection of children at risk for persisting symptoms and their response to prevention and intervention? Vicki Anderson, Franz Babl, Vera Ignjatovic, **Gavin Davis**, Karen Barlow, Stephen Hearps, Michael Takagi. MRF1202073. Medical Research Future Fund (MRFF) - 2020 Traumatic Brain Injury Grant. Murdoch Children's Research Institute. 2020-2023. GD has attended meetings organised by sporting organisations including the NFL, NRL, IOC, IIHF and FIFA; however has not received any payment, research funding, or other monies from these groups other than for travel costs. GD is a member of the Scientific Committee of the 6th International Consensus Conference on Concussion in Sport; an honorary member of the AFL Concussion Scientific Committee; Section Editor, Sport and Rehabilitation, NEUROSURGERY;

Member	Disclosure
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Dr Howard Flavell	Nil
Dr Sarah Harris	In-kind consultation for WA football commission, Perth football league, Karrinyup Physiotherapy, SMA Unpaid work for WA Concussion network and Ramsay Healthcare WA/SA Human Research Ethics Committee
Dr Gary Mitchell	Paid contracts/grants with Jamieson Trauma Institute, Rugby Australia, Queensland Rugby Union, Fiji Rugby Union Financial support for presenting at Abbott conference 2022
Prof John Olver	Grant from Transport Accident Commission (VIC) Paid consultation fees for membership on advisory boards and lecture presentations of ABAVIE Pharmaceuticals and IPSEN pharmaceuticals.
A/prof Rhonda Orr	Grant- AUS-mTBI: designing and implementing the health informatics approaches to enhance treatment and care for people with mild TBI (ID 2015762, CIA: L. Fitzgerald)[MRFF Traumatic Brain Injury (2023-25), $3 mill]
Dr Mark Ralfe	Nil
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Nick Rushworth	Executive officer of Brain Injury Australia — Brain Injury Australia received $3,500.00 (incl GST) to act as a consumer representative on the Medical Research Future Fund research “AUS-mTBI: designing and implementing the health informatics approaches to enhance treatment and care for people with mild TBI”. BIA receives advocacy funding from Dept of Social Services; NDIS; Royal Commission into Violence, Abuse, Neglect and Exploitation of People with Disability. BIA has a partnership agreement with MAX employment, a Disability Employment Service provider.
Dr Julia Treleaven	Payments for: Various post graduate education providers such as IFOMPT, APA, MKS physiotherapist Payment (planned for 2023) for involvement in Concussion corner academy Reports written for patients with post-concussion symptoms - various solicitors.
A/Prof Sean Tweedy	NHMRC grants: (1) Implementation and scale-up of a consumer co-designed physical activity promotion program for people with moderate-to-profound disabilities (2) From injury to long-term physical activity for people living with traumatic brain injury. Paid contract: PacificAus Sports (Dept Foreign Affairs and Trade) for Pacific Pathway to Brisbane Games 2032. Paid travel expenses for International Paralympic Committee and World Para Athletics, Member of: Principal Investigator, International Paralympic Committee Classification Research and Development Centre

Member	Disclosure
Dr Caroline Yates	Consultant for ADHA and Cubicko about electronic health systems Paid work for Health Pathways for BSPHN Paid member of the GDG on this project

B Methodology

This appendix provides an overview of the methods used to develop the ANZ Concussion Guideline.

The guideline development process commenced with a Scoping Review to assess the potential of using existing national and international mTBI/concussion clinical practice guidelines as source guidelines to develop the ANZ Concussion Guideline. To assess the suitability for use of the potential source guidelines, the scope, methods, transparency in reporting and applicability of the guidelines to the ANZ healthcare setting were explored.

The scoping review found there was no existing single clinical practice guideline whose coverage completely aligned with that proposed for the ANZ Concussion Guideline. In addition, most guidelines were developed internationally with applicability concerns for the ANZ healthcare context. Therefore, using a single source guideline for the development of the ANZ Concussion Guideline was not appropriate. The Scoping Review was also used to inform the scope of the ANZ Concussion guideline (in terms of the topics to be addressed).

Due to the breadth of topics to be addressed by the ANZ Concussion guideline, the traditional guideline approach of developing research questions and associated eligibility criteria (usually in PICO format), and de novo evidence reviews to answer the research questions was not feasible. Instead, the ANZ Concussion Guideline was developed using the following main methodologies:

1. **Meta-guideline approach, closely aligned to the ADAPTE approach:**[10] a pragmatic process to expedite guideline development through analysis, synthesis and expansion of multiple existing high-quality national and international guidelines[1] (see Section B1).
2. **De novo evidence reviews** for topics within the scope of the ANZ Concussion Guideline, but outside the scope of existing high-quality clinical practice guidelines (see Section B2).

B1 Meta-guideline approach, closely aligned to the ADAPTE approach

The meta-guideline approach used to develop recommendations consisted of the following steps.

1. Identification of relevant guidelines
2. Assessing multiple potential source guidelines (for recency, relevance, and quality)
3. Selecting acceptable source guidelines
4. Extracting potentially suitable source recommendations (including their grading and the evidence associated with the recommendations)
5. Assessing potentially suitable source recommendations
6. Adopting, adapting or discarding source recommendations through a considered judgement process and developing new recommendations where appropriate
7. Grading the adopted, adapted or new recommendations.

Identification of relevant guidelines

The scoping review focussed on six potential existing evidence-based concussion guidelines. This included the guidelines in Table 5, with the exception of the Concussion in Para Sport (CIPS) Group[396] which was found later in the guideline development process. The Sports Medicine Australia Concussion in Sport Policy (2018) was also included in the scoping review. These guidelines were selected due to alignment with the proposed ANZ concussion guideline scope, generalisability to the

[1] https://www.guidancebreastcancer.gov.au/development-guidance

Australian and Aotearoa New Zealand health care context, and because they had been published within the last 5 years.

Assessing and selecting acceptable source guidelines

To assess the extent to which the potential source guidelines complied with internationally recognised standards for evidence-based guidelines, an appraisal using the Appraisal of Guidelines Research and Evaluation (AGREE II) tool[397] was undertaken on the guidelines included in the Scoping Review. The tool assessed the methodological quality of development of the potential source guidelines.

Considering the recency, scope, setting, context, and methodological rigour of development, the guidelines listed in Table 4 were identified as acceptable source guidelines for recommendations in adults, children and sport-related concussion. The Sports Medicine Australia Concussion in Sport Policy (2018) was not included based on AGREE II assessment, particularly the rigour of development domain. The source guideline developers were contacted, and permission was granted to adapt recommendations from these guidelines.

The first position statement developed by the Concussion in Para Sport (CIPS) Group[396] was identified later in the guideline development process. It was reviewed and accepted as a source guideline for recommendations in para-athletes (a sub-group of interest).

Table 5 Accepted source guidelines

Guideline developer/ID (reference)	Publication Date	Guideline title	Target population	Country	AGREE II overall score
Living Concussion Guidelines[30]	Living Guideline	Living Concussion Guidelines: Guideline for Concussion & Prolonged Symptoms for Adults 18 years of Age or Older	Adults	Canada	6/7
PedsConcussion[31]	Living Guideline	Living Guideline for Pediatric Concussion Care	Children/adolescents 5-18 years	Canada	6/7
PREDICT[7]	2021	Australian and New Zealand Guideline for Mild to Moderate Head Injuries in Children	Children < 18 years	Australia and Aotearoa New Zealand	6/7
CDC[5]	2018	CDC Guideline on the Diagnosis and Management of Mild Traumatic Brain Injury Among Children	Children ≤ 18 years	United States	6/7
Concussion in Sport Group[32]	2023	Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport- Amsterdam, October 2022	Sport-related concussion	International	4/7[a]
Concussion in Para Sport (CIPS) Group[396]	2021	Concussion in para sport: the first position statement of the Concussion in Para Sport (CIPS) Group	Para athletes	International	ND

Abbreviations: CDC = Centers for Disease Control and Prevention; mTBI = mild traumatic brain injury; ND = not done; PREDICT = Paediatric Research in Emergency Departments International Collaborative.

[a] The AGREE II assessment was performed on the 5th Consensus statement on concussion in sport as the 6th statement was not published at the time of the scoping review.

Extraction of recommendations

All recommendations from the Living Concussion Guidelines, PedsConcussion and PREDICT Guidelines that addressed topics within the scope of the ANZ Concussion Guideline were extracted.

Extracted recommendations were categorised into sections, topics and sub-topics and the following key information was summarised:

- source guideline name and section
- recommendation (and supporting information/context where available)
- level of evidence (from source guideline)
- supporting evidence (list of references, recommendation rationale from source guideline where available)
- associated tools and resources.

Where topics within the scope of the ANZ Concussion Guideline were not addressed in the PREDICT or PedsConcussion guidelines for children, recommendations were extracted from the CDC guideline where available. The decision to prioritise recommendations from the PREDICT and PedsConcussion guidelines was based on the recency and applicability of these source guidelines to the ANZ healthcare context compared with the CDC guideline.

Recommendations on sport-related concussion extracted from the Living Concussion Guidelines, PedsConcussion and PREDICT guidelines were supplemented with information extracted from the Consensus statement on concussion in sport (2023). As the Consensus statement on concussion in sport (2023) did not make discrete recommendations, key information from narrative text deemed suitable for adaptation into a recommendation was extracted. Similarly, key information was extracted from the Concussion in para sport position statement (2021).

Considered judgement process

The Guideline Development Group (GDG) undertook a considered judgement process via virtual meetings held throughout 2023. During these GDG meetings, the extracted source guideline recommendations were assessed to determine whether they were suitable for adoption or adaptation in the ANZ Concussion Guideline.

Recommendations were reviewed by topic, with all recommendations on the same topic (for both adults and children) across the guidelines reviewed together. Consideration was given to:

- the evidence base supporting the source recommendation as reported by the developer of the source guideline (references, certainty of evidence, strength and rationale where available)
- transparency in decision-making by the source guideline developer
- the feasibility of implementing the recommendations in the ANZ healthcare context
- applicability of the recommendation to the ANZ healthcare context
- generalisability of the recommendation to specific sub-groups of interest
- individual preferences and values.

The process was documented in considered judgement tables. This included the GDG's decision on whether to adopt, adapt or discard a source recommendation, or develop an entirely new recommendation; the rationale for the decision (and any adaptations made); implementation considerations (including for sub-groups of interest); gaps in the recommendations; and research priorities.

The decision by the GDG to adopt or adapt a source recommendation was not always clear. The NHMRC advise that minor editorial changes may be made to adopted recommendations to ensure they are consistent with the rest of the guideline. The decision to adapt a recommendation rather than adopt it verbatim was often related to its transferability. Although there is some flexibility to amend the wording to reflect local issues, needs and context, recommendations must stay true to the evidence on the balance of benefits and harms and other considerations to be valid.

Where substantial amendments to the wording of recommendations change the meaning or the strength of the language used, the recommendation may no longer have reflected the available evidence. In these cases, the recommendation may have been designated a Practice Point.

Sport-related concussion

The 2023 Consensus Statement on concussion in sport was considered the primary source of evidence for sport-related concussion recommendations due to its recency and the extensive systematic reviews performed to inform the statement. Sport-related concussion recommendations from other source guidelines were often informed by the prior consensus statement published in 2017, and were therefore considered less recent and not prioritised.

GRADE methods

GRADE is an internationally recognised systematic and transparent approach for developing and presenting summaries of evidence and deriving evidence-based recommendations. GRADE is designed to assess prespecified outcomes that are based on an underlying research question (usually developed in PICO format) (GRADE Working Group, 2013). Due to the breadth of topics to be addressed by the ANZ Concussion Guideline, the traditional approach of developing research questions and associated PICO criteria was not feasible. In addition, application of the GRADE approach to adoption or adaptation of recommendations from source guidelines is limited because none of the source guidelines used a full GRADE approach, or they did not provide sufficient information to apply the GRADE approach.

GRADE methods were incorporated where possible, such as in the categorisation of recommendations according to GRADE guidance that a "recommendation should have one of two strengths (strong or conditional, also called weak) and one of two directions (for or against). The definitions for each category should be consistent with the definitions used by the GWG (although different terminology may be used, such as strong and discretionary)" (Schunemann et al. 2023).

Grading of recommendations

Types of recommendations

The types of recommendations included in the ANZ Concussion Guideline are outlined in **Table 5**.

Table 6 ANZ Concussion Guideline types of recommendations

Recommendation	Description
Recommended (Strong)	Benefits of a recommended course of action clearly outweigh the harms, and this is supported by high-quality evidence.
Not recommended (Strong)	Harms of a recommended course of action clearly outweigh the benefits, and this is supported by high-quality evidence.
Conditionally recommended	Denotes uncertainty over the balance of benefits, such as when the evidence quality is low or very low, or when personal preferences or costs are expected to impact the decision, and as such refer to decisions where consideration of personal preferences is essential for decision-making.
Generally not recommended	Denotes uncertainty over the balance of harms, such as when the evidence quality is low or very low, or when personal preferences or costs are expected to impact the decision, and as such refer to decisions where consideration of personal preferences is essential for decision-making
Consensus-based recommendation CBR	Recommendation formulated by the GDG in the absence of quality evidence, after a systematic review of the evidence was conducted and failed to identify sufficient admissible evidence on the clinical question.
Practice point PP	Used to address important aspects of care that are not addressed by relevant source guidelines, practical considerations or where evidence is lacking. These are developed by consensus of the GDG.

CBR = consensus-based recommendation; EBR = evidence-based recommendation; PP = practice point.

While the GRADE Working Group advises that the strength of recommendations should be assessed using two categories (Strong or Conditional), for improved implementation across settings the recommended terminology was slightly modified for the ANZ Concussion Guideline. The terms 'Recommended' or 'Not

Recommended' were used to denote strong recommendations, and 'Conditionally recommended' or 'Generally not recommended' to denote conditional recommendations.

Consensus-based recommendations were made where an evidence review was conducted by the source guideline developers and no evidence-based recommendation/s could be made, but the committee was able to reach consensus.

Practice points were used to address important aspects of care that were not addressed by relevant source guidelines, to describe practical considerations or where evidence was lacking.

Mapping of recommendations

A set of decision-rules were developed to harmonise mapping the grade of source guideline recommendations to the ANZ Concussion Guideline grading conventions.

Where the source recommendation was adapted but the intention of the recommendation did not change, the recommendation was mapped to the ANZ Concussion Guideline grading as per the decision rules. If there were concerns regarding the directness of the source recommendation, or transparency in the decision-making process by the source guideline developers, then the GDG may have chosen to map the recommendation to a lower strength than the source recommendation. Downgrading may have also occurred when a source recommendation was adapted, with the adaptation being outside the evidence-based used to formulate the source recommendation. The rationale for any downgrading of the strength of a recommendation is documented in the rationale report to ensure transparency in decision making.

Where different elements of an ANZ Concussion Guideline recommendation were derived from different source recommendations, the different grading is transparently reported alongside the recommendation.

Gaps in existing recommendations or evidence

There were instances where there were no source recommendations to address important topics in the guideline, or the evidence was insufficient (e.g. CTE). To address these topics, the GDG combined consensus deliberations followed by a formal Delphi voting process to achieve consensus.

B2 De novo evidence review

De novo evidence reviews were undertaken to address critical areas within the agreed scope of the ANZ Concussion Guideline that were not addressed in source guidelines.

Clinical questions

The research questions addressed through de novo evidence review were:

1. What specific considerations should be given to the diagnosis, assessment and management of mTBI in Aboriginal and Torres Strait Islander peoples?
2. What specific considerations should be given to the diagnosis, assessment and management of mTBI in Māori people and Pasifika peoples of Aotearoa New Zealand?

Eligibility criteria

The systematic evidence review aimed to identify any research that addressed the diagnosis, assessment, or management of mTBI in Aboriginal and/or Torres Strait Islander peoples, or Māori and/or Pasifika peoples of Aotearoa New Zealand). The study eligibility criteria were developed using PICo (Population; activity, process or event of Interest; Context) criteria, and were intentionally broad to capture all relevant evidence. Evidence was included if it met the PICo criteria outlined in **Table 6** or **Table 7.**

Table 7 Evidence selection criteria for research question 1

Question 1	**What specific considerations should be given to the diagnosis, assessment and management of mTBI in Aboriginal and/or Torres Strait Islander peoples?**
Population	• Aboriginal and/or Torres Strait Islander people of any age, with suspected or confirmed mTBI due to any cause • Health professionals working with Aboriginal and/or Torres Strait Islander peoples with suspected or confirmed mTBI

Question 1	What specific considerations should be given to the diagnosis, assessment and management of mTBI in Aboriginal and/or Torres Strait Islander peoples?	
Interest	The diagnosis, assessment and management of confirmed or suspected mTBI	
Context	Australian healthcare settings	
Study types	• Peer-reviewed publications (quantitative and qualitative) of clinical studies • Systematic reviews of the above • Targeted grey literature	***Exclusions:*** • Conference abstracts/presentations • Theses • Letters or commentaries • Editorials • Book chapters
Search date restrictions	• December 2012 onwards	
Bibliographic databases	• MEDLINE • Embase	
Other limits	• English language only	

Abbreviations: mTBI = mild traumatic brain injury.

Table 8 Evidence selection criteria for research question 2

Question 2	What specific considerations should be given to the diagnosis, assessment and management of mTBI in Māori people and/or Pasifika peoples of Aotearoa (New Zealand)?	
Population	• Māori people and/or Pasifika peoples of Aotearoa (New Zealand) of any age, with suspected or confirmed mTBI due to any cause • Health professionals working with Māori people and/or Pasifika peoples of Aotearoa (New Zealand) with suspected or confirmed mTBI	
Interest	The diagnosis, assessment and management of confirmed or suspected mTBI	
Context	Aotearoa New Zealand healthcare settings	
Study types	• Peer-reviewed publications (quantitative and qualitative) of clinical studies • Systematic reviews of the above • Targeted grey literature	***Exclusions:*** • Conference abstracts/presentations • Theses • Letters or commentaries • Editorials • Book chapters
Search date restrictions	• December 2012 onwards	
Bibliographic databases	• MEDLINE • Embase	
Other limits	• English language only	

Abbreviations: mTBI = mild traumatic brain injury.

Literature search

A literature search was undertaken on 22 November 2022 in MEDLINE and Embase (using EMBASE.com) to identify peer-reviewed publications meeting the pre-defined evidence selection criteria. Evidence published since the 01 January 2012 was included.

Peer-reviewed publications (including systematic reviews) of clinical studies (quantitative and qualitative) were eligible; conference abstracts/presentations, theses, letters, commentaries, editorials, and book chapters were excluded. Searches were restricted to English language articles.

In addition to the formal literature search, references identified by members of the GDG, or grey literature searching were also assessed against the evidence selection criteria to determine eligibility.

Deduplication of records and determination of study eligibility was performed in EndNote.

Study eligibility

Evidence selection criteria were applied in two stages: first to the titles and abstracts, and then to the full publications of potentially included studies. Records were excluded for the following reasons:

- wrong population
- wrong activity, process, or event of interest
- wrong context/setting
- wrong publication type
- wrong study type.

Studies that included a mixed population of participants with stroke and traumatic brain injury (TBI) and/or participants across the spectrum of TBI severity (mild, moderate, severe) were excluded unless the results were presented separately for participants with mTBI, or at least 75% of participants were categorised as having mTBI.

Assessment of the evidence

Formal assessment of the evidence was not undertaken as no evidence was identified that met the eligibility criteria. A technical report was provided to the GDG outlining the methodology and results of the de novo evidence reviews. The report provided a narrative summary of key literature that was identified, including the reason for the literature not meeting the PICo criteria outlined in Section B2.

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