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

Consultation draft — April 2024

DRAFT

Contents

DRAFT

Summary

Affecting 210,000 people in Australia and Aotearoa New Zealand and 50-60 million people world wide every year,[1] there is an increasing recognition of the significant long-term symptoms and functional impairments following mild traumatic brain injury. Concussions are a form of mild traumatic brain injury (mTBI). The term "mild", however, is a misnomer when 25% to 35% of people experience longer term problems which may last months or years after their injury and finding help for these symptoms can be difficult. Indeed, many studies in Australia and worldwide have shown that patient care along the journey from injury to recovery is highly variable, advice from health care practitioners is often inconsistent, and management is 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. Sport is the most recognized cause, especially due to the propensity for repeated injury, however, many mTBI/concussions are also due to falls (most common), motor vehicle accidents, assault/domestic violence, and military activities. It observes no social or economic boundaries and can occur in anyone; children, young adults, elderly and aboriginal peoples being 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 of health professionals, providing a source of up-to-date management recommendations, offering key tools to support care, and ultimately aiming to standardize practice across Australia and Aotearoa New Zealand.

Over the last decade, there have been significant advances in the approach to mTBI/concussion and post-concussion symptoms, yet management continues to significantly lag behind the medical evidence. Indeed, Australians are concerned that care professionals have significant knowledge gaps in this area.[2] Clinical practice guidelines are key tools to bridge knowledge gaps, improve outcomes and optimize resource utilization.[3] 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 disciplines in a coordinated approach.

There are several evidence-based clinical practice guidelines to help guide the management of mTBI/concussion across specific populations[4-8] 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,[9] 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 aimed to support patient assessment are provided throughout the Guideline.

For practical purposes, we have structured the Guideline into three sections based on phases of recovery: Initial diagnosis and management (day 1-3), early symptom management and return to activities (day 3-28), and the assessment and management of persisting post-concussion symptoms (>1 month). 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, allow for their prevous 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.

DRAFT

Summary of recommendations and practice points

The table below lists the recommendations and practice points included in this draft 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 graded either:
  - ‘strong’ – 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’ – 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

INITIAL DIAGNOSIS, ASSESSMENT AND MANAGEMENT

Initial diagnosis and assessment

1	EBR	Suspected mTBI/concussion should be recognised as soon as possible.	Strong
i	CBR	Adults and children with suspected mTBI/concussion should be referred to an appropriately qualified health professional for confirmation of diagnosis.	
ii	CBR	People with mTBI/concussion should be assessed in a hospital setting if the mechanism of injury was severe[1] or if they develop 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)[3]	

iii	CBR	Children with head injuries sustained from ground-level falls or walking or running into stationary objects, with no loss of consciousness, a GCS score of 15 and no signs or symptoms of head trauma other than abrasions, do not need to attend hospital for assessment; they can be safely managed in primary care or at home.	
iv	CBR	Special consideration needs to be made for elderly people 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.	
2	EBR	An appropriately qualified health professional should conduct a review of every person who has sustained mTBI/concussion to confirm diagnosis.	Strong
3	EBR	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	Conditional
4	EBR	Consideration should be given to use of an age-appropriate standardised concussion symptom inventory tool.	Conditional
5	EBR	Neuroimaging should not be routinely used for the purpose of diagnosing mTBI/concussion.	Conditional
6	EBR	In children with mTBI/concussion who have one or more risk factors for a brain injury, health care professionals should take into account the number, severity and persistence of signs and symptoms (see Figure 1 and Appendix C), and family factors (e.g. distance from hospital and social context) when choosing between structured observation and a head CT.	Conditional
7	EBR	The need for neuroimaging of people 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.	Conditional
v	CBR	Plain skull x-rays are not recommended for the purpose of diagnosing mTBI/concussion.	
vi	CBR	Health professionals should not use single-photon emission CT (SPECT) or quantitative electroencephalogram in the acute evaluation of suspected or diagnosed mTBI/concussion.	
8	EBR	After a normal initial head CT in people presenting to an acute care setting following mTBI/concussion, neurological deterioration should prompt urgent reappraisal, with consideration of an immediate repeat head CT and consultation with a neurosurgical service.	Strong

9	EBR	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.	Strong
vii	CBR	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.	
viii	CBR	Consultation with a neurological services should occur in all adults with a base of skull fracture, or skull fracture and confusion, decreased conscious level, or neurological symptoms or signs.	
a	PP	Where structured observation is undertaken, observation period should be 4 hours or greater and should include amnesia and orientation assessment.	
b	PP	If the GCS does not return to 15, repeat assessment should be performed.	
c	PP	Discharge criteria should be met, even if there is a normal head CT.	
Complicating factors			
d	PP	Consider the possibility of abusive head trauma in all presentations of mTBI/concussion.	
e	PP	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.	
10	EBR	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 Box A) 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.	Conditional
f	PP	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.	
g	PP	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 haemoatologist.	

h	PP	In adults on anticoagulant or antiplatelet therapy or who have known bleeding disorders, CT should be strongly considered. Health professionals should follow local protocols and guidelines for management of anticoagulation agents in trauma patients.	
ix	CBR	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.	
x	CBR	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. Brain imaging decision rules may not have adequate sensitivity for this group.	

Initial management

11	EBR	Provide patient/parent/support person with clear, age-appropriate verbal and written advice including: • reassurance that most people recover fully • natural history of early post concussive symptoms • possibility of persisting symptoms • advice on early symptom management • advice on return to activities/school/work • follow-up with heath care practitioner if symptoms persist • discharge letter (for people seen in the emergency department).	Strong
12	EBR	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.	Strong
13	EBR	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.	Strong
xi	CBR	Advise people who have experienced mTBI/concussion to avoid alcohol and other recreational drugs while symptoms persist.	
xii	CBR	Provide people who have experienced mTBI/concussion with guidance on fatigue management and age-appropriate sleep hygiene methods.	
14	EBR	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.	Conditional

15	EBR	People presenting with acute mTBI/concussion can be safely discharged for home observation in the care of a responsible adult if they meet 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).	Conditional

Follow-up

16	EBR	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.	Conditional
i	PP	People (or their parents or carers) should be reassured that most post-concussive symptoms are not a clinical indication for imaging.	

Prognosis

17	EBR	For people at high risk of persisting symptoms (see Box A), health professionals should consider earlier referral to specialist services for post-concussive symptom management.	Conditional
j	PP	For people presenting with mTBI/concussion, health professionals should consider factors known to be associated with an increased risk of developing post-concussive symptoms (see Box A).	
k	PP	Health 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.	

RETURN TO ACTIVITY

General activity

18	EBR	Strict rest until the complete resolution of mTBI/concussion-related symptoms is not beneficial and not recommended.	Strong
19	EBR	Relative (not strict) rest is recommended for 24-48 hours after mTBI/concussion. Most activities of daily living can resume immediately.	Strong

20	EBR	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.	Strong
xiii	CBR	Individuals should be advised to avoid the risk of re-injury (i.e. contact, collision or fall) until a qualified health professional determines it is safe for higher risk activities.	
l	PP	Where a fall was the cause of mTBI/concussion in an elderly person, early resumption of daily activities should be encouraged. It is important to provide information on falls prevention strategies. Refer to the RACGP Falls Prevention in Older Adults website or World falls guidelines 2022 for further details on assessing and managing falls risk.	
21	EBR	Explain that transient symptom worsening with increased activity is common.	Conditional
22	EBR	Reduced screen use in the first 48 hours after mTBI/concussion is warranted but may not be effective beyond that time.	Strong
m	PP	Parents and caregivers 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.	
Return to driving/operating machinery			
xiv	CBR	People who have experienced mTBI/concussion should be advise to avoid driving during the first 24 hours.	
xv	CBR	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.	
Return to work			
23	EBR	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).	Conditional
24	EBR	Students should have returned to school full-time before commencing extra-curricular work (unless part of educational activity).	Conditional

xvi	CBR	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.	

School/learning

xvii	CBR	To minimise academic and social disruptions following mTBI/concussion, health professionals should not recommend complete rest and isolation, even for the initial 24–48 hours, and instead recommend a period of relative rest.	
xviii	CBR	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.	
xix	CBR	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 medical and school-based teams and be modified based on ongoing assessment of symptoms.	
xx	CBR	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.	
25	EBR	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.	Conditional
26	EBR	For students who experience prolonged symptoms and academic difficulties despite an active treatment approach, health professionals should refer the child for a formal evaluation by a specialist in paediatric mTBI, or a multidisciplinary concussion team where available.	Conditional

Return to sport

xxi	CBR	Return to sport strategies should be individualized, follow the recommended guidelines, and be monitored by an appropriately qualified health professional.	

xxii	CBR	People who experience mTBI/concussion should progress through return to learn; see Table 1) and the return to sport steps (see Table 2), ensuring a minimum time away from play of 21 days from injury.	

ASSESSMENT AND MANAGEMENT OF PERSISTING SYMPTOMS

Assessing persisting symptoms

27	EBR	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.	Conditional
28	EBR	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 assessment • cognitive screening • further examination of the individual should be based on symptoms. In some settings, assessments may need to be conducted over a number of appointments.	Conditional
xxiii	CBR	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.	
xxiv	CBR	Repeat medical assessment is advisable for people with concerning or worsening post-concussion symptoms at 1-2 weeks following acute injury and then at 3-4 weeks in people with persisting symptoms.	
29	EBR	When neck pain is present, careful and thorough clinical examination is required, and investigation (i.e. imaging) should only be conducted according to established imaging guidelines (e.g. NEXUS, Canadian Canadian C-spine rule).	Strong

n	PP	For people with persisting symptoms following mTBI/concussion, clinical assessment including identification of factors that may suggest an alternative diagnosis is recommended.	
30	EBR	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).	Strong
Managing persisting symptoms			
31	EBR	Individuals with symptoms that persist after 1 month 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 success.	Conditional
32	EBR	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.	Conditional
33	EBR	The use of hyperbaric oxygen to treat symptoms post-mTBI/concussion is not recommended.	Strong
xxv	CBR	Treatment for specific symptoms or concerns should be initiated while waiting for a referral to an interdisciplinary concussion team or sub-specialist.	
xxvi	CBR	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.	
xxvii	CBR	Referral to interdisciplinary concussion services/clinics or subspecialist (where available) should be considered for people who have symptoms persisting for more than 1 month.	

ASSESSMENT AND MANAGEMENT OF SPECIFIC SYMPTOMS

Headache

34	EBR	Identification of the headache phenotype can inform management.	Conditional
35	EBR	An appropriately qualified health 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.	Conditional
36	EBR	Personal, environmental, work-related, school-related, and physical factors such as neck pain should be identified and addressed as potential headache contributors.	Conditional
37	EBR	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).	Conditional
xxviii	CBR	The health 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.	
xxix	CBR	People older than 5 years with post-traumatic headache should be encouraged to maintain an accurate headache and medication diary (see Box E) and to bring it to every follow-up visit with their treating health professional.	
xxx	CBR	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 upper cervical injury.	
xxxi	CBR	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.	
xxxii	CBR	Over the counter analgesics (e.g. acetaminophen, ibuprofen, acetylsalicylic acid, naproxen) should be used less than 15 days per month.	
xxxiii	CBR	Combination analgesics (i.e. with caffeine or codeine) should be used less than 10 days per month.	
xxxiv	CBR	Migraine-specific acute therapies should be trialed when non-specific acute therapies are incompletely effective. Triptans can be used for migrainous-type headaches less than 10 days per month.	
xxxv	CBR	When headaches are too frequent (e.g. more than 10 days per month) or disabling, prophylactic therapy should be considered	
o	PP	Prophylactic therapy should be guided by headache phenotype.	
xxxvi	CBR	Post-traumatic headaches may be unresponsive to conventional treatments. If headaches remain inadequately controlled, referral to a neurologist, headache specialist, paediatrician, or interdisciplinary concussion clinic is recommended.	

Sleep disturbances

xxxvii	CBR	A repeat medical assessment should be performed for all people presenting with post-concussion sleep disturbances 1-2 weeks following acute injury.	
xxxviii	CBR	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	
xxxix	CBR	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.	
xl	CBR	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.	
38	EBR	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.	Conditional
xli	CBR	Education on sleep disturbances should be provided in written, verbal and/or pictorial formats.	
xlii	CBR	People with insomnia should be given advice on sleep hygiene and self-management strategies or programs.	
39	EBR	Advise people with post-concussive insomnia to use melatonin (2-5 mg two hours before bedtime).	Strong
40	EBR	Advise on reduced evening light exposure and consider bright light exposure or blue light therapy in the morning.	Conditional
p	PP	Maintain a high index of suspicion for sleep problems.	
q	PP	Screen for obstructive sleep apnoea and depression as causes of poor sleep	
r	PP	Assess sleep using a sleep diary over 2–3 weeks.	
s	PP	Encourage physical activity.	
t	PP	Avoid using benzodiazepines.	
41	EBR	Refer people with prolonged post-concussive insomnia for cognitive behavioural therapy (CBT) specifically for sleep or to a sleep physician (where accessible).	Conditional

xliii	CBR	If non-pharmacological treatment options have not been effective in treating sleep disturbances that persist beyond 1 month, 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	
42	EBR	If sleep problems emerge or continue despite appropriate sleep hygiene measures, health professionals may consider referral of people with mTBI/concussion to a sleep disorder specialist or a complex mTBI/concussion management clinic.	Conditional
Fatigue			
43	EBR	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 3 for useful assessment tools).	Conditional
44	EBR	People with significant symptoms of fatigue should be given information about management of contributing factors (see Table 3).	Strong
45	EBR	Advise people with fatigue resulting from disturbed sleep to use melatonin (2-5 mg two hours before bedtime).	Conditional
xliv	CBR	Blue light therapy may be considered to reduce symptoms of fatigue and excessive daytime sleepiness.	
46	EBR	Referral to interdisciplinary concussion services/clinics or an appropriately qualified health professional should be considered if fatigue causing functional impairment persisting for more than 1 month.	Conditional
Mental health disorders, mood and behaviour symptoms			
47	EBR	Health professionals should routinely monitor for and manage depression and anxiety after mTBI/concussion.	Conditional
48	EBR	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).	Strong
49	EBR	If a mental health disorder is determined to be present, existing practice guidelines for the treatment of the diagnosed condition should be followed.	Strong

50	EBR	Cognitive behavioural therapy (CBT) and other psychotherapeutic modalities should be recommended for people with mental health conditions following mTBI/concussion.	Conditional
51	EBR	Mindfulness-based stress reduction may be recommended to help manage chronic symptoms following mTBI/concussion.	Conditional
u	PP	If pharmacological treatment of mental health disorders, mood and behaviour symptoms in people following mTBI/concussion is considered, a health professional with experience in managing mental health should be involved.	
xlv	CBR	Treat mental health conditions or consider referral to a mental health specialist, especially where there is a lack of response to treatment.	

Cognitive difficulties

xlvi	CBR	Health professionals should attempt to determine the aetiology of cognitive dysfunction within the context of other mTBI symptoms.	
v	PP	Cognitive change in an elderly person could be a symptom of dementia. An early assessment to exclude intracranial pathology is recommended in elderly people with mTBI/concussion. After exclusion of other organic pathology, consider referral of elderly people with cognitive difficulties for further assessment (e.g. to a geriatrician, neurologist).	
52	EBR	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.	Conditional
53	EBR	Manage cognitive symptoms that interfere with daily functioning which may include self-directed compensatory strategies (i.e. internal, external, environmental). If cognitive difficulties persist beyond 6 months, they should be reassessed by a specialist. If there is ongoing persistence and complexity of cognitive symptom presentation, refer to a specialised program.	Conditional
xlvii	CBR	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 (ie. beyond 1 month)	
xlviii	CBR	Elderly people should be referred to a geriatrician,neurologist, memory clinic or cognitive medical specialist for evaluation.	

xlix	CBR	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.	

Sensory sensitivity

l	CBR	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.	

Balance, dizziness and visual dysfunction

54	EBR	If vestibular, vision, balance and coordination symptoms are endorsed, they should be screened for and monitored at follow-up appointments using validated screening tools.	Conditional
55	EBR	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.	Conditional
w	PP	An eye examination should be undertaken to rule out ocular injuries and/or pre-existing disease that may impact vision.	
56	EBR	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).	Conditional
li	CBR	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.	
x	PP	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).	
lii	CBR	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.	

liii	CBR	Screen for and consider underlying psychosocial symptoms that may exacerbate symptoms of vestibular, vision, and oculomotor dysfunction.	
liv	CBR	Provide general post-concussion education that outlines symptoms of mTBI/concussion, and provide suggestions regarding accommodations to manage visual, vestibular and oculomotor symptoms.	
57	EBR	When the Dix-Hallpike manoeuvre is positive, the Epley/canalith repositioning manoeuvre should be used to treat benign paroxysmal positional vertigo.	Conditional
lv	CBR	If BPPV does not resolve within 1-3 treatments, consider referral to an otolaryngologist or health professional certified in vestibular rehabilitation.	
58	EBR	Consider referral to an interdisciplinary concussion team or physiotherapist with competency-based training. Here, tests may include Functional Gait Assessment and the Bruininks-Oseretsky Test of Motor Proficiency.	Conditional
59	EBR	Vestibular rehabilitation therapy is recommended for people experiencing functionally limiting dizziness.	Strong
60	EBR	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 made if no apparent cause is found.	Conditional
lvi	CBR	There is no evidence to suggest for or against the use of any particular modality for the treatment of tinnitus after mTBI/concussion. If tinnitus is present, referral to a neuro-otolaryngologist may be considered if self-management strategies are not effective.	
lvii	CBR	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 health professional with specialised training in the vision or vestibular system is recommended, where available.	

Autonomic nervous system

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

REPEAT CONCUSSION/CHRONIC TRAUMATIC ENCEPHALOPATHY

Repeat concussion

lviii	CBR	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.
z	PP	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.

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 New Zealand, every year).[1, 10, 11] They occur most commonly in children, affecting 20% of children under 16 years of age,[12, 13] 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-Indigneous population.[10, 14, 15] The most common causes are falls, mechanical forces, motor vehicle accidents, assault/family violence, and blast-related injury (military personnel).[10] Additionly, individuals sustaining a mTBI/concussion are at increased risk of repeated mTBI/concussion, which often results in more severe and protracted symptoms.[16-18]

The diagnostic criteria for mild traumatic brain injury were revised in 2023.[19] 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.[19, 20] 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 are collectively known as Post-Concussion Symptoms (PCS) and Peristing Post-Concussion Symtplms (PPCS) when lasting for longer than one month. Symptoms categorized 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 [21, 22]. Children and youth are often thought to have slower recovery rates, 30–40% have post-concussion symptoms for longer that 1 month after injury.[23] There is increasing evidence, however, that as many as 20-50% of adults also have delayed recovery (Nelson; Theadom13). Good acute management including patient education, avoidance of repeat injury, and early follow-up can reduce the risk of PPCS and its significant emotional and financial burden.[24, 25]. However, between 40-80% of people leave the emergency department without education or discharge instructions and without a clear follow-up plan.[16-18]

The management of mTBI/concussion is highly variable across health professionals[2, 26] and there is a lack of knowledge about the best practice and care of people with mTBI/concussion and persistent symptoms. Clinical practice guidelines can help to improve outcomes, optimize resource utilization, and increase cost-effectiveness.[3] 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,[4-6] and sport-related concussion,[7] or are for use in specific settings e.g. the emergency department.[6, 8] 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 system.

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.

DRAFT

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 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:[9] 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 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*[27]
- Paediatric Research in Emergency Departments International Collaborative (PREDICT) 2021 *Australian and New Zealand guideline for mild to moderate head injuries in children – Full guideline*[6]
- *Living guideline for pediatric concussion care* 2023[28]
- *Centers for Disease Control and Prevention guideline on the diagnosis and management of mild traumatic brain injury among children*[29]
- *Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport-Amsterdam, October 2022*.[30]

Guideline Development Group

A multidisciplinary group of medical and allied health professionals, who work with mTBI/concussion patients, came together to form the Guideline Development Group (GDG, 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 pediatric, adult, elderly populations. The GDG also involved consumer representation and advocates for Aboriginal and Torres Strait Islanders, Maori and Pacifica populations, and people living with disability. Additionally, a Consumer Working Group informed the GDG across scope, lived experience, and areas of need. 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 Maori. The GDG was also informed by a subgroup of physiotherapists and occupational therapists who were consulted in areas specific to their expertise. Relevant advice was also sought from subspecialists such as ethicists, haematologists, and geriatricians.

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:

DRAFT

- 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 professionals who are likely to play a role in the assessment and management of people with mTBI/concussion and post-concussive symptoms. As such, these will be health professionals across a wide variety of settings from general practice, emergency departments, medical/surgical specialists, and radiologists to a variety of rehabilitation and sports medicine clinicians in community offices or hospital.

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 Delphi consensus in 2023 to improve clarity and aid clinical care.[19] 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.[19, 20] 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.

DRAFT

"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 between 0 and 18 years. Elderly or old age includes individuals who are 65 years or older, except in Aboriginal and Torres Strait Islander people where old age is considered to be 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,[31] no age range has been specified as "elderly" 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 "appropriately qualified health 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),[32] UK government (non-elite sports),[33] and sporting organisations such as World Rugby[34] 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 indication of ongoing recovery or compensatory changes. The GDG was unable to reach unanimous consensus. All agreed that return to play should be individualized. 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 concensus was reached independently, before the recommendations of the Australian Institute of Sport (AIS)[35] were released.

There is increasing pubic concern about the potential link between concussion/mTBI and neurodegenerative disease later in life. The GDG reviewed the evidence, including recent systemic reviews, about whether repetitive head injuries are associated with increased risk of dementia, and neurological problems. 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

DRAFT

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 abnd 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 review of the guideline recommendations will be undertaken in 5 years.

Public consultation and next steps

This consultation draft is being provided to key stakeholders, professional associations, consumer groups, general public to seek feedback on the clarity of the recommendations, their implementability and feasibility. We also seek input on the accompanying Toolbox and any gaps identified. Following the consultation process, the GDG will review and discuss the public comments, and provide a summary of final changes made in an appendix to the guidelines. An independent review will then be performed, and final guidelines sent for NHMRC approval.

DRAFT

1 Initial diagnosis, assessment and management

1.1 Initial diagnosis and assessment

Diagnosis of mTBI/concussion is the critical first step in successful management, leading to improved outcomes and prevention of further injury.[27] This requires a high index of suspicion in situations of increased risk of mTBI concussion such as playing contact sport; here, any person suspected of a possible mTBI/concussion should be removed of 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.[36]

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.[27]

1.1.1 Recognition and referral

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 an appropriately qualified health professional.

Recommendation for children and adults[37-39]	**Strong**
1. Suspected mTBI/concussion should be recognised as soon as possible.	Adapted

Recommendation for children and adults	**Consensus-based**
i. Adults and children with suspected mTBI/concussion should be referred to an appropriately qualified health professional for confirmation of diagnosis.	Adapted[27]

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 include the NEXUS tool for neck assessment and the Canadian C Spine Rule

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.[40] These are identified as "red flags" in concussion recognition tools. Additional considerations apply for elderly adults due to the likely presence of comorbidities.

DRAFT

Recommendation for children and adults	Consensus-based	
ii.	People with mTBI/concussion should be assessed in a hospital setting if the mechanism of injury was severe[1] or if they develop 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[6]

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	Consensus-based	
iii.	Children with head injuries sustained from ground-level falls or walking or running into stationary objects, with no loss of consciousness, a GCS score of 15 and no signs or symptoms of head trauma other than abrasions, do not need to attend hospital for assessment; they can be safely managed in primary care or at home.	Adopted[6]

Recommendation for elderly adults	Consensus-based	
iv.	Special consideration needs to be made for elderly people 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

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.[41, 42] 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.[43]

Recommendation for children and adults[38, 39, 44-53]	Strong	
2.	An appropriately qualified health professional should conduct a review of every person who has sustained mTBI/concussion to confirm diagnosis.	Adapted[27]

1.1.4 Clinical history, physical examination and assessment tools

A thorough assessment of a person with mTBI/concussion should be carried out by an appropriately qualified health professional to both assess the condition and to exclude potential neurosurgical or medical complications. The examination should include:[27]

- 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).

Recommendation for children and adults[41, 54-63]	**Conditional**
3. 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[27]

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[38, 39, 44-53, 64]	**Conditional**
4. Consideration should be given to use of an age-appropriate standardised concussion symptom inventory tool.	Adapted[27]

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.[65-67] 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[65, 67-71]	**Conditional**
5. Neuroimaging should not be routinely used for the purpose of diagnosing mTBI/concussion.	Adapted[27]

Recommendation for children	**Conditional**
6. In children with mTBI/concussion who have one or more risk factors for a brain injury, health care professionals should take into account the number, severity and persistence of signs and symptoms (see Figure 1 and Appendix C), and family factors (e.g. distance from hospital and social context) when choosing between structured observation and a head CT.	Adopted[28]

Recommendations for adults[65, 67-71]	**Conditional**
7. The need for neuroimaging of people 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[27]

Recommendations for children and adults	Consensus-based
v. Plain skull x-rays are not recommended for the purpose of diagnosing mTBI/concussion.	Adapted[27, 28]
vi. Health professionals should not use single-photon emission CT (SPECT) or quantitative electroencephalogram in the acute evaluation of suspected or diagnosed mTBI/concussion.	Adopted[29]

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 signes of altered mental status Abnormal neurological examination Severe mechanism of injury* Post-traumatic seizures	Palpable skull fracture Non-frontal scalp haemotoma 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: See also Appendix C.

* 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	**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)**	**Rule not applicable if:** Non-trauma cases GCS <13 Age <16 years Anticoagulants or bleeding disorder Obvious open skull fracture

Fall from elevation ≥3 metres or 5 stairs	6. Amnesia before impact ≥30 min 7. Dangerous mechanism **	

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.[72]

Further guidance

For information regarding the need for neuroimaging in children who present to the emergency department, 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.[73] 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.[74] Other studies have found that repeat head CT is not warranted in people with mTBI/concussion, even in people at higher risk of intracranial haemorrhage progression.[75, 76]

Recommendation for children and adults[73, 77]	**Strong**	
8. After a normal initial head CT in people presenting to an acute care setting following mTBI/concussion, neurological deterioration should prompt urgent reappraisal, with consideration of an immediate repeat head CT and consultation with a neurosurgical service. 9. 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[6]

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.[78-82] 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.Marincowitz, Lecky (83) Risk factors for deterioration include anticoagulation, GCS<15, abnormal neurological examination, and significant extracranial injury. Marincowitz, Lecky (83) Evidence of intracranial injury or intracranial haemorrhage on head CT requires urgent neurosurgical consultation.

Recommendations for children and adults	**Consensus-based**	
vii. 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[6]
viii. Consultation with a neurosurgical service should occure in all adults with a base of skull fracture, or skull fracture and confusion, decreased conscious level, or neurological symptoms or signs.		Adapted[6]

Notes:

1 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 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[6]
b. If the GCS does not return to 15, repeat assessment should be performed.	Adapted[6]
c. Discharge criteria should be met, even if there is a normal head CT.	Adapted[6]

Further guidance

Please refer to the PREDICT guidelines for details about observation and mild and moderate head injuries in children.

1.2 Complicating factors

1.2.1 Abusive head trauma

Practice point for children and adults	
d. Consider the possibility of abusive head trauma in all presentations of mTBI/concussion.	Adapted[6]

Further guidance

Please refer to the PREDICT guidelines for further consideration of abusive head trauma in children.

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[6]

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).[84-87] People without symptoms and a GCS of 15 may not need a head CT and instead undergo structured observation.[88] However, elderly people (>60 years) are at higher risk of intracranial haemorrhage and have a higher mortality,[86, 87] thus elderly patients 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.[89]

Urgent anticoagulant reversal should be considered for people with acute intracranial haemorrhage, as ongoing bleeding and hemorrhage enlargement can cause neurologic deterioration, elevation in intracranial pressure, and poor functional outcome or death.[90] Urgent reversal may not be necessary for a clinically stable person with a small, chronic subdural hemorrhage 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.

DRAFT

Recommendation for children and adults[89, 91]	Conditional
10. 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[6]

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[6]

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 haemoatologist.	Adapted[6]

Practice point for adults[92-94]	
h. In adults on anticoagulant or antiplatelet therapy or who have known bleeding disorders, CT should be strongly considered. Health 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 thrombocytopaenia 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.[95]

Recommendation for children and adults	Consensus-based
ix. 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[6]

1.2.5 Intoxication

Recommendation for children and adults	Consensus-based
x. 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. Brain imaging decision rules may not have adequate sensitivity for this group.	Adapted[6]

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.[25, 96]

Recommendations for children and adults[97-99]	Strong	
11. Provide patient/parent/support person with clear, age-appropriate verbal and written advice including: • reassurance that most people recover fully • natural history of early post concussive symptoms • possibility of persisting symptoms • advice on early symptom management • advice on return to activities/school/work • follow-up with a healthcare professional if symptoms persist • discharge letter (for people seen in the emergency department).		Adapted[6, 27]

Education and advice before sending the person home

Recommendation for children and adults[77]	Strong	
12. 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[6]
13. 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[6]

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	
xi. Advise people who have experienced mTBI/concussion to avoid alcohol and other recreational drugs while symptoms persist.		Adapted[28]

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[100] and, when not adequate, adversely affects medical conditions, including mTBI/concussion.[101-103] 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.[104-106] Following mTBI/concussion that has been assessed by an appropriately qualified health care professional, there is no need to keep person awake.

Recommendation for children and adults	Consensus-based
xii. Provide people who have experienced mTBI/concussion with guidance on fatigue management and age-appropriate sleep hygiene methods.	Adapted[29]

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[107, 108]	Conditional
14. 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 anteplatelet medication.	Adapted[28]

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.[37, 50, 68, 69] No age range has been specified as “elderly” among among Māori and Psifika peoples.

Recommendation for children and adults[37, 50, 68, 69]	Conditional
15. People presenting with acute mTBI/concussion can be safely discharged for home observation in the care of a responsible adult if they meet 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[27]

1.4 Follow-up

Follow-up provides the opportunity for healthcare professionals to identify persisting post-concussive symptoms, which occur in 25-40% of children,[109] and are also prevalent in adults[110] and elderly adults.[111, 112]

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[97, 98]	Conditional
16. 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[6, 27, 28]

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 a clinical indication for imaging.	New

1.4.3 Referral of people with poor prognosis following mTBI/concussion

Recommendation for children and adults[113]	Conditional
17. For people at high risk of persisting symptoms (see Box A), health professionals should consider earlier referral to specialist services for post-concussive symptom management.	Adapted[6]

1.5 Prognosis

The symptoms experienced by most people with mTBI/concussion resolve within 1 to 3 months of the injury[114] 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.[29] 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.[112] These include concurrent factors such as pain, anxiety, depression, post-traumatic stress and ligation.[112] Pre-injury variables, including psychopathology, substance misuse, and other forms of acquired brain injury, can also affect recovery.[112] 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.[115]

Practice point for children and adults[41, 54-63, 113, 116-119]	
j. For people presenting with mTBI/concussion, health professionals should consider factors known to be associated with an increased risk of developing post-concussive symptoms (see Box A).	Adapted[6, 27, 28]

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 – Lower level of education – Litigation

1.5.2 Counselling of prognosis/advice regarding prognosis

Practice point for children and adults[23, 25, 120-125]	
k. Health 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[29]

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.

DRAFT

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.[126]

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.[127] Return to sport (defined as activity where physical exertion and skill are a primary focus, with elements of competition or social participation[128]) 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.[126]

Recommendations for children and adults[126, 129, 130]	**Strong**
18. Strict rest until the complete resolution of mTBI/concussion-related symptoms is not beneficial and not recommended. 19. Relative (not strict) rest is recommended for 24-48 hours after mTBI/concussion. Most activities of daily living can resume immediately.	Adapted[30]

Recommendation for children and adults[126, 131-133]	**Strong**
20. 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[6, 30]

2.1.2 General recommendations

Recommendation for children and adults[126]	**Consensus-based**
xiii. Individuals should be advised to avoid the risk of re-injury (i.e. contact, collision or fall) until a qualified health professional determines it is safe for higher risk activities.	Adopted[30]

Practice point for elderly adults	
I. Where a fall was the cause of mTBI/concussion in an elderly person, early resumption of daily activities should be encouraged. It is important to provide information on falls prevention strategies. Refer to the RACGP Falls Prevention in Older Adults website or World falls guidelines 2022[134] for further details on assessing and managing falls risk.	New

Recommendations for children and adults[135-137]	Conditional	
21. Explain that transient symptom worsening with increased activity is common.		Adapted[27]

2.1.3 Screen time

Recommendation for children and adults[138]	Strong	
22. Reduced screen use in the first 48 hours after mTBI/concussion is warranted but may not be effective beyond that time.		Adopted[30]

Practice point for children	
m. Parents and caregivers 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[6]

2.2 Return to driving/operating machinery

Recommendation for children and adults[139-141]	Consensus-based	
xiv. People who have experienced mTBI/concussion should be advise to avoid driving during the first 24 hours.		Adapted[27]
xv. 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.		Adapted[27]

2.3 Return to work

Evidence indicates that encouraging people to gradually and progressively (hours and duties) return to some form of meaningful work 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.[142]

Recommendation for adolescents and adults[143-145]	Conditional	
23. 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[27]
24. Students should have returned to school full-time before commencing extra-curricular work (unless part of educational activity).		

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[146]		Consensus-based
xvi.	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[27]

2.4 School/learning

The transition back to school 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.[147] 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.[147]

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.[148] 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.[149] 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[146]		Consensus-based
xvii.	To minimise academic and social disruptions following mTBI/concussion, health professionals should not recommend complete rest and isolation, even for the initial 24–48 hours, and instead recommend a period of relative rest.	Adopted[30]
xviii.	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[28]

Recommendation for children and adolescents		Consensus-based
xix.	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 medical and school-based teams and be modified based on ongoing assessment of symptoms.	Adapted[28, 29]

DRAFT

Table 1: 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.

2.4.2 Supports/accommodations for return to learning

Recommendation for children and adolescents	Consensus-based
xx. 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[30]

2.4.3 Prioritisation of return to school/learning

Recommendations for children and adolescents[147]	Conditional
25. 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[28, 30]

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 communitcation 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[150-154]	**Conditional**	
26.	For students who experience prolonged symptoms and academic difficulties despite an active treatment approach, health professionals should refer the child for a formal evaluation by a specialist in paediatric mTBI, or a multidisciplinary concussion team where available.	Adapted[29]

2.5 Return to sport

Deferring return to sport decreases the likelihood of repeat mTBI/concussion.[147] Avoidance of repeated head injury increases time to recovery and decreases length of persisting symptoms.[147] The graduated return to play should be individualized 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 Australian Institute of Sport (AIS), 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 recommendation 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.

Recommendation for children and adults	**Consensus-based**	
xxi.	Return to sport strategies should be individualized, follow the recommended guidelines, and be monitored by an appropriately qualified health professional.	New
xxii.	People who experience mTBI/concussion should progress through return to learn; see Table 1) and the return to sport steps (see Table 2), ensuring a minimum time away from play of 21 days from injury.	New

DRAFT

Table 2: Return-to-sport (RTS) 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. 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. Written determination of readiness to RTS should be provided by an HCP before unrestricted RTS as directed by local laws and/or sporting regulations.

HCP=healthcare professional; 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.

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.[30] 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 not arise from mTBI/concussion.[30]

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 and the mechanism and setting for the initial injury.[27] While related symptoms usually resolve within a few weeks of the injury, they may continue for longer than 1 month. These are considered as 'persisting symptoms' and occur in 15-20% of adults and 30–40% of children.[155]

A coordinated approach to the assessment and management of persisting symptoms facilitates symptom improvement and potential recovery.[27] Validated assessment and monitoring tools may assist this approach.[27] Common considerations in the context of persisting symptoms include headache disorders and migraine; sleep disturbance; mental health issues; learning or attention difficulties; visual, oculomotor, cervical and vestibular problems; dysautonomia, including orthostatic intolerance and postural orthostatic tachycardia syndrome; and pain.[30]

3.1 Assessing persisting symptoms

Symptoms that are considered the most debilitating and that are therefore prioritised for assessment and management are headache, mood and insomnia.[156] These symptoms frequently impede the ability to administer active rehabilitation interventions.[156] ADD in a comment about validity of some of the tools in PPCS

Recommendation for children and adults[156-166]	**Conditional**
27. 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[27]

28. 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 assessment • cognitive screening • further examination of the individual should be based on symptoms. In some settings, assessments may need to be conducted over a number of appointments.	Adapted [28]

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.[167] Another concern is the potential for commonly encountered complications such as medication-overuse headache with the use of simple analgesics.[168]

Recommendations for children and adults	**Consensus-based**
xxiii. 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[27]
xxiv. Repeat medical assessment is advisable for people with concerning or worsening post-concussion symptoms at 1-2 weeks following acute injury and then at 3-4 weeks in people with persisting symptoms.	Adapted [28]

Further guidance

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

Pain can be a factor in maintaining persisting symptoms and/or can overlap with or exacerbate symptoms of mTBI/concussion.[169] Neck injury and pain is a common comorbid condition following mTBI/concussion and can impede recovery.[169] There is significant overlap in symptoms of a neck injury and concussion (e.g. headache, dizziness and visual disturbances) and the neck should be considered as a potential source of symptoms post mTBI/concussion.[170, 171]

Recommendation for children and adults[169, 172]	**Strong**
29. When neck pain is present, careful and thorough clinical examination is required, and investigation (i.e. imaging) should only be conducted according to established imaging guidelines (e.g. NEXUS, Canadian C-spine rule)	Adapted[27]
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.[7, 173] The medical practitioner should continue to consider alternative diagnoses or factors which may be preventing or delaying symptom resolution and seek medical advice.

Recommendation for children and adults[157-161, 169]	Strong	
30. 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).		Adapted[27]

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. Strategies for management include symptom reduction strategies, targeted treatments to the causes of the symptoms and strategies for graduated return to function.

Gradual reintroduction to activity is recommended,[174] 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.[175, 176]

Targeted treatments combined with accessible and comprehensible education about mTBI/concussion aim to resolve symptoms, with the goal of return to baseline function.[113, 155, 156, 177, 178] 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[179-187]	Conditional	
31. Individuals with symptoms that persist after 1 month 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 success.		Adapted[27, 28]

Recommendations for children and adults[135-137]	Conditional	
32. 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[27]

Recommendations for children and adults[188-196]	Strong	
33. The use of hyperbaric oxygen to treat symptoms post- mTBI/concussion is not recommended.		Adapted[27]

Recommendation for children and adults	Consensus-based	
xxv. Treatment for specific symptoms or concerns should be initiated while waiting for a referral to an interdisciplinary concussion team or sub-specialist.		Adapted[28]

3.2.1 Return to activity with persisting symptoms

Recommendation for children and adults[126]	Consensus-based	
xxvi. 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[28]

3.2.2 Follow-up and referral for people with persisting symptoms

An interdisciplinary concussion clinic 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. Management at an interdisciplinary concussion clinic 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 general practitioner is recommended. Organisation of an interdisciplinary concussion clinic should follow specific outlined standards. In rural and remote areas access to such services can be difficult, here GP 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	Consensus-based	
xxvii. Referral to interdisciplinary concussion services/clinics or subspecialist (where available) should be considered for people who have symptoms persisting for more than 1 month.		Adapted[27]

DRAFT

4 Assessment and management of specific symptoms

4.1 Headache

Headaches are the most common symptom following mTBI/concussion.[197] The pathophysiology of post-traumatic headaches is not well understood.[198] 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.[199] The International Classification of Headache Disorders (ICHD-III) includes diagnostic criteria for both acute and persistent post-traumatic headache following mTBI.[200] 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.[201] Identifying the headache phenotype, can inform management. Post-traumatic headaches with migraine-like phenotype often lasts longer and has a worse outcome than a tension-type phenotype.[202]

In addition to the trigeminal system, the upper cervical nerve roots and upper cervical cord play and important role in headache.[203] 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,[126, 204] the evidence for its effectiveness in post-traumatic headache is limited. Regardless, gradual introduction of exercise is recommended.[174] As worsening of headache is commonly reported with exercise, headache can impede graded return to activity.[149] 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 which limits recovery. This can lead to avoidance of physical activity (kinesiophobia), cognitive activity (cogniphobia),[176] and sensory stimuli (such as noise and light). As this is often associated with significantly increased disability and the involvement of a psychologist or behavioural occupational therapist can be helpful.[176]

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.[205]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.[206, 207] Identification of headache subtypes can help to guide management.

Recommendation for children and adults	Conditional
34. Identification of the headache phenotype can inform management.	Adapted[27]
35. An appropriately qualified health 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[27]

DRAFT

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[206-210]	Conditional	
36. Personal, environmental, work-related, school-related, and physical factors such as neck pain should be identified and addressed as potential headache contributors.		Adopted[27]
37. 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[27]

Recommendation for children and adults	Consensus-based	
xxviii. The health 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[27]

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 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 recognize potential headache triggers
- guide treatment decisions and evaluate response to treatment
- help the health 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.[211, 212]

Recommendation for children and adults	Consensus-based	
xxix. 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 professional.		Adapted[27]

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	
xxx.	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 upper cervical injury.	Adopted[27]

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.[27]

Recommendation for children and adults	Consensus-based	
xxxi.	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[27]

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 minimize the potential for medication overuse (rebound) headache.

Recommendations for children and adults	Consensus-based	
xxxii.	Over the counter analgesics (e.g. acetaminophen, ibuprofen, acetylsalicylic acid, naproxen) should be used less than 15 days per month.	Adopted[27]
xxxiii.	Combination analgesics (i.e. with caffeine or codeine) should be used less than 10 days per month.	Adopted[27]
xxxiv.	Migraine-specific acute therapies should be trialed when non-specific acute therapies are incompletely effective. Triptans can be used for migrainous-type headaches less than 10 days per month.	Adopted[27]
xxxv.	When headaches are too frequent (e.g. more than 10 days per month) or disabling, prophylactic therapy should be considered	Adopted[27]

Practice point		
o.	Prophylactic therapy should be guided by headache phenotype.	Adopted[27]

4.1.5 Follow-up and referral for headache

Recommendations for children and adults	Consensus-based
xxxvi. Post-traumatic headaches may be unresponsive to conventional treatments. If headaches remain inadequately controlled, referral to a neurologist, headache specialist, paediatrician, or interdisciplinary concussion clinic is recommended.	Adopted[27, 28]

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.[213-218] While the need for sleep may increase in the immediate acute stage of mTBI/concussion,[213] 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.[219-223] 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, progressive muscle relaxation, meditation, and breathing techniques can help manage insomnia.[224] 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; this should occur in conjunction with sleep hygiene, insomnia, and circadian rhythm disorder management.

4.2.1 Diagnosis

Recommendation for children and adults	Consensus-based
xxxvii. A repeat medical assessment should be performed for all people presenting with post-concussion sleep disturbances 1-2 weeks following acute injury.	Adapted[28]
xxxviii. 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[27]

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 recognize patterns in sleep habits.[225] 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.[225]

DRAFT

Recommendation for children and adults	Consensus-based	
xxxix. 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[27]
xl. 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.		

4.2.3 Education

Sleep disturbance is common following mTBI/concussion, with most people having mild symptoms and achieving full recovery with time.[220] While most sleep-related problems will resolve spontaneously targeted intervention may be required to facilitate recovery.[220] Poor sleep may exacerbate other symptoms such as headache, fatigue, mood disturbances and cognitive problems possibly contributing to delayed recovery.[221, 226, 227] 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[158, 185, 217, 219, 223, 226, 228-235]	Conditional	
38. 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[27]

Recommendation for children and adults	Consensus-based	
xli. Education on sleep disturbances should be provided in written, verbal and/or pictorial formats.		Adapted[27]

Further guidance

Further information on providing education about sleep disturbance is available from the RACGP.

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 children with persisting post-concussion symptoms [236] and adults with traumatic brain injury.[237]

Recommendation for children and adults	Consensus-based	
xlii. People with insomnia should be given advice on sleep hygiene (see Box E) and self-management strategies or programs.		Adapted[27]

Box E

Sleep hygiene suggestions could include:	
– 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

DRAFT

Supplements

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.

Recommendation for children and adults[238-241]	**Strong**	
39. Advise people with post-concussive insomnia to use melatonin (2-5 mg two hours before bedtime).		Adapted[27]

Recommendation for children and adults[242]	**Conditional**	
40. Advise on reduced evening light exposure and consider bright light exposure or blue light therapy in the morning.		Adapted[27]

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

Cognitive behavioural therapy

Cognitive behavioural therapy (CBT) is established as the treatment of choice for sleep-wake disorders following mTBI/concussion.[243-245] If CBT provided by a licensed practitioner 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

Recommendation for children and adults[243, 244]	**Conditional**	
41. Refer people with prolonged post-concussive insomnia for cognitive behavioural therapy (CBT) specifically for sleep or to a sleep physician (where accessible).		Adapted[27]

Further guidance

For virtual CBT resources, please view the following: Shut-I: Online application offering CBT-I, CBT-I coach, Sleep Foundation.

Additional resources are available from the Western Australian government, Sleep Therapy Australia, ThisWayUp, and Calm.

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.

Recommendation for children and adults	Consensus-based
xliii. If non-pharmacological treatment options have not been effective in treating sleep disturbances that persist beyond 1 month, 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[27]

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.[101-103] Maintenance of appropriate sleep and the management of disrupted sleep may be a critical target of treatment for the people with mTBI/concussion.[104-106]

Recommendation for children and adults[101-106]	Conditional
42. If sleep problems emerge or continue despite appropriate sleep hygiene measures, health professionals may consider referral of people with mTBI/concussion to a sleep disorder specialist or a complex mTBI/concussion management clinic.	Adapted[4]

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[246] and are associated with a constellation of disabling symptoms which may lead to poor outcomes post-injury.[247, 248 249] Acute fatigue can be associated with mTBI/concussion. Fatigue that lasts longer than 1 month 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.

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,[250] consequences of adverse effects of medications and supplements,[251] polypharmacy, alcohol, substance use, and/or nutritional deficiencies.[27]

Recommendation for children and adults[185, 209, 252]	Conditional
43. 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 3 for useful assessment tools).	Adapted[27]

Table 3: 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. Barrow Neurological Institute Fatigue Scale, 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 • 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

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 with mTBI/concussion.[253] For example, distributing activities and breaks across the day may assist people to achieve more without exceeding tolerance levels.[249, 253] 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.[253] 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[243, 253, 254]	**Strong**	
44. People with significant symptoms of fatigue should be given information about management of contributing factors (see Table 3).		Adapted[27]

4.3.3 Treatment

Cogniitive Behavioural therapy

Cognitive behavioural therapy may be used successfully to address fatigue as well as sleep disturbance following traumatic brain injury.[245, 255] Such therapy focuses on monitoring and adjusting the daily routine to intersperse periods of activity with rest, often requiring adjustment of ways of thinking about activity levels, and learning specific strategies to manage cognitive slowing.

Melatonin

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.[254]

Recommendation for children and adults[254]	Conditional	
45. Advise people with fatigue resulting from disturbed sleep to use melatonin (2-5 mg two hours before bedtime).		Adapted[27]

Blue wavelength light therapy

Daily morning blue light therapy for 30 minutes over the course of 6 weeks may reduce daytime sleepiness following mTBI/concussion.[239, 256]

Recommendation for children and adults	Consensus-based	
xliv. Blue light therapy may be considered to reduce symptoms of fatigue and excessive daytime sleepiness.		Adopted[27]

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 clinic wherein practitioners from multiple disciplines coordinate care by providing diagnostic, educational, physical, cognitive, functional and emotional support.[145, 257-259] Interventions that may be effective in individuals with symptoms of fatigue include cognitive behavioural therapy, psychoeducation, psychotherapy, and exercise.[181]

Recommendation for children and adults[254]	Conditional	
46. Referral to interdisciplinary concussion services/clinics or an appropriately qualified health professional should be considered if fatigue causing functional impairment persisting for more than 1 month.		Adapted[27]

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 psychiatric psychological history or diagnosis of a psychiatric disorder is a predictor of persistent symptoms following mTBI/concussion.[42, 43, 60, 62, 260] Additionally, people experiencing prolonged symptoms following mTBI/concussion are at an increased risk of developing new or worsening mental health symptoms. Identification and treatment of changes in mood may facilitate recovery following a mTBI/concussion.

Diagnosis

Recommendation for children and adults[41, 54, 56, 58, 60]	Conditional	
47. Health professionals should routinely monitor for and manage depression and anxiety after mTBI/concussion.		Adapted[27]

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.[41, 42, 261, 262]

Recommendation for adults[43, 54, 60, 160, 161, 262-275]	Strong	
48. 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[27]

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:

Beck Depression Inventory

Bipolar self test

Depression self-report questionnaire

Hamilton Depression Rating Scale

Health of the Nation Outcomes Scales

Hospital Anxiety and Depression Scale

Kessler Psychological Distress Scale (K10)

International trauma questionnaire for PTSD

Tools for the assessment of children include:

Post-Concussion Mental Health Considerations Algorithm

Management of Prolonged Mental Health Disorders Algorithm

Strength and difficulties questionnaire

GAD-7

Patient Health Questionnaire 9

4.4.1 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. 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.[276-281] It has been shown to be efficacious in individuals with TBI when both depression and anxiety are addressed together.[282] CBT has been shown to be effectively delivered across various modalities, such as telehealth virtual psychotherapy.[283, 284] 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.[285, 286]

Recommendation for children and adults[276]	Strong	
49. If a mental health disorder is determined to be present, existing practice guidelines for the treatment of the diagnosed condition should be followed.		Adapted[27]

Recommendation for children and adults[186, 277, 278, 284, 286-291]	Conditional	
50. Cognitive behavioural therapy (CBT) and other psychotherapeutic modalities should be recommended for people with mental health conditions following mTBI/concussion.		Adapted[27]

Recommendation for children and adults[285, 292]	Conditional	
51. Mindfulness-based stress reduction may be recommended to help manage chronic symptoms following mTBI/concussion.		Adopted[27]

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 health professional with experience in managing mental health should be involved.	New

4.4.2 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.

Recommendation for children and adults	Consensus-based	
xlv. Treat mental health conditions or consider referral to a mental health specialist, especially where there is a lack of response to treatment.		Adapted[28]

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.[293-296]

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. Neuropsychological evaluations that also consider these factors can assist in determining the aetiology of cognitive impairment and directing treatment.[296]

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

Assessment has unique challenges in elderly and cultually 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.

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 4–6 weeks, referral for further assessment should be considered.

4.5.1 Assessment

Recommendation for children and adults	Consensus-based
xlvi. Health professionals should attempt to determine the aetiology of cognitive dysfunction within the context of other mTBI symptoms.	Adapted[4]

Practice point for elderly adults	
v. Cognitive change in an elderly person could be a symptom of dementia. An early assessment to exclude intracranial pathology is recommended in elderly people with mTBI/concussion. After exclusion of other organic pathology, consider referral of elderly 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.[25, 96] Education should be offered in multiple formats to ensure information is accessible and comprehensible.

Prolonged cognitive symptoms following mTBI/concussion (beyond 1 month) are often generated and exacerbated by other pre-existing and comorbid conditions such as headache, insomnia, visual disturbances and disturbances in mood. If a person presents with prolonged symptoms, they should be made aware that the presence of comorbidities may be interfering with recovery.[156, 297] 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[158, 172, 234, 267, 297-308]	Conditional
52. 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[4, 27]

4.5.3 Treatment

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).[309, 310] Additionally, external compensatory strategies such as the use of environmental supports and reminders (e.g. mobile/smartphones, notebooks) may also be employed.[284]

Recommendation for children and adults[284, 285, 309, 311-316]	Conditional	
53. Manage cognitive symptoms that interfere with daily functioning which may include self-directed compensatory strategies (i.e. internal, external, environmental). If cognitive difficulties persist beyond 6 months, they should be reassessed by a specialist. If there is ongoing persistence and complexity of cognitive symptom presentation, refer to a specialised program.		Adapted[27]

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. Specialized 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	
xlvii. 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).		Adapted[27]

Recommendation for elderly adults	Consensus-based	
xlviii. Elderly people should be referred to a geriatrician,neurologist, memory clinic or cognitive medical specialist for evaluation.		Adapted[27]

Recommendation for children and adults[146]	Consensus-based	
xlix. 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[27]

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 a 2-point increase on the 10-point scale ranging from 0-10), so long as the symptoms resolve shortly afterwards.[317] People with mTBI/concussion may consider using noise cancelling headphones or reduced screen brightness when gradually returning to functional activities. Lingering symptoms should not prevent activities of daily living.[317]

Recommendation for children and adults	Consensus-based
l. 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[27]

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.[318] 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.[318-321] The use of an objective screening tool can assist in decision-making regarding referral for further assessment for people not showing improvement.

Recommendation for children and adults[318-321]	Conditional
54. If vestibular, vision, balance and coordination symptoms are endorsed, they should be screened for and monitored at follow-up appointments using validated screening tools.	Adapted[27]

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.[322, 323]

Recommendation for children and adults[322, 323]	Conditional
55. 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[28]

Practice point for children and adults	
w. An eye examination should be undertaken to rule out ocular injuries and/or pre-existing disease that may impact vision.	Adapted[27]

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.[322, 323]

Recommendation for children and adults[322, 323]	**Conditional**
56. 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 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.	Adapted[28]

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.

Recommendation for children and adults	**Consensus-based**
li. 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.	Adopted[28]

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[28]

Recommendation for children and adults	**Consensus-based**
lii. 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[27]

4.7.4 Psychosocial assessment

Recommendation for children and adults	**Consensus-based**
liii. Screen for and consider underlying psychosocial symptoms that may exacerbate symptoms of vestibular, vision, and oculomotor dysfunction.	Adapted[28]

4.7.5 Education

Recommendation for children and adults	**Consensus-based**
liv. 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[28]

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 health professional for treatment (usually a physiotherapist with competency-based training in vestibular rehabilitation). If severe symptoms are provoked by pressure (i.e. val salva) or accompanied by a change in hearing, referral to an otolaryngologist or neuro-otologist is warranted.

Recommendation for children and adults[186, 324-327]	**Conditional**	
57. When the Dix-Hallpike manoeuvre is positive, the Epley/canalith repositioning manoeuvre should be used to treat benign paroxysmal positional vertigo.		Adapted[27]

Recommendation for children and adults	**Consensus-based**	
Iv. If BPPV does not resolve within 1-3 treatments, consider referral to an otolaryngologist or health professional certified in vestibular rehabilitation.		Adapted[27]

Recommendation for children and adults[322, 323]	**Conditional**	
58. Consider referral to an interdisciplinary concussion team or physiotherapist with competency-based training. Here, tests may include Functional Gait Assessment and the Bruininks-Oseretsky Test of Motor Proficiency.		Adapted[28]

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[328-330]	**Strong**	
59. Vestibular rehabilitation therapy is recommended for people experiencing functionally limiting dizziness.		Adapted[27]

4.7.8 Assessment of hearing

Hearing problems as a predominant post-concussion symptom are uncommon following mTBI/concussion, and should alert the HCP 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.

Recommendation for children and adults[331, 332]	**Conditional**	
60. 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 made if no apparent cause is found.		Adapted[27]

4.7.9 Treatment 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.

DRAFT

Recommendation for children and adults	Consensus-based
lvi. There is no evidence to suggest for or against the use of any particular modality for the treatment of tinnitus after mTBI/concussion. If tinnitus is present, referral to a neuro-otolaryngologist may be considered if self-management strategies are not effective.	Adapted[27]

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	Consensus-based
lvii. 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 health professional with specialised training in the vision or vestibular system is recommended, where available.	Adapted[27]

4.8 Autonomic nervous system

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.[333, 334]

An orthostatic challenge using the Active Standing Test (see SCOAT6 – orthostatic vital signs) or an exercise tolerance test performed by a qualified health professional) can help identify whether autonomic dysfunction is possibly contributing to post-concussion symptoms. These symptoms often respond to graded substhreshold exercise program.

Practice point for children and adults	
y. Autonomic dysfunction can occur following mTBI/concussion and may contribute to persisting symptoms.	New

DRAFT

5 Repeat concussion/chronic traumatic encephalopathy

5.1 Repeat concussion

5.1.1 Management

Recommendation for children and adults	Consensus-based
lviii. 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[6]

5.2 Long-term effects

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/risk of long-term effects of mTBI or chronic traumatic encephalopathy (CTE). As there is no conclusive data to support this risk or its management, the GDG were unable to develop any recommendations.

Chronic traumatic encephalopathy is a pathological syndrome with degenerative changes that can can only be diagnosed at autopsy (CTE-NC). CTE-NC has been 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 atheletes e.g. those who have played for more that 14.5 years were 10 times as likely to have CTE pathology.[335]

The relationship between clinical symptoms and signs and the pathology CTE-NC is not clear. The clinical syndrome that may accompany CTE-NC is reffered to as Traumatic Encephalopathy Syndrome (TES), a non-specific constellation of progressive cognitive, psychiatric 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 TES classification criteria have been developed in order to help understand how TES may or may not relate to CTE-NC and repetitive head injury.[336]

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 (Iverson 2023). Other factors that may increase this risk include genetic, general health factors (e.g. obstructive sleep apnoea, cardiovascular disease), 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.[337]

Practice point for children and adults	
z. 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

DRAFT

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.
Appropriately qualified health professional	Depending on the context, this includes medical and/or allied health professionals.
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.[6]
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).[338] Concussion is a form of mild traumatic brain injury.
Elderly adult:	A person aged more than 65 years or more than 50 years in an Aboriginal and/or Torres Strait Islander person.
Exercise:	A form of physical activity that is planned, structured, and repetitive and aims to improve physical fitness.
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.
Persisting symptoms:	Symptoms that have persisted for more than 1 month following mTBI/concussion.
Physical activity:	Any bodily movement produced by skeletal muscles that requires energy expenditure.
Sport:	A human activity involving physical exertion and skill as the primary focus of the activity, with elements of competition or social participation.[128]

DRAFT

Acronyms and abbreviations

ADHD	attention deficit hyperactivity disorder
ANZ	Australia Aotearoa New Zealand
CSF	cerebrospinal fluid
CT	computed tomography
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
PECARN	Pediatric Emergency Care Applied Research Network
PREDICT	Paediatric Research in Emergency Departments International Collaborative
S100B	S100 calcium binding protein B
SCAT	sport concussion assessment tool
SPECT	single photon emission computed tomography

DRAFT

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 Jennie Ponsford	Professor of Neuropsychology	Monash University; Monash-Epworth Rehabilitation Research Centre	Melbourne, Victoria, Australia
Prof Franz Babl	Paediatric Emergency Physician	Murdoch Children's Research Institute; University of Melbourne; Royal Children's Hospital	Melbourne, Victoria, Australia
Prof Alice Theadom	Professor of Psychology and Neuroscience	Auckland University of technology	Auckland, Aotearoa New Zealand
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	Clinical excellence Queensland; Royal Brisbane and Women's hospital; University of Queensland	Brisbane, Queensland, Australia
Mr David Cole	Consumer advocate		Brisbane, Queensland, Australia

Guideline Development Group

Name	Expertise	Institution	Location
Prof Vicki Anderson	Paediatric Neuropsychologist	Murdoch Children's Research Institute; University of Melbourne	Melbourne, Victoria, Australia
Prof Gary Browne	Emergency physician; Sports and exercise medicine physician	University of Sydney, Children's Hospital Westmead	Sydney, New South Wales, Australia

Name	Expertise	Institution	Location
Adjunct A/Prof Jennifer Cullen	CEO of Synapse; Patient advocate; Advocate for Aboriginal and Torres Strait Islander peoples with a disability	Synapse; Griffith University	Brisbane, Queensland, Australia
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
Prof Melinda Fitzgerald	Professor of Neurotrauma	Curtin Health Innovation Research Institute, Curtin University; Perron Institute for Neurological and Translational Science; Connectivity Traumatic Brain Injury Australia	Perth, Western Australia, Australia
Dr Howard Flavell	Rehabilitation medicine physician	Royal Darwin Hospital	Darwin, Northern Territory, Australia
Dr Sarah Harris	Research fellow with focus on exercise and sports science	Notre Dame University	Perth, Western Australia, Australia
Dr Gary Mitchell	Emergency Physician	Royal Brisbane and Women's Hospital; University of Queensland	Brisbane, Queensland, Australia
Prof John Olver	Rehabilitation physician	Epworth Healthcare; Monash University	Melbourne, Victoria, Australia
A/Prof Rhonda Orr	Professor in exercise and sports science	University of Sydney; Children's Hospital Westmead	Sydney, New South Wales, Australia
Dr Mark Ralfe	Sports medicine physician; General Practitioner	Wakefield Sports and Exercise Clinic; RACGP; Flinders University	Adelaide, South Australia, Australia
A/Prof Michael Rose	Consultant physician and geriatrician	Cabrini Health	Melbourne, Victoria, Australia
Mr Nick Rushworth	Executive officer of Brain Injury Australia; Patient advocate	Brain Injury Australia	Sydney, New South Wales; Australia

Name	Expertise	Institution	Location
Dr Julia Treleaven	Senior Lecturer Physiotherapy Clinical Physiotherapist	University of Queensland	Brisbane; Queensland, Australia
A/Prof Sean Tweedy	Professor of sports and exercise science, with a particular interest in Parasport	International Paralympic Committee; University of Queensland	Brisbane, Queensland, Australia
Dr Caroline Yates	General Practitioner; Rural specialist	Brisbane South Health Pathways; Royal Flying Doctor Service	Brisbane, Queensland, Australia

Consumer Working Group

Name	Location
Andrew Cocks	WA, Australia
Paulien Robinson	QLD, Australia
Brenda Desplace	QLD, Australia
Sarah Taimana Brodrick	Auckland, New Zealand
Gerard Thomas	WA, Australia
Tayla Fletcher	QLD, Australia
Kirsty Foreman	WA, Australia
Megan Butner	QLD, Australia

Four other consumers were also members of the Consumer Working Group

DRAFT

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:**[9] a pragmatic process to expedite guideline development through analysis, synthesis and expansion of multiple existing high-quality national and international guidelines[1] (see Section 0).
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 0).

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 1, with the exception of the Concussion in Para Sport (CIPS) Group[339] 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

DRAFT

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[340] 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[339] 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 4: Accepted source guidelines

Guideline developer/ID (reference)	Publication Date	Guideline title	Target population	Country	AGREE II overall score
Living Concussion Guidelines[27]	Living Guideline	Living Concussion Guidelines: Guideline for Concussion & Prolonged Symptoms for Adults 18 years of Age or Older	Adults	Canada	6/7
PedsConcussion[28]	Living Guideline	Living Guideline for Pediatric Concussion Care	Children/adolescents 5-18 years	Canada	6/7
PREDICT[6]	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[29]	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[30]	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[339]	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.

DRAFT

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.

DRAFT

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 5: 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.

DRAFT

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.**

DRAFT

Table 6: Evidence selection criteria for 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	
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 7: Evidence selection criteria for 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.

DRAFT

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.

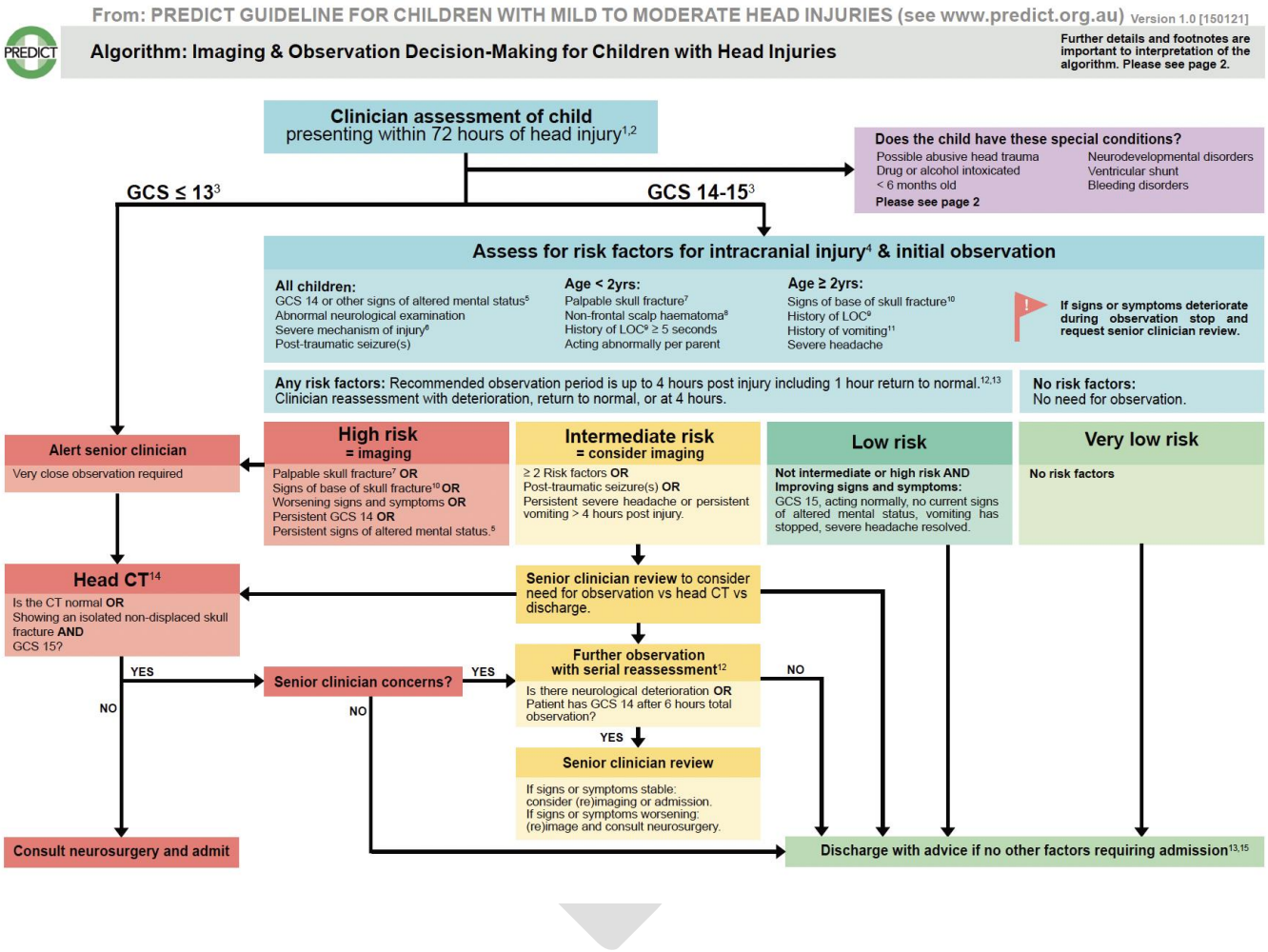
Studies that included a mixed population of participants with stroke and traumatic brain injury (TBI) and/or participants across the spectrum of TBI severity (mild, moderate, severe) were excluded unless the results were presented separately for participants with mTBI, or at least 75% of participants 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 0.

DRAFT

C PREDICT algorithm



From: PREDICT GUIDELINE FOR CHILDREN WITH MILD TO MODERATE HEAD INJURIES (see www.predict.org.au) Version 1.0 [150121]

Further details to aid algorithm interpretation

[1] Always consider possible cervical spine injuries and abusive head trauma in children presenting with head injuries.

[2] Children with delayed initial presentation (24-72 hrs post head injury) and GCS 15 should be risk stratified the same way as children presenting within 24 hours. They do not need to be assessed with a further 4 hrs of observation.

[3] Remember to use an age-appropriate Glasgow Coma Scale (GCS).

[4] Risk factors adapted from Kuppermann N et al. *Lancet* 2009;374(9696):1160-70.

[5] Other signs of altered mental status: agitation, drowsiness, repetitive questioning, slow response to verbal communication.

[6] Severe mechanism of injury: motor vehicle accident with patient ejection or rollover, death of another passenger, pedestrian or cyclist without helmet struck by motor vehicle, falls of ≥ 1m (< 2 yrs), fall > 1.5m (≥ 2yrs), head struck by high impact object.

[7] Palpable skull fracture: on palpation or possible on the basis of swelling or distortion of the scalp.

[8] Non-frontal scalp haematoma: occipital, parietal, or temporal.

[9] Loss of consciousness.

[10] Signs of base of skull fracture: haemotympanum, 'raccoon' eyes, cerebrospinal fluid (CSF) otorrhoea or CSF rhinorrhoea, Battle's signs.

[11] Isolated vomiting, without any other risk factors, is an uncommon presentation of clinically important traumatic brain injury (ciTBI). Vomiting, regardless of the number or persistence of vomiting, in association with other risk factors, increases concern for ciTBI.

[12] Observation to occur in an optimal environment based on local resources. Frequency of observation to be ½ hourly for the first 2 hours, then 1-hourly until 4 hours post injury. After 4 hours, continue 2-hourly as long as the patient is in hospital. Observation duration may be modified based on patient and family variables. These include time elapsed since injury/symptoms and ability of child/parent to follow advice on when to return to hospital.

[13] Shared decision-making between families and clinicians should be considered.

[14] Do not use plain X-rays, or ultrasound of the skull, prior to or in lieu of CT scan, to diagnose or risk stratify a head injury for possible intracranial injuries.

[15] Other factors warranting hospital admission may include other injuries or clinician concerns e.g. persistent vomiting, drug or alcohol intoxication, social factors, underlying medical conditions, possible abusive head trauma.

Special Conditions

Possible abusive head trauma

Follow local screening tools for abusive head trauma (AHT). CT should be used as initial diagnostic tool to evaluate possible intracranial injury and other injuries relevant for the evaluation of AHT e.g. skull fractures. The extent of the assessment of a child with possible AHT should be co-ordinated with the involvement of an expert in the evaluation of non-accidental injury.

Drug or alcohol intoxicated

Treat as if the neurological findings are due to the head injury. Decision to CT scan or observe should be informed by risk factors for intracranial injury rather than the child being intoxicated.

< 6 months of age

Consider at higher risk of intracranial injury with a lower threshold for observation or imaging. Discuss with a senior clinician.

Neurodevelopmental disorders

It is unclear whether these children have a different background risk for intracranial injury. As these children may be difficult to assess, consider structured observation or head CT scan and include the paediatric team that knows the child (parents, caregivers, and clinicians) in shared decision-making.

Ventricular shunt (e.g. ventriculo-peritoneal shunt)

Consider structured observation over immediate CT scan if there are no risk factors of intracranial injury. If there are local signs of shunt disconnection/shunt fracture (such as palpable disruption or swelling) or signs of shunt malfunction, consider obtaining a shunt series based on consultation with a neurosurgical service.

Bleeding disorders or anti-coagulant or anti-platelet therapy

Urgently seek advice from the treating haematology team around risk of bleeding and management of coagulopathy. Consider structured observation over immediate CT scan if there are no risk factors for intracranial injury. If there is a risk factor for intracranial injury a head CT should be performed. If there is a deterioration in neurological status, perform urgent head CT scan.

Coagulation factor deficiency

CT scan or decision to observe must not delay the urgent administration of replacement factor.

Immune thrombocytopaenias (ITP)

Check a platelet count in all patients and blood group in all symptomatic patients if not already available. For ITP with platelet counts < 20 x 10^9 /L, consider empirical treatment after discussion with the treating haematology team.

On warfarin therapy or other newer anticoagulants (e.g. direct oral-anticoagulant) or anti-platelet therapy

Consider CT regardless of the presence or absence of risk factors for intracranial injury. Seek senior clinician review to inform timing of the CT and discuss the patient with the team managing the anticoagulation regarding early consideration of reversal agents. For children on anticoagulation therapy, if available, check the appropriate anticoagulant measure (e.g. International normalised ratio).

Citation: Babl FE, Tavender E, Dalziel S. On behalf of the Guideline Working Group for the Paediatric Research in Emergency Departments International Collaborative (PREDICT). Australian and New Zealand Guideline for Mild to Moderate Head injuries in Children – Algorithm (2021). PREDICT, Melbourne, Australia.

Source: www.predict.org

References

1. Hyder AA, Wunderlich CA, Puvanachandra P, Gururaj G, Kobusingye OC. The impact of traumatic brain injuries: a global perspective. NeuroRehabilitation. 2007;22(5):341-53. doi:
2. White PE, Register-Mihalik J, Donaldson A, Sullivan SJ, Finch CF. Concussion guideline implementation perceptions and experiences among parents of community-level Australian Football junior players. BMJ Open Sport Exerc Med. 2017;3(1):e000215. doi: 10.1136/bmjsem-2016-000215.
3. Bergeron S, Flint H, Hansen Z. Economic Evaluation of Concussion Programs in the State of Idaho: The Collective Potential of Prevention and Clinical Care. Popul Health Manag. 2019;22(1):32-9. doi: 10.1089/pop.2017.0204.
4. Lumba-Brown A, Yeates Keith O, Sarmiento K, Breiding Matthew J, Haegerich Tamara M, Gioia Gerard A, et al. Centers for Disease Control and Prevention Guideline on the Diagnosis and Management of Mild Traumatic Brain Injury among Children. JAMA Pediatrics. 2018;172(11):1-13. doi: 10.1001/jamapediatrics.2018.2853.
5. Hingley S, Ross J. Guidelines for diagnosing and managing paediatric concussion: Ontario Neurotrauma Foundation guideline. Arch Dis Child Educ Pract Ed. 2016;101(2):58-60. doi: 10.1136/archdischild-2014-307252.
6. Babl FE, Tavender E, Dalziel S. Australian and New Zealand Guideline for Mild to Moderate Head injuries in Children – Full Guideline. 2021. Melbourne: Paediatric Research in Emergency Departments International Collaborative; 2021.
7. McCrory P, Meeuwisse W, Dvořák J, Aubry M, Bailes J, Broglio S, et al. Consensus statement on concussion in sport-the 5(th) international conference on concussion in sport held in Berlin, October 2016. Br J Sports Med. 2017;51(11):838-47. doi: 10.1136/bjsports-2017-097699.
8. Silverberg ND, Iaccarino MA, Panenka WJ, Iverson GL, McCulloch KL, Dams-O'Connor K, et al. Management of Concussion and Mild Traumatic Brain Injury: A Synthesis of Practice Guidelines. Arch Phys Med Rehabil. 2020;101(2):382-93. doi: 10.1016/j.apmr.2019.10.179.
9. Fervers B, Burgers JS, Voellinger R, Brouwers M, Browman GP, Graham ID, et al. Guideline adaptation: an approach to enhance efficiency in guideline development and improve utilisation. BMJ Qual Saf. 2011;20(3):228-36. doi: 10.1136/bmjqs.2010.043257.
10. Feigin VL, Theadom A, Barker-COllo S, Starkey NJ. Incidence of TBI in New Zealand: a population-based study. Lancet Neurol. 2013;12(1):53-64. doi:
11. Maas AIR, Menon DK, Adelson PD, Andelic N, Bell MJ, Belli A, et al. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. Lancet Neurol. 2017;16(12):987-1048. doi: 10.1016/S1474-4422(17)30371-X.
12. Browne GJ, Dimou S. Concussive head injury in children and adolescents. Aust Fam Physician. 2016;45(7):470-6. doi:
13. Zhang AL, Sing DC, Rugg CM, Feeley BT, Senter C. The Rise of Concussions in the Adolescent Population. Orthop J Sports Med. 2016;4(8):2325967116662458. doi: 10.1177/2325967116662458.
14. Jamieson LM, Harrison JE, Berry JG. Hospitalisation for head injury due to assault among Indigenous and non-Indigenous Australians, July 1999--June 2005. Med J Aust. 2008;188(10):576-9. doi: 10.5694/j.1326-5377.2008.tb01793.x.
15. Lagolago W, Theadom A, Fairbairn-Dunlop P, Ameratunga S, Dowell A, McPherson KM, et al. Traumatic brain injury within Pacific people of New Zealand. N Z Med J. 2015;128(1412):29-38. doi:
16. Seabury SA, Gaudette E, Goldman DP, Markowitz AJ, Brooks J, McCrea MA, et al. Assessment of Follow-up Care After Emergency Department Presentation for Mild Traumatic Brain Injury and Concussion: Results From the TRACK-TBI Study. JAMA Netw Open. 2018;1(1):e180210. doi: 10.1001/jamanetworkopen.2018.0210.
17. Bosch M, McKenzie JE, Ponsford JL, Turner S, Chau M, Tavender EJ, et al. Evaluation of a targeted, theory-informed implementation intervention designed to increase uptake of emergency management recommendations regarding adult patients with mild traumatic brain injury: results of the NET cluster randomised trial. Implement Sci. 2019;14(1):4. doi: 10.1186/s13012-018-0841-7.
18. Tavender EJ, Bosch M, Fiander M, Knott JC, Gruen RL, O'Connor D. Implementation research in emergency medicine: a systematic scoping review. Emerg Med J. 2016;33(9):652-9. doi: 10.1136/emermed-2015-205053.
19. Silverberg ND, Iverson GL, members ABISIGMTTF, Cogan A, Dams OCK, Delmonico R, et al. The American Congress of Rehabilitation Medicine Diagnostic Criteria for Mild Traumatic Brain Injury. Arch Phys Med Rehabil. 2023;104(8):1343-55. doi: 10.1016/j.apmr.2023.03.036.

DRAFT

20. Davis GA, Patricios J, Schneider KJ, Iverson GL, Silverberg ND. Definition of sport-related concussion: the 6th International Conference on Concussion in Sport. British journal of sports medicine. 2023;57(11):617-8. doi: 10.1136/bjsports-2022-106650.
21. Treleaven J. Dizziness, Unsteadiness, Visual Disturbances, and Sensorimotor Control in Traumatic Neck Pain. J Orthop Sports Phys Ther. 2017;47(7):492-502. doi: 10.2519/jospt.2017.7052.
22. Barlow KM. Postconcussion Syndrome: A Review. J Child Neurol. 2016;31(1):57-67. doi: 10.1177/0883073814543305.
23. Barlow KM, Crawford S, Stevenson A, Sandhu SS, Belanger F, Dewey D. Epidemiology of postconcussion syndrome in pediatric mild traumatic brain injury. Pediatrics. 2010;126(2):e374-e81. doi:
24. Ponsford J, Willmott C, Rothwell A, Cameron P, Kelly AM, Nelms R, Curran C. Impact of early intervention on outcome following mild head injury in adults. J Neurol Neurosurg Psychiatry. 2002;73(3):330-2. doi:
25. Ponsford J, Willmott C, Rothwell A, Cameron P, Ayton G, Nelms R, et al. Impact of early intervention on outcome after mild traumatic brain injury in children. Pediatrics. 2001;108(6):1297-303. doi: 10.1542/peds.108.6.1297.
26. Galbraith H, Quesnele J, Kenrick-Rochon S, Grenier S, Baldisera T. What are the knowledge, attitudes and beliefs regarding concussion of primary care physicians and family resident physicians in rural communities? Journal of Concussion. 2020;4. doi: 10.1177/2059700220974548.
27. 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.
28. Zemek R, Reed N, Dawson J, Ledoux AA. Living Guideline for Pediatric Concussion Care 2023 [Available from: www.pedsconcussion.com; https://doi.org/10.17605/OSF.IO/3VWN9.
29. Lumba-Brown A, Yeates KO, Sarmiento K, Breiding MJ, Haegerich TM, Gioia GA, et al. Centers for Disease Control and Prevention Guideline on the Diagnosis and Management of Mild Traumatic Brain Injury Among Children. JAMA Pediatr. 2018;172(11):e182853. doi: 10.1001/jamapediatrics.2018.2853.
30. 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.
31. Parr-Brownlie LC, Waters DL, Neville S, Neha T, Muramatsu N. Aging in New Zealand: Ka haere ki te ao pakeketanga. Gerontologist. 2020;60(5):812-20. doi: 10.1093/geront/gnaa032.
32. NZ Accident Compensation Corporation. Sport concussion in New Zealand: National guidelines. Wellington: NZ ACC; 2024.
33. UK Government. If in doubt, sit them out. UK concussion guidelines for non-elite (grassroots) sport. London: UK Government; 2023.
34. World Rugby. Putting players first. Concussion guidance. World Rugby; 2023.
35. Australian Institute of Sport. Australian concussion guidelines for youth and comunity sport. Canberra: Australian Institute of Sport, Australasian College of Sport & Exercise Physicians, Sports Medicine Australia and Australian Physiotherapy Association; 2024.
36. Parachute. Canadian Guideline on Concussion in Sport. Toronto: Parachute; 2017.
37. Carney N, Ghajar J, Jagoda A, Bedrick S, Davis-O'Reilly C, du Coudray H, et al. Concussion guidelines step 1: systematic review of prevalent indicators. Neurosurgery. 2014;75 Suppl 1:S3-15. doi: 10.1227/NEU.0000000000000433.
38. Patricios J, Fuller GW, Ellenbogen R, Herring S, Kutcher JS, Loosemore M, et al. What are the critical elements of sideline screening that can be used to establish the diagnosis of concussion? A systematic review. Br J Sports Med. 2017;51(11):888-94. doi: 10.1136/bjsports-2016-097441.
39. Davis GA, Makdissi M, Bloomfield P, Clifton P, Echemendia RJ, Falvey EC, et al. International consensus definitions of video signs of concussion in professional sports. Br J Sports Med. 2019;53(20):1264-7. doi: 10.1136/bjsports-2019-100628.
40. 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. doi: 10.1016/s0140-6736(09)61558-0.
41. Cnossen MC, Winkler EA, Yue JK, Okonkwo DO, Valadka AB, Steyerberg EW, et al. Development of a Prediction Model for Post-Concussive Symptoms following Mild Traumatic Brain Injury: A TRACK-TBI Pilot Study. J Neurotrauma. 2017;34(16):2396-409. doi: 10.1089/neu.2016.4819.

42. Booker J, Sinha S, Choudhari K, Dawson J, Singh R. Description of the predictors of persistent post-concussion symptoms and disability after mild traumatic brain injury: the SHEFBIT cohort. Br J Neurosurg. 2019;33(4):367-75. doi: 10.1080/02688697.2019.1598542.

43. Campbell-Sills L, Jain S, Sun X, Fisher LB, Agtarap SD, Dikmen S, et al. Risk Factors for Suicidal Ideation Following Mild Traumatic Brain Injury: A TRACK-TBI Study. J Head Trauma Rehabil. 2021;36(1):E30-E9. doi: 10.1097/HTR.0000000000000602.

44. Broglio SP, Harezlak J, Katz B, Zhao S, McAllister T, McCrea M, Investigators CC. Acute Sport Concussion Assessment Optimization: A Prospective Assessment from the CARE Consortium. Sports Med. 2019;49(12):1977-87. doi: 10.1007/s40279-019-01155-0.

45. Coscia A, Stolz U, Barczak C, Wright N, Mittermeyer S, Shams T, et al. Use of the Sports Concussion Assessment Tool 3 in Emergency Department Patients With Psychiatric Disease. J Head Trauma Rehabil. 2021;36(5):E302-E11. doi: 10.1097/HTR.0000000000000648.

46. Dagher JH, Richard-Denis A, Lamoureux J, de Guise E, Feyz M. Acute global outcome in patients with mild uncomplicated and complicated traumatic brain injury. Brain Inj. 2013;27(2):189-99. doi: 10.3109/02699052.2012.729288.

47. Fuller GW, Cross MJ, Stokes KA, Kemp SPT. King-Devick concussion test performs poorly as a screening tool in elite rugby union players: a prospective cohort study of two screening tests versus a clinical reference standard. Br J Sports Med. 2019;53(24):1526-32. doi: 10.1136/bjsports-2017-098560.

48. Fuller GW, Tucker R, Starling L, Falvey E, Douglas M, Raftery M. The performance of the World Rugby Head Injury Assessment Screening Tool: a diagnostic accuracy study. Sports Med Open. 2020;6(1):2. doi: 10.1186/s40798-019-0231-y.

49. Garcia GP, Broglio SP, Lavieri MS, McCrea M, McAllister T, Investigators CC. Quantifying the Value of Multidimensional Assessment Models for Acute Concussion: An Analysis of Data from the NCAA-DoD Care Consortium. Sports Med. 2018;48(7):1739-49. doi: 10.1007/s40279-018-0880-x.

50. Hartwell JL, Spalding MC, Fletcher B, O'Mara M S, Karas C. You cannot go home: routine concussion evaluation is not enough. Am Surg. 2015;81(4):395-403. doi:

51. Miller KJ, Ivins BJ, Schwab KA. Self-reported mild TBI and postconcussive symptoms in a peacetime active duty military population: effect of multiple TBI history versus single mild TBI. J Head Trauma Rehabil. 2013;28(1):31-8. doi: 10.1097/HTR.0b013e318255ceae.

52. Meares S, Shores EA, Smyth T, Batchelor J, Murphy M, Vukasovic M. Identifying posttraumatic amnesia in individuals with a Glasgow Coma Scale of 15 after mild traumatic brain injury. Arch Phys Med Rehabil. 2015;96(5):956-9. doi: 10.1016/j.apmr.2014.12.014.

53. Silverberg ND, Luoto TM, Ohman J, Iverson GL. Assessment of mild traumatic brain injury with the King-Devick Test in an emergency department sample. Brain Inj. 2014;28(12):1590-3. doi: 10.3109/02699052.2014.943287.

54. Madhok DY, Yue JK, Sun X, Suen CG, Coss NA, Jain S, et al. Clinical Predictors of 3- and 6-Month Outcome for Mild Traumatic Brain Injury Patients with a Negative Head CT Scan in the Emergency Department: A TRACK-TBI Pilot Study. Brain Sci. 2020;10(5). doi: 10.3390/brainsci10050269.

55. Nelson LD, Furger RE, Ranson J, Tarima S, Hammeke TA, Randolph C, et al. Acute Clinical Predictors of Symptom Recovery in Emergency Department Patients with Uncomplicated Mild Traumatic Brain Injury or Non-Traumatic Brain Injuries. J Neurotrauma. 2018;35(2):249-59. doi: 10.1089/neu.2017.4988.

56. Ponsford J, Cameron P, Fitzgerald M, Grant M, Mikocka-Walus A, Schonberger M. Predictors of postconcussive symptoms 3 months after mild traumatic brain injury. Neuropsychology. 2012;26(3):304-13. doi: 10.1037/a0027888.

57. Schmidt BR, Moos RM, Konu-Leblebicioglu D, Bischoff-Ferrari HA, Simmen HP, Pape HC, Neuhaus V. Higher age is a major driver of in-hospital adverse events independent of comorbid diseases among patients with isolated mild traumatic brain injury. Eur J Trauma Emerg Surg. 2019;45(2):191-8. doi: 10.1007/s00068-018-1029-1.

58. Silverberg ND, Gardner AJ, Brubacher JR, Panenka WJ, Li JJ, Iverson GL. Systematic review of multivariable prognostic models for mild traumatic brain injury. J Neurotrauma. 2015;32(8):517-26. doi: 10.1089/neu.2014.3600.

59. Sutton M, Chan V, Escobar M, Mollayeva T, Hu Z, Colantonio A. Neck Injury Comorbidity in Concussion-Related Emergency Department Visits: A Population-Based Study of Sex Differences Across the Life Span. J Womens Health (Larchmt). 2019;28(4):473-82. doi: 10.1089/jwh.2018.7282.

60. Yue JK, Cnossen MC, Winkler EA, Deng H, Phelps RRL, Coss NA, et al. Pre-injury Comorbidities Are Associated With Functional Impairment and Post-concussive Symptoms at 3- and 6-Months After Mild Traumatic Brain Injury: A TRACK-TBI Study. Front Neurol. 2019;10:343. doi: 10.3389/fneur.2019.00343.

61. Coffeng SM, Jacobs B, de Koning ME, Hageman G, Roks G, van der Naalt J. Patients with mild traumatic brain injury and acute neck pain at the emergency department are a distinct category within the mTBI spectrum: a prospective multicentre cohort study. BMC Neurol. 2020;20(1):315. doi: 10.1186/s12883-020-01887-x.
62. Cnossen MC, van der Naalt J, Spikman JM, Nieboer D, Yue JK, Winkler EA, et al. Prediction of Persistent Post-Concussion Symptoms after Mild Traumatic Brain Injury. J Neurotrauma. 2018;35(22):2691-8. doi: 10.1089/neu.2017.5486.
63. Roy D, Peters ME, Everett AD, Leoutsakos JS, Yan H, Rao V, et al. Loss of Consciousness and Altered Mental State as Predictors of Functional Recovery Within 6 Months Following Mild Traumatic Brain Injury. J Neuropsychiatry Clin Neurosci. 2020;32(2):132-8. doi: 10.1176/appi.neuropsych.18120379.
64. Ponsford J, Nguyen S, Downing M, Bosch M, McKenzie JE, Turner S, et al. Factors associated with persistent post-concussion symptoms following mild traumatic brain injury in adults. J Rehabil Med. 2019;51(1):32-9. doi: 10.2340/16501977-2492.
65. Cipriano A, Park N, Pecori A, Bionda A, Bardini M, Frassi F, et al. Predictors of post-traumatic complication of mild brain injury in anticoagulated patients: DOACs are safer than VKAs. Intern Emerg Med. 2021;16(4):1061-70. doi: 10.1007/s11739-020-02576-w.
66. Riccardi A, Spinola B, Minuto P, Ghinatti M, Guiddo G, Malerba M, Lerza R. Intracranial complications after minor head injury (MHI) in patients taking vitamin K antagonists (VKA) or direct oral anticoagulants (DOACs). Am J Emerg Med. 2017;35(9):1317-9. doi: 10.1016/j.ajem.2017.03.072.
67. Turcato G, Zannoni M, Zaboli A, Zorzi E, Ricci G, Pfeifer N, et al. Direct Oral Anticoagulant Treatment and Mild Traumatic Brain Injury: Risk of Early and Delayed Bleeding and the Severity of Injuries Compared with Vitamin K Antagonists. J Emerg Med. 2019;57(6):817-24. doi: 10.1016/j.jemermed.2019.09.007.
68. Ayaz SI, Thomas C, Kulek A, Tolomello R, Mika V, Robinson D, et al. Comparison of quantitative EEG to current clinical decision rules for head CT use in acute mild traumatic brain injury in the ED. Am J Emerg Med. 2015;33(4):493-6. doi: 10.1016/j.ajem.2014.11.015.
69. Ip IK, Raja AS, Gupta A, Andruchow J, Sodickson A, Khorasani R. Impact of clinical decision support on head computed tomography use in patients with mild traumatic brain injury in the ED. Am J Emerg Med. 2015;33(3):320-5. doi: 10.1016/j.ajem.2014.11.005.
70. Klein AP, Tetzlaff JE, Bonis JM, Nelson LD, Mayer AR, Huber DL, et al. Prevalence of Potentially Clinically Significant Magnetic Resonance Imaging Findings in Athletes with and without Sport-Related Concussion. J Neurotrauma. 2019;36(11):1776-85. doi: 10.1089/neu.2018.6055.
71. Sharp AL, Nagaraj G, Rippberger EJ, Shen E, Swap CJ, Silver MA, et al. Computed Tomography Use for Adults With Head Injury: Describing Likely Avoidable Emergency Department Imaging Based on the Canadian CT Head Rule. Acad Emerg Med. 2017;24(1):22-30. doi: 10.1111/acem.13061.
72. 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.
73. Holmes JF, Borgialli DA, Nadel FM, Quayle KS, Schambam N, Cooper A, et al. Do children with blunt head trauma and normal cranial computed tomography scan results require hospitalization for neurologic observation? Ann Emerg Med. 2011;58(4):315-22. doi: 10.1016/j.annemergmed.2011.03.060.
74. Kreitzer N, Lyons MS, Hart K, Lindsell CJ, Chung S, Yick A, Bonomo J. Repeat neuroimaging of mild traumatic brain-injured patients with acute traumatic intracranial hemorrhage: clinical outcomes and radiographic features. Acad Emerg Med. 2014;21(10):1083-91. doi: 10.1111/acem.12479.
75. Fadzil F, Mei AKC, Mohd Khairy A, Kumar R, Mohd Azli AN. Value of Repeat CT Brain in Mild Traumatic Brain Injury Patients with High Risk of Intracerebral Hemorrhage Progression. Int J Environ Res Public Health. 2022;19(21). doi: 10.3390/ijerph192114311.
76. Battle B, Sexton KW, Fitzgerald RT. Understanding the Value of Repeat Head CT in Elderly Trauma Patients on Anticoagulant or Antiplatelet Therapy. J Am Coll Radiol. 2018;15(2):319-21. doi: 10.1016/j.jacr.2017.09.021.
77. NICE: National Institute for Health and Care Excellence. Head Injury: assessment and early management (NICE Guideline CG176). 2019.
78. Bressan S, Marchetto L, Lyons TW, Monuteaux MC, Freedman SB, Da Dalt L, Nigrovic LE. A Systematic Review and Meta-Analysis of the Management and Outcomes of Isolated Skull Fractures in Children. Annals of emergency medicine. 2018;71(6):714-7.24E+04. doi:
79. Arrey EN, Kerr ML, Fletcher S, Cox CS, Jr., Sandberg DI. Linear nondisplaced skull fractures in children: who should be observed or admitted? Journal of Neurosurgery Pediatrics. 2015;16(6):703-8. doi:
80. Blanchard A, Cabrera KI, Kuppermann N, Dayan PS. Acute Outcomes of Isolated Pneumocephali in Children After Minor Blunt Head Trauma. Pediatric emergency care. 2018;34(9):656-60. doi:

81. Hassan S, Alarhayema AQ, Cohn SM, Wiersch JC, Price MR. Natural History of Isolated Skull Fractures in Children. Cureus. 2018;10(7):e3078. doi:
82. Kommaraju K, Haynes JH, Ritter AM. Evaluating the Role of a Neurosurgery Consultation in Management of Pediatric Isolated Linear Skull Fractures. Pediatric neurosurgery. 2019;54(1):21-7. doi:
83. Marincowitz C, Lecky FE, Townend W, Borakati A, Fabbri A, Sheldon TA. The risk of deterioration in GCS13-15 patients with traumatic brain injury identified by computed tomography imaging: A systematic review and meta-analysis. Journal of neurotrauma. 2018;35(5):703-18. doi:
84. Mina AA, Knipfer JF, Park DY, Bair HA, Howells GA, Bendick PJ. Intracranial complications of preinjury anticoagulation in trauma patients with head injury. J Trauma. 2002;53(4):668-72. doi: 10.1097/00005373-200210000-00008.
85. Cohen DB, Rinker C, Wilberger JE. Traumatic brain injury in anticoagulated patients. J Trauma. 2006;60(3):553-7. doi: 10.1097/01.ta.0000196542.54344.05.
86. Reynolds FD, Dietz PA, Higgins D, Whitaker TS. Time to deterioration of the elderly, anticoagulated, minor head injury patient who presents without evidence of neurologic abnormality. J Trauma. 2003;54(3):492-6. doi: 10.1097/01.TA.0000051601.60556.FC.
87. Franko J, Kish KJ, O'Connell BG, Subramanian S, Yuschak JV. Advanced age and preinjury warfarin anticoagulation increase the risk of mortality after head trauma. J Trauma. 2006;61(1):107-10. doi: 10.1097/01.ta.0000224220.89528.fc.
88. Kuczawski M, Stevenson M, Goodacre S, Teare MD, Ramlakhan S, Morris F, Mason S. Should all anticoagulated patients with head injury receive a CT scan? Decision-analysis modelling of an observational cohort. BMJ Open. 2016;6(12):e013742. doi: 10.1136/bmjopen-2016-013742.
89. Lee LK, Dayan PS, Gerardi MJ, Borgialli DA, Badawy MK, Callahan JM, et al. Intracranial hemorrhage after blunt head trauma in children with bleeding disorders. J Pediatr. 2011;158(6):1003-8 e1-2. doi: 10.1016/j.jpeds.2010.11.036.
90. Bower MM, Sweidan AJ, Shafie M, Atallah S, Groysman LI, Yu W. Contemporary Reversal of Oral Anticoagulation in Intracerebral Hemorrhage. Stroke. 2019;50(2):529-36. doi: 10.1161/STROKEAHA.118.023840.
91. Giordano PN, A.; Lassandro, G.; Notarangelo, L.D.; Bressan, S.; Ramenghi, U.; Saracco, P.; Da Dalt, L.; Molinari, A.C. . Head injury in children with coagulation disorders a position paper by the Italian Society of Pediatric Emergency Medicine (SIMEUP) and the Italian Association of Pediatric Hematology and Oncology – Coagulation Disorders Working Group (AIEOP),. Italian Journal of Pediatrics (in press). 2020. doi:
92. Fuller G, Sabir L, Evans R, Bradbury D, Kuczawski M, Mason SM. Risk of significant traumatic brain injury in adults with minor head injury taking direct oral anticoagulants: a cohort study and updated meta-analysis. Emerg Med J. 2020;37(11):666-73. doi: 10.1136/emermed-2019-209307.
93. Park N, Barbieri G, Turcato G, Cipriano A, Zaboli A, Giampaoli S, et al. Multi-centric study for development and validation of a CT head rule for mild traumatic brain injury in direct oral anticoagulants: the HERO-M nomogram. BMC Emerg Med. 2023;23(1):122. doi: 10.1186/s12873-023-00884-w.
94. Rajesh S, Wonderling D, Bernstein I, Balson C, Lecky F, Guideline C. Head injury: assessment and early management-summary of updated NICE guidance. BMJ (Clinical research ed). 2023;381:1130. doi: 10.1136/bmj.p1130.
95. Gunn BS, McAllister TW, McCrea MA, Broglio SP, Moore RD, Investigators CC. Neurodevelopmental Disorders and Risk of Concussion: Findings from the National Collegiate Athletic Association Department of Defense Grand Alliance Concussion Assessment, Research, and Education (NCAA-DOD CARE) Consortium (2014-2017). J Neurotrauma. 2022;39(5-6):379-89. doi: 10.1089/neu.2020.7446.
96. Ponsford J, Willmott C, Rothwell A, Cameron P, Kelly AM, Nelms R, Curran C. Impact of early intervention on outcome following mild head injury in adults. J Neurol Neurosurg Psychiatry. 2002;73(3):330-2. doi: 10.1136/jnnp.73.3.330.
97. Eliyahu L, Kirkland S, Campbell S, Rowe BH. The Effectiveness of Early Educational Interventions in the Emergency Department to Reduce Incidence or Severity of Postconcussion Syndrome Following a Concussion: A Systematic Review. Acad Emerg Med. 2016;23(5):531-42. doi: 10.1111/acem.12924.
98. Nygren-de Boussard C, Holm LW, Cancelliere C, Godbolt AK, Boyle E, Stalnacke BM, et al. Nonsurgical interventions after mild traumatic brain injury: a systematic review. Results of the International Collaboration on Mild Traumatic Brain Injury Prognosis. Arch Phys Med Rehabil. 2014;95(3 Suppl):S257-64. doi: 10.1016/j.apmr.2013.10.009.

99. Hoek AE, Joosten M, Dippel DWJ, van Beeck EF, van den Hengel L, Dijkstra B, et al. Effect of Video Discharge Instructions for Patients With Mild Traumatic Brain Injury in the Emergency Department: A Randomized Controlled Trial. Ann Emerg Med. 2021;77(3):327-37. doi: 10.1016/j.annemergmed.2020.10.023.
100. Stores G. Children's sleep disorders: modern approaches, developmental effects, and children at special risk. Dev Med Child Neurol. 1999;41(8):568-73. doi: 10.1017/s001216229900119x.
101. Baumann CR, Werth E, Stocker R, Ludwig S, Bassetti CL. Sleep-wake disturbances 6 months after traumatic brain injury: a prospective study. Brain. 2007;130(Pt 7):1873-83. doi: 10.1093/brain/awm109.
102. Owens JA, Mindell JA. Pediatric insomnia. Pediatr Clin North Am. 2011;58(3):555-69. doi: 10.1016/j.pcl.2011.03.011.
103. Venter R. Role of sleep in performance and recovery of athletes: a review article. S Afr J Res Sport Phys Educ Recreation. 2012;34(1):167–84. doi:
104. Kemp S, Biswas R, Neumann V, Coughlan A. The value of melatonin for sleep disorders occurring post-head injury: a pilot RCT. Brain Inj. 2004;18(9):911-9. doi: 10.1080/02699050410001671892.
105. Broglio SP, Macciocchi SN, Ferrara MS. Neurocognitive performance of concussed athletes when symptom free. J Athl Train. 2007;42(4):504-8. doi:
106. Mollayeva T, Pratt B, Mollayeva S, Shapiro CM, Cassidy JD, Colantonio A. The relationship between insomnia and disability in workers with mild traumatic brain injury/concussion: insomnia and disability in chronic mild traumatic brain injury. Sleep Med. 2016;20:157–66. doi:
107. Hanalioglu D, Hanalioglu S, Arango Jorge I, Adelson PD. Current evidence for pharmacological management of pediatric concussion: a systematic review. Child's nervous system : ChNS : official journal of the International Society for Pediatric Neurosurgery. 2023;39(7):1831-49. doi: https://dx.doi.org/10.1007/s00381-023-05960-x.
108. Feinberg C, Carr C, Zemek R, Yeates Keith O, Master C, Schneider K, et al. Association of Pharmacological Interventions With Symptom Burden Reduction in Patients With Mild Traumatic Brain Injury: A Systematic Review. JAMA Neurology. 2021. doi:
109. Ewing-Cobbs L, Cox Charles S, Clark Amy E, Holubkov R, Keenan Heather T. Persistent postconcussion symptoms after injury. Pediatrics. 2018;142(5):4-15. doi: 10.1542/peds.2018-0939.
110. Permenter CM, Fernandez-de Thomas RJ, Sherman AL. Postconcussive Syndrome. StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Ricardo Fernandez-de Thomas declares no relevant financial relationships with ineligible companies. Disclosure: Andrew Sherman declares no relevant financial relationships with ineligible companies.2024.
111. Chung JW, Liu D, Wei L, Wen YT, Lin HY, Chen HC, Chiu HY. Postconcussion Symptoms After an Uncomplicated Mild Traumatic Brain Injury in Older Adults: Frequency, Risk Factors, and Impact on Quality of Life. J Head Trauma Rehabil. 2022;37(5):278-84. doi: 10.1097/HTR.0000000000000733.
112. King NS. A systematic review of age and gender factors in prolonged post-concussion symptoms after mild head injury. Brain Inj. 2014;28(13-14):1639-45. doi: 10.3109/02699052.2014.954271.
113. Zemek R, Barrowman N, Freedman Stephen B, Gravel J, Gagnon I, McGahern C, et al. Clinical risk score for persistent postconcussion symptoms among children with acute concussion in the ED. JAMA - Journal of the American Medical Association. 2016;315(10):1014-25. doi: 10.1001/jama.2016.1203.
114. Cowley LE, Morris CB, Maguire SA, Farewell DM, Kemp AM. Validation of a prediction tool for abusive head trauma. Pediatrics. 2015;136(2):291-8. doi:
115. Meehan William P, Mannix R, Monuteaux Michael C, Stein Cynthia J, Bachur Richard G. Early symptom burden predicts recovery after sport-related concussion. Neurology. 2014;83(24):2204-10. doi: 10.1212/WNL.0000000000001073.
116. Babcock L, Kurowski BG, Zhang N, Dexheimer JW, Dyas J, Wade SL. Adolescents with mild traumatic brain injury get SMART: An analysis of a novel web-based intervention. Telemedicine and e-Health. 2017;23(7):600-7. doi:
117. Iverson GL, Gardner AJ, Terry DP, Ponsford JL, Sills AK, Broshek DK, Solomon GS. Predictors of clinical recovery from concussion: a systematic review. Br J Sports Med. 2017;51(12):941-8. doi: 10.1136/bjsports-2017-097729.
118. Mortenson P, Singhal A, Hengel AR, Purtzki J. Impact of Early Follow-Up Intervention on Parent-Reported Postconcussion Pediatric Symptoms: a Feasibility Study. Journal of head trauma rehabilitation. 2016;31(6):E23-E32. doi: 10.1097/HTR.0000000000000223.
119. Nowacki R, van Eldik N, Eikens M, Roijen R, Haga N, Schott D, et al. Evaluation of a follow-up program for mild traumatic brain injury in schoolchildren. European Journal of Paediatric Neurology. 2017;21(2):382-7. doi: 10.1016/j.ejpn.2016.10.009.

120. Babikian T, Satz P, Zaucha K, Light R, Lewis RS, Asarnow RF. The UCLA longitudinal study of neurocognitive outcomes following mild pediatric traumatic brain injury. J Int Neuropsychol Soc. 2011;17(5):886-95. doi: 10.1017/S1355617711000907.
121. Yeates KO, Taylor HG, Rusin J, Bangert B, Dietrich A, Nuss K, et al. Longitudinal trajectories of postconcussive symptoms in children with mild traumatic brain injuries and their relationship to acute clinical status. Pediatrics. 2009;123(3):735-43. doi:
122. Zemek RL, Farion KJ, Sampson M, McGahern C. Prognosticators of persistent symptoms following pediatric concussion: a systematic review. JAMA Pediatr. 2013;167(3):259-65. doi: 10.1001/2013.jamapediatrics.216.
123. Centers for Disease Control and Prevention. HEADS UP Updated March 14, 2017 [February 16, 2018]. Available from: http://www.cdc.gov/headsup.
124. Broglio SP, Cantu RC, Gioia GA, Guskiewicz KM, Kutcher J, Palm M, et al. National Athletic Trainers' Association position statement: management of sport concussion. J Athl Train. 2014;49(2):245-65. doi: 10.4085/1062-6050-49.1.07.
125. Adams RJ. Improving health outcomes with better patient understanding and education. Risk Manag Healthc Policy. 2010;3:61-72. doi: 10.2147/RMHP.S7500.
126. Leddy JJ, Burma JS, Toomey CM, Hayden A, Davis GA, Babl FE, et al. Rest and exercise early after sport-related concussion: a systematic review and meta-analysis. British journal of sports medicine. 2023;57(12):762-70. doi: 10.1136/bjsports-2022-106676.
127. Australian Government Department of Health and Aged Care. About physical activity and exercise. 2021. doi:
128. Clearinghouse for Sport. What is sport? 2024 [Available from: https://www.clearinghouseforsport.gov.au/kb/what-is-sport#:~:text=All%20forms%20of%20physical%20activity,in%20competition%20at%20all%20levels.
129. Haider MN, Leddy JJ, Wilber CG, Viera KB, Bezherano I, Wilkins KJ, et al. The Predictive Capacity of the Buffalo Concussion Treadmill Test After Sport-Related Concussion in Adolescents. Front Neurol. 2019;10:395. doi: 10.3389/fneur.2019.00395.
130. Willer Barry S, Haider Mohammad N, Bezherano I, Wilber Charles G, Mannix R, Kozlowski K, Leddy John J. Comparison of Rest to Aerobic Exercise and Placebo-like Treatment of Acute Sport-Related Concussion in Male and Female Adolescents. Archives of Physical Medicine and Rehabilitation. 2019:1-9. doi: 10.1016/j.apmr.2019.07.003.
131. Grool AM, Aglipay M, Momoli F, Meehan WP, 3rd, Freedman SB, Yeates KO, et al. Association Between Early Participation in Physical Activity Following Acute Concussion and Persistent Postconcussive Symptoms in Children and Adolescents. JAMA. 2016;316(23):2504-14. doi:
132. Leddy JJ, Haider MN, Ellis MJ, Mannix R, Darling SR, Freitas MS, et al. Early Subthreshold Aerobic Exercise for Sport-Related Concussion: A Randomized Clinical Trial. JAMA Pediatr. 2019;173(4):319-25. doi: 10.1001/jamapediatrics.2018.4397.
133. Leddy JJ, Master CL, Mannix R, Wiebe DJ, Grady MF, Meehan WP, et al. Early targeted heart rate aerobic exercise versus placebo stretching for sport-related concussion in adolescents: a randomised controlled trial. Lancet Child Adolesc Health. 2021;5(11):792-9. doi: 10.1016/S2352-4642(21)00267-4.
134. Montero-Odasso M, van der Velde N, Martin FC, Petrovic M, Tan MP, Ryg J, Aguilar-Navarro S. World guidelines for falls prevention and management for older adults: a global initiative. Age and Ageing. 2022;51(9):1-36. doi:
135. Maerlender A, Rieman W, Lichtenstein J, Condiracci C. Programmed Physical Exertion in Recovery From Sports-Related Concussion: A Randomized Pilot Study. Dev Neuropsychol. 2015;40(5):273-8. doi: 10.1080/87565641.2015.1067706.
136. Remigio-Baker RA, Bailie JM, Gregory E, Cole WR, McCulloch KL, Cecchini A, et al. Activity Level During Acute Concussion May Predict Symptom Recovery Within an Active Duty Military Population. J Head Trauma Rehabil. 2020;35(2):92-103. doi: 10.1097/HTR.0000000000000498.
137. Brett BL, Breedlove K, McAllister TW, Broglio SP, McCrea MA, Investigators CC, et al. Investigating the Range of Symptom Endorsement at Initiation of a Graduated Return-to-Play Protocol After Concussion and Duration of the Protocol: A Study From the National Collegiate Athletic Association-Department of Defense Concussion, Assessment, Research, and Education (CARE) Consortium. Am J Sports Med. 2020;48(6):1476-84. doi: 10.1177/0363546520913252.
138. Macnow T, Curran T, Tolliday C, Martin K, McCarthy M, Ayturk D, et al. Effect of Screen Time on Recovery From Concussion: A Randomized Clinical Trial. JAMA Pediatrics. 2021. doi: 10.1001/jamapediatrics.2021.2782.
139. D'Silva L, Devos H, Hunt SL, Chen J, Smith D, Rippee MA. Concussion symptoms experienced during driving may influence driving habits. Brain Inj. 2021;35(1):59-64. doi: 10.1080/02699052.2020.1857839.

140. Lempke LB, Lynall RC, Hoffman NL, Devos H, Schmidt JD. Slowed driving-reaction time following concussion-symptom resolution. J Sport Health Sci. 2021;10(2):145-53. doi: 10.1016/j.jshs.2020.09.005.
141. Schmidt JD, Hoffman NL, Ranchet M, Miller LS, Tomporowski PD, Akinwuntan AE, Devos H. Driving after Concussion: Is It Safe To Drive after Symptoms Resolve? J Neurotrauma. 2017;34(8):1571-8. doi: 10.1089/neu.2016.4668.
142. Cancelliere C, Kristman VL, Cassidy JD, Hincapie CA, Cote P, Boyle E, et al. Systematic review of return to work after mild traumatic brain injury: results of the International Collaboration on Mild Traumatic Brain Injury Prognosis. Arch Phys Med Rehabil. 2014;95(3 Suppl):S201-9. doi: 10.1016/j.apmr.2013.10.010.
143. Gourdeau J, Fingold A, Colantonio A, Mansfield E, Stergiou-Kita M. Workplace accommodations following work-related mild traumatic brain injury: what works? Disabil Rehabil. 2020;42(4):552-61. doi: 10.1080/09638288.2018.1503733.
144. Graff HJ, Deleu NW, Christiansen P, Rytter HM. Facilitators of and barriers to return to work after mild traumatic brain injury: A thematic analysis. Neuropsychol Rehabil. 2021;31(9):1349-73. doi: 10.1080/09602011.2020.1778489.
145. Howe EI, Fure SCR, Lovstad M, Enehaug H, Sagstad K, Hellstrom T, et al. Effectiveness of Combining Compensatory Cognitive Training and Vocational Intervention vs. Treatment as Usual on Return to Work Following Mild-to-Moderate Traumatic Brain Injury: Interim Analysis at 3 and 6 Month Follow-Up. Front Neurol. 2020;11:561400. doi: 10.3389/fneur.2020.561400.
146. Varner CE, McLeod S, Nahiddi N, Lougheed RE, Dear TE, Borgundvaag B. Cognitive Rest and Graduated Return to Usual Activities Versus Usual Care for Mild Traumatic Brain Injury: A Randomized Controlled Trial of Emergency Department Discharge Instructions. Acad Emerg Med. 2017;24(1):75-82. doi: 10.1111/acem.13073.
147. Putukian M, Purcell L, Schneider KJ, Black AM, Burma JS, Chandran A, et al. Clinical recovery from concussion-return to school and sport: a systematic review and meta-analysis. British journal of sports medicine. 2023;57(12):798-809. doi: 10.1136/bjsports-2022-106682.
148. CDC. CDC Heads Up: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2022 [Available from: https://www.cdc.gov/headsup/index.html.
149. Halstead ME, Walter KD, Council on Sports M, Fitness. American Academy of Pediatrics. Clinical report--sport-related concussion in children and adolescents. Pediatrics. 2010;126(3):597-615. doi: 10.1542/peds.2010-2005.
150. Ransom DM, Vaughan CG, Pratson L, Sady MD, McGill CA, Gioia GA. Academic Effects of Concussion in Children and Adolescents. PEDIATRICS. 2015;135(6):1043-50. doi: 10.1542/peds.2014-3434.
151. Babikian T, McArthur D, Asarnow Robert F. Predictors of 1-Month and 1-Year Neurocognitive Functioning from the UCLA Longitudinal Mild, Uncomplicated, Pediatric Traumatic Brain Injury Study. Journal of the International Neuropsychological Society. 2013;19(2):145-54. doi: 10.1017/S135561771200104X.
152. Sady MD, Vaughan CG, Gioia GA. School and the concussed youth: recommendations for concussion education and management. Phys Med Rehabil Clin N Am. 2011;22(4):701-19, ix. doi: 10.1016/j.pmr.2011.08.008.
153. Broglio SP, Collins MW, Williams RM, Mucha A, Kontos AP. Current and emerging rehabilitation for concussion: a review of the evidence. Clin Sports Med. 2015;34(2):213-31. doi: 10.1016/j.csm.2014.12.005.
154. DeMatteo C, Stazyk K, Giglia L, Mahoney W, Singh SK, Hollenberg R, et al. A Balanced Protocol for Return to School for Children and Youth Following Concussive Injury. Clin Pediatr (Phila). 2015;54(8):783-92. doi: 10.1177/0009922814567305.
155. Theadom A, Parag V, Dowell T, McPherson K, Starkey N, Barker-Collo S, et al. Persistent problems 1 year after mild traumatic brain injury: a longitudinal population study in New Zealand. Br J Gen Pract. 2016;66(642):e16-23. doi: 10.3399/bjgp16X683161.
156. Quinn DK, Mayer AR, Master CL, Fann JR. Prolonged Postconcussive Symptoms. Am J Psychiatry. 2018;175(2):103-11. doi: 10.1176/appi.ajp.2017.17020235.
157. Buttner F, Howell DR, Doherty C, Blake C, Ryan J, Delahunt E. Headache- and Dizziness-Specific Health-Related Quality-of-Life Impairments Persist for 1 in 4 Amateur Athletes Who Are Cleared to Return to Sporting Activity Following Sport-Related Concussion: A Prospective Matched-Cohort Study. J Orthop Sports Phys Ther. 2020;50(12):692-701. doi: 10.2519/jospt.2020.9485.
158. Hromas GA, Houck ZM, Asken BM, Svingos AM, Greif SM, Heaton SC, et al. Making a Difference: Affective Distress Explains Discrepancy Between Objective and Subjective Cognitive Functioning After Mild Traumatic Brain Injury. J Head Trauma Rehabil. 2021;36(3):186-95. doi: 10.1097/HTR.0000000000000618.
159. Ngwenya LB, Gardner RC, Yue JK, Burke JF, Ferguson AR, Huang MC, et al. Concordance of common data elements for assessment of subjective cognitive complaints after mild-traumatic brain injury: a TRACK-TBI Pilot Study. Brain Inj. 2018;32(9):1071-8. doi: 10.1080/02699052.2018.1481527.
DRAFT

160. Teymoori A, Gorbunova A, Haghish FE, Real R, Zeldovich M, Wu YJ, et al. Factorial Structure and Validity of Depression (PHQ-9) and Anxiety (GAD-7) Scales after Traumatic Brain Injury. J Clin Med. 2020;9(3). doi: 10.3390/jcm9030873.
161. Donders J, Pendery A. Clinical Utility of the Patient Health Questionnaire-9 in the Assessment of Major Depression After Broad-Spectrum Traumatic Brain Injury. Arch Phys Med Rehabil. 2017;98(12):2514-9. doi: 10.1016/j.apmr.2017.05.019.
162. Langer LK, Comper P, Ruttan L, Saverino C, Alavinia SM, Inness EL, et al. Can Sport Concussion Assessment Tool (SCAT) Symptom Scores Be Converted to Rivermead Post-concussion Symptoms Questionnaire (RPQ) Scores and Vice Versa? Findings From the Toronto Concussion Study. Front Sports Act Living. 2021;3:737402. doi: 10.3389/fspor.2021.737402.
163. Medvedev ON, Theadom A, Barker-Collo S, Feigin V, Group BR. Distinguishing between enduring and dynamic concussion symptoms: applying Generalisability Theory to the Rivermead Post Concussion Symptoms Questionnaire (RPQ). PeerJ. 2018;6:e5676. doi: 10.7717/peerj.5676.
164. Snell DL, Iverson GL, Panenka WJ, Silverberg ND. Preliminary Validation of the World Health Organization Disability Assessment Schedule 2.0 for Mild Traumatic Brain Injury. J Neurotrauma. 2017;34(23):3256-61. doi: 10.1089/neu.2017.5234.
165. Parrington L, King LA, Hoppes CW, Klaiman MJ, Michielutti P, Fino PC, et al. Exploring Vestibular Ocular Motor Screening in Adults With Persistent Complaints After Mild Traumatic Brain Injury. J Head Trauma Rehabil. 2022;37(5):E346-E54. doi: 10.1097/HTR.0000000000000762.
166. Shaikh N, Theadom A, Siegert R, Hardaker N, King D, Hume P. Rasch analysis of the Brain Injury Screening Tool (BIST) in mild traumatic brain injury. BMC Neurol. 2021;21(1):376. doi: 10.1186/s12883-021-02410-6.
167. Halstead ME. Pharmacologic Therapies for Pediatric Concussions. Sports Health. 2016;8(1):50-2. doi: 10.1177/1941738115622158.
168. Wakerley BR. Medication-overuse headache. Pract Neurol. 2019;19(5):399-403. doi: 10.1136/practneurol-2018-002048.
169. Cheever K, McDevitt J, Phillips J, Kawata K. The Role of Cervical Symptoms in Post-concussion Management: A Systematic Review. Sports Med. 2021;51(9):1875-91. doi: 10.1007/s40279-021-01469-y.
170. Gil C, Decq P. How similar are whiplash and mild traumatic brain injury? A systematic review. Neurochirurgie. 2021;67(3):238-43. doi: 10.1016/j.neuchi.2021.01.016.
171. Rebbeck T, Evans K, Elliott JM. Concussion in Combination With Whiplash-Associated Disorder May Be Missed in Primary Care: Key Recommendations for Assessment and Management. J Orthop Sports Phys Ther. 2019;49(11):819-28. doi: 10.2519/jospt.2019.8946.
172. Anderson JFI. The association between pain type, cognition and complaint after mild traumatic brain injury in prospectively studied premorbidly healthy adults admitted to hospital. Neuropsychology. 2020;34(1):53-62. doi: 10.1037/neu0000585.
173. Hsu HH, Lai WH, Yu HT, Xiao SH, Tsai YH, Wang KC, et al. Long-Term Presentation of Postconcussion Symptoms and Associated Factors: Analysis of Latent Class Modeling. Arch Clin Neuropsychol. 2021;36(1):62-73. doi: 10.1093/arclin/acaa063.
174. Haider MN, Bezherano I, Wertheimer A, Siddiqui AH, Horn EC, Willer BS, Leddy JJ. Exercise for Sport-Related Concussion and Persistent Postconcussive Symptoms. Sports Health. 2021;13(2):154-60. doi: 10.1177/1941738120946015.
175. O'Brien MJ, Howell DR, Pepin MJ, Meehan WP, 3rd. Sport-Related Concussions: Symptom Recurrence After Return to Exercise. Orthop J Sports Med. 2017;5(10):2325967117732516. doi: 10.1177/2325967117732516.
176. Silverberg ND, Iverson GL, Panenka W. Cogniphobia in Mild Traumatic Brain Injury. J Neurotrauma. 2017;34(13):2141-6. doi: 10.1089/neu.2016.4719.
177. Dwyer B, Katz DI. Postconcussion syndrome. Handb Clin Neurol. 2018;158:163-78. doi: 10.1016/B978-0-444-63954-7.00017-3.
178. Varner C, Thompson C, de Wit K, Borgundvaag B, Houston R, McLeod S. Predictors of persistent concussion symptoms in adults with acute mild traumatic brain injury presenting to the emergency department. CJEM. 2021;23(3):365-73. doi: 10.1007/s43678-020-00076-6.
179. Beaton MD, Hadly G, Babul S. Stakeholder Recommendations to Increase the Accessibility of Online Health Information for Adults Experiencing Concussion Symptoms. Front Public Health. 2020;8:557814. doi: 10.3389/fpubh.2020.557814.
DRAFT

180. Belanger HG, Toyinbo P, Barrett B, King E, Sayer NA. Concussion coach for postconcussive symptoms: A randomized, controlled trial of a smartphone application with Afghanistan and Iraq war Veterans. Clin Neuropsychol. 2022;36(8):2093-119. doi: 10.1080/13854046.2021.1936188.

181. Caplain S, Chenuc G, Blancho S, Marque S, Aghakhani N. Efficacy of Psychoeducation and Cognitive Rehabilitation After Mild Traumatic Brain Injury for Preventing Post-concussional Syndrome in Individuals With High Risk of Poor Prognosis: A Randomized Clinical Trial. Front Neurol. 2019;10:929. doi: 10.3389/fneur.2019.00929.

182. Donnelly KZ, Goldberg S, Fournier D. A qualitative study of LoveYourBrain Yoga: a group-based yoga with psychoeducation intervention to facilitate community integration for people with traumatic brain injury and their caregivers. Disabil Rehabil. 2020;42(17):2482-91. doi: 10.1080/09638288.2018.1563638.

183. Losoi H, Silverberg ND, Waljas M, Turunen S, Rosti-Otajarvi E, Helminen M, et al. Recovery from Mild Traumatic Brain Injury in Previously Healthy Adults. J Neurotrauma. 2016;33(8):766-76. doi: 10.1089/neu.2015.4070.

184. O'Neil ME, Carlson K, Storzbach D, Brenner L, Freeman M, Quinones A, et al. Complications of Mild Traumatic Brain Injury in Veterans and Military Personnel: A Systematic Review. VA Evidence-based Synthesis Program Reports. Washington (DC)2013.

185. Rakers SE, Timmerman ME, Scheenen ME, de Koning ME, van der Horn HJ, van der Naalt J, Spikman JM. Trajectories of Fatigue, Psychological Distress, and Coping Styles After Mild Traumatic Brain Injury: A 6-Month Prospective Cohort Study. Arch Phys Med Rehabil. 2021;102(10):1965-71 e2. doi: 10.1016/j.apmr.2021.06.004.

186. Rytter HM, Graff HJ, Henriksen HK, Aaen N, Hartvigsen J, Hoegh M, et al. Nonpharmacological Treatment of Persistent Postconcussion Symptoms in Adults: A Systematic Review and Meta-analysis and Guideline Recommendation. JAMA Netw Open. 2021;4(11):e2132221. doi: 10.1001/jamanetworkopen.2021.32221.

187. McMahon P, Hricik A, Yue JK, Puccio AM, Inoue T, Lingsma HF, et al. Symptomatology and functional outcome in mild traumatic brain injury: results from the prospective TRACK-TBI study. J Neurotrauma. 2014;31(1):26-33. doi: 10.1089/neu.2013.2984.

188. Cifu DX, Hart BB, West SL, Walker W, Carne W. The effect of hyperbaric oxygen on persistent postconcussion symptoms. J Head Trauma Rehabil. 2014;29(1):11-20. doi: 10.1097/HTR.0b013e3182a6aaf0.

189. Cifu DX, Walker WC, West SL, Hart BB, Franke LM, Sima A, et al. Hyperbaric oxygen for blast-related postconcussion syndrome: three-month outcomes. Ann Neurol. 2014;75(2):277-86. doi: 10.1002/ana.24067.

190. Walker WC, Franke LM, Cifu DX, Hart BB. Randomized, Sham-Controlled, Feasibility Trial of Hyperbaric Oxygen for Service Members With Postconcussion Syndrome: Cognitive and Psychomotor Outcomes 1 Week Postintervention. Neurorehabil Neural Repair. 2014;28(5):420-32. doi: 10.1177/1545968313516869.

191. Dong Y, Hu X, Wu T, Wang T. Effect of hyperbaric oxygenation therapy on post-concussion syndrome. Exp Ther Med. 2018;16(3):2193-202. doi: 10.3892/etm.2018.6463.

192. Hart BB, Weaver LK, Gupta A, Wilson SH, Vijayarangan A, Deru K, Hebert D. Hyperbaric oxygen for mTBI-associated PCS and PTSD: Pooled analysis of results from Department of Defense and other published studies. Undersea Hyperb Med. 2019;46(3):353-83. doi:

193. Meehan A, Hebert D, Deru K, Weaver LK. Longitudinal study of hyperbaric oxygen intervention on balance and affective symptoms in military service members with persistent post-concussive symptoms. J Vestib Res. 2019;29(4):205-19. doi: 10.3233/VES-180671.

194. Walker JM, Mulatya C, Hebert D, Wilson SH, Lindblad AS, Weaver LK. Sleep assessment in a randomized trial of hyperbaric oxygen in U.S. service members with post concussive mild traumatic brain injury compared to normal controls. Sleep Med. 2018;51:66-79. doi: 10.1016/j.sleep.2018.06.006.

195. Weaver LK, Wilson SH, Lindblad AS, Churchill S, Deru K, Price RC, et al. Hyperbaric oxygen for post-concussive symptoms in United States military service members: a randomized clinical trial. Undersea Hyperb Med. 2018;45(2):129-56. doi:

196. Harch PG, Andrews SR, Rowe CJ, Lischka JR, Townsend MH, Yu Q, Mercante DE. Hyperbaric oxygen therapy for mild traumatic brain injury persistent postconcussion syndrome: a randomized controlled trial. Med Gas Res. 2020;10(1):8-20. doi: 10.4103/2045-9912.279978.

197. Lew HL, Lin PH, Fuh JL, Wang SJ, Clark DJ, Walker WC. Characteristics and treatment of headache after traumatic brain injury: a focused review. Am J Phys Med Rehabil. 2006;85(7):619-27. doi: 10.1097/01.phm.0000223235.09931.c0.

198. Kamins J. Models for Treating Post-traumatic Headache. Curr Pain Headache Rep. 2021;25(8):52. doi: 10.1007/s11916-021-00970-3.

199. Lew HL, Poole JH, Guillory SB, Salerno RM, Leskin G, Sigford B. Persistent problems after traumatic brain injury: The need for long-term follow-up and coordinated care. J Rehabil Res Dev. 2006;43(2):vii-x. doi: 10.1682/jrrd.2006.05.0054.

200. International Headache Society. The International Classification of Headache Disorders 3rd edition 2023 [Available from: https://ichd-3.org.
201. Lucas S, Hoffman JM, Bell KR, Dikmen S. A prospective study of prevalence and characterization of headache following mild traumatic brain injury. Cephalalgia. 2014;34(2):93-102. doi: 10.1177/0333102413499645.
202. Kontos Anthony P, Elbin RJ, Lau B, Simensky S, Freund B, French J, Collins Michael W. Posttraumatic migraine as a predictor of recovery and cognitive impairment after sport-related concussion. American Journal of Sports Medicine. 2013;41(7):1497-504. doi: 10.1177/0363546513488751.
203. Seeger Trevor A, Orr S, Bodell L, Lockyer L, Rajapakse T, Barlow Karen M. Occipital nerve blocks for pediatric posttraumatic headache: A case series. Journal of Child Neurology. 2015;30(9):1142-6. doi: 10.1177/0883073814553973.
204. Song TJ, Chu MK. Exercise in Treatment of Migraine Including Chronic Migraine. Curr Pain Headache Rep. 2021;25(3):14. doi: 10.1007/s11916-020-00929-w.
205. Heyer Geoffrey L, Idris Syed A. Does analgesic overuse contribute to chronic post-traumatic headaches in adolescent concussion patients? Pediatric Neurology. 2014;50(5):464-8. doi: 10.1016/j.pediatrneurol.2014.01.040.
206. Yilmaz T, Roks G, de Koning M, Scheenen M, van der Horn H, Plas G, et al. Risk factors and outcomes associated with post-traumatic headache after mild traumatic brain injury. Emerg Med J. 2017;34(12):800-5. doi: 10.1136/emermed-2015-205429.
207. Nordhaug LH, Linde M, Follestad T, Skandsen ON, Bjarko VV, Skandsen T, Vik A. Change in Headache Suffering and Predictors of Headache after Mild Traumatic Brain Injury: A Population-Based, Controlled, Longitudinal Study with Twelve-Month Follow-Up. J Neurotrauma. 2019;36(23):3244-52. doi: 10.1089/neu.2018.6328.
208. Dumke HA. Posttraumatic Headache and Its Impact on Return to Work After Mild Traumatic Brain Injury. J Head Trauma Rehabil. 2017;32(2):E55-E65. doi: 10.1097/HTR.0000000000000244.
209. Meltzer KJ, Juengst SB. Associations between frequent pain or headaches and neurobehavioral symptoms by gender and TBI severity. Brain Inj. 2021;35(1):41-7. doi: 10.1080/02699052.2020.1857438.
210. Silverberg ND, Martin P, Panenka WJ. Headache Trigger Sensitivity and Avoidance after Mild Traumatic Brain Injury. J Neurotrauma. 2019;36(10):1544-50. doi: 10.1089/neu.2018.6025.
211. Yumul J, Anderson V, Catroppa C, Mckinlay A. Parent–child interaction after mild traumatic injury in preschoolers. Brain Impairment. 2024;25(1). doi: 10.1071/ib23089.
212. Beauchamp MH, Seguin M, Gagner C, Lalonde G, Bernier A. The PARENT model: a pathway approach for understanding parents' role after early childhood mild traumatic brain injury. Clin Neuropsychol. 2021;35(5):846-67. doi: 10.1080/13854046.2020.1834621.
213. Raikes AC, Schaefer SY. Sleep Quantity and Quality during Acute Concussion: A Pilot Study. Sleep. 2016;39(12):2141-7. doi: 10.5665/sleep.6314.
214. Mathias JL, Alvaro PK. Prevalence of sleep disturbances, disorders, and problems following traumatic brain injury: a meta-analysis. Sleep Med. 2012;13(7):898-905. doi: 10.1016/j.sleep.2012.04.006.
215. Baumann CR. Traumatic brain injury and disturbed sleep and wakefulness. Neuromolecular Med. 2012;14(3):205-12. doi: 10.1007/s12017-012-8178-x.
216. Castriotta RJ, Wilde MC, Lai JM, Atanasov S, Masel BE, Kuna ST. Prevalence and consequences of sleep disorders in traumatic brain injury. J Clin Sleep Med. 2007;3(4):349-56. doi:
217. Theadom A, Cropley M, Parmar P, Barker-Collo S, Starkey N, Jones K, et al. Sleep difficulties one year following mild traumatic brain injury in a population-based study. Sleep Med. 2015;16(8):926-32. doi: 10.1016/j.sleep.2015.04.013.
218. Wiseman-Hakes C, Colantonio A, Gargar J. Sleep and wake disorders following traumatic brain injury: A systematic review of the literature. Critical Reviews in Physical and Rehabilitation Medicine. 2009;21(3-4):317-74. doi:
219. Wiseman-Hakes C, Foster E, Langer L, Chandra T, Bayley M, Comper P. Characterizing Sleep and Wakefulness in the Acute Phase of Concussion in the General Population: A Naturalistic Cohort from the Toronto Concussion Study. J Neurotrauma. 2022;39(1-2):172-80. doi: 10.1089/neu.2021.0295.
220. Montgomery MC, Baylan S, Gardani M. Prevalence of insomnia and insomnia symptoms following mild-traumatic brain injury: A systematic review and meta-analysis. Sleep Med Rev. 2022;61:101563. doi: 10.1016/j.smrv.2021.101563.

221. Wickwire EM, Albrecht JS, Capaldi VF, 2nd, Jain SO, Gardner RC, Werner JK, et al. Trajectories of Insomnia in Adults After Traumatic Brain Injury. JAMA Netw Open. 2022;5(1):e2145310. doi: 10.1001/jamanetworkopen.2021.45310.
222. Wei L, Wen YT, Thompson HJ, Liu CY, Su YK, Chen PY, et al. Sleep Disturbances Following Traumatic Brain Injury in Older Adults: A Comparison Study. J Head Trauma Rehabil. 2020;35(4):288-95. doi: 10.1097/HTR.0000000000000563.
223. Oyegbile TO, Delasobera BE, Zecavati N. Gender differences in sleep symptoms after repeat concussions. Sleep Med. 2017;40:110-5. doi: 10.1016/j.sleep.2017.09.026.
224. Winkelman JW. Overview of the treatment of insomnia in adults. In: Benca R, editor. UpToDate. Waltham MA2020.
225. Morse AM, Kothare SV. Sleep disorders and concussion. Handbook of clinical neurology. 2018;158:127-34. doi:
226. Kalmbach DA, Conroy DA, Falk H, Rao V, Roy D, Peters ME, et al. Poor sleep is linked to impeded recovery from traumatic brain injury. Sleep. 2018;41(10). doi: 10.1093/sleep/zsy147.
227. Wickwire EM, Schnyer DM, Germain A, Williams SG, Lettieri CJ, McKeon AB, et al. Sleep, Sleep Disorders, and Circadian Health following Mild Traumatic Brain Injury in Adults: Review and Research Agenda. J Neurotrauma. 2018;35(22):2615-31. doi: 10.1089/neu.2017.5243.
228. Chan LG, Feinstein A. Persistent Sleep Disturbances Independently Predict Poorer Functional and Social Outcomes 1 Year After Mild Traumatic Brain Injury. J Head Trauma Rehabil. 2015;30(6):E67-75. doi: 10.1097/HTR.0000000000000119.
229. Mollayeva T, Sharma B, Vernich L, Mantis S, Lewko J, Gibson B, et al. Sleep before and after work-related concussion: Sex differences in effects and functional outcomes. Work. 2020;67(4):927-38. doi: 10.3233/WOR-203343.
230. Sullan MJ, Crocker LD, Thomas KR, Orff HJ, Davey DK, Jurick SM, et al. Baseline sleep quality moderates symptom improvement in veterans with comorbid PTSD and TBI receiving trauma-focused treatment. Behav Res Ther. 2021;143:103892. doi: 10.1016/j.brat.2021.103892.
231. Tkachenko N, Singh K, Hasanaj L, Serrano L, Kothare SV. Sleep Disorders Associated With Mild Traumatic Brain Injury Using Sport Concussion Assessment Tool 3. Pediatr Neurol. 2016;57:46-50 e1. doi: 10.1016/j.pediatrneurol.2015.12.019.
232. Kraemer Y, Maki K, Marinkovic I, Nybo T, Isokuortti H, Huovinen A, et al. Post-traumatic headache after mild traumatic brain injury in a one-year follow up study - risk factors and return to work. J Headache Pain. 2022;23(1):27. doi: 10.1186/s10194-022-01398-9.
233. Skandsen T, Stenberg J, Follestad T, Karaliute M, Saksvik SB, Einarsen CE, et al. Personal Factors Associated With Postconcussion Symptoms 3 Months After Mild Traumatic Brain Injury. Arch Phys Med Rehabil. 2021;102(6):1102-12. doi: 10.1016/j.apmr.2020.10.106.
234. Anderson JFI, Jordan AS. An observational study of the association between sleep disturbance, fatigue and cognition in the post-acute period after mild traumatic brain injury in prospectively studied premorbidly healthy adults. Neuropsychol Rehabil. 2021;31(9):1444-65. doi: 10.1080/09602011.2020.1781665.
235. Brett BL, Meier TB, Savitz J, Guskiewicz KM, McCrea MA. Research Letter: Sleep Mediates the Association Between Prior Concussion and Depressive Symptoms. J Head Trauma Rehabil. 2021;36(4):E284-E8. doi: 10.1097/HTR.0000000000000663.
236. Barlow Karen M, Brooks Brian L, Esser Michael J, Kirton A, Mikrogianakis A, Zemek Roger L, et al. Efficacy of melatonin in children with postconcussive symptoms: A randomized clinical trial. Pediatrics. 2020;145(4). doi: 10.1542/peds.2019-2812.
237. Grima NA, Rajaratnam SMW, Mansfield D, Sletten TL, Spitz G, Ponsford JL. Efficacy of melatonin for sleep disturbance following traumatic brain injury: a randomised controlled trial. BMC medicine. 2018;16(1):8. doi: 10.1186/s12916-017-0995-1.
238. Barlow KM, Kirk V, Brooks B, Esser MJ, Yeates KO, Zemek R, et al. Efficacy of Melatonin for Sleep Disturbance in Children with Persistent Post-Concussion Symptoms: Secondary Analysis of a Randomized Controlled Trial. J Neurotrauma. 2021;38(8):950-9. doi: 10.1089/neu.2020.7154.
239. Srisurapanont K, Samakarn Y, Kamklong B, Siratrairat P, Bumiputra A, Jaikwang M, Srisurapanont M. Blue-wavelength light therapy for post-traumatic brain injury sleepiness, sleep disturbance, depression, and fatigue: A systematic review and network meta-analysis. PLoS ONE. 2021;16(2):e0246172. doi: 10.1371/journal.pone.0246172.
240. Bajaj S, Vanuk JR, Smith R, Dailey NS, Killgore WDS. Blue-Light Therapy following Mild Traumatic Brain Injury: Effects on White Matter Water Diffusion in the Brain. Front Neurol. 2017;8:616. doi: 10.3389/fneur.2017.00616.

241. Raikes AC, Dailey NS, Forbeck B, Alkozei A, Killgore WDS. Daily Morning Blue Light Therapy for Post-mTBI Sleep Disruption: Effects on Brain Structure and Function. Front Neurol. 2021;12:625431. doi: 10.3389/fneur.2021.625431.

242. Connolly LJ, Rajaratnam SMW, Murray JM, Spitz G, Lockley SW, Ponsford JL. Home-based light therapy for fatigue following acquired brain injury: a pilot randomized controlled trial. BMC Neurol. 2021;21(1):262. doi: 10.1186/s12883-021-02292-8.

243. Sullivan KA, Blaine H, Kaye SA, Theadom A, Haden C, Smith SS. A Systematic Review of Psychological Interventions for Sleep and Fatigue after Mild Traumatic Brain Injury. J Neurotrauma. 2018;35(2):195-209. doi: 10.1089/neu.2016.4958.

244. Theadom A, Barker-Collo S, Jones K, Dudley M, Vincent N, Feigin V. A pilot randomized controlled trial of on-line interventions to improve sleep quality in adults after mild or moderate traumatic brain injury. Clin Rehabil. 2018;32(5):619-29. doi: 10.1177/0269215517736671.

245. Ymer L, McKay A, Wong D, Frencham K, Grima N, Tran J, et al. Cognitive behavioural therapy versus health education for sleep disturbance and fatigue after acquired brain injury: A pilot randomised trial. Ann Phys Rehabil Med. 2021;64(5):101560. doi: 10.1016/j.rehab.2021.101560.

246. Dijkers MP, Bushnik T. Assessing fatigue after traumatic brain injury: an evaluation of the HIV-Related Fatigue Scale [corrected]. J Head Trauma Rehabil. 2008;23(1):3-16. doi: 10.1097/01.HTR.0000308716.80590.6b.

247. Cantor JB, Ashman T, Gordon W, Ginsberg A, Engmann C, Egan M, et al. Fatigue after traumatic brain injury and its impact on participation and quality of life. J Head Trauma Rehabil. 2008;23(1):41-51. doi: 10.1097/01.HTR.0000308720.70288.af.

248. Juengst S, Skidmore E, Arenth PM, Niyonkuru C, Raina KD. Unique contribution of fatigue to disability in community-dwelling adults with traumatic brain injury. Arch Phys Med Rehabil. 2013;94(1):74-9. doi: 10.1016/j.apmr.2012.07.025.

249. Ponsford JL, Ziino C, Parcell DL, Shekleton JA, Roper M, Redman JR, et al. Fatigue and sleep disturbance following traumatic brain injury--their nature, causes, and potential treatments. J Head Trauma Rehabil. 2012;27(3):224-33. doi: 10.1097/HTR.0b013e31824ee1a8.

250. Ponsford J, Schonberger M, Rajaratnam SM. A Model of Fatigue Following Traumatic Brain Injury. J Head Trauma Rehabil. 2015;30(4):277-82. doi: 10.1097/HTR.0000000000000049.

251. Lichstein KL, Payne KL, Soeffing JP, Heith Durrence H, Taylor DJ, Riedel BW, Bush AJ. Vitamins and sleep: an exploratory study. Sleep Med. 2007;9(1):27-32. doi: 10.1016/j.sleep.2006.12.009.

252. Andelic N, Roe C, Brunborg C, Zeldovich M, Lovstad M, Loke D, et al. Frequency of fatigue and its changes in the first 6 months after traumatic brain injury: results from the CENTER-TBI study. J Neurol. 2021;268(1):61-73. doi: 10.1007/s00415-020-10022-2.

253. Caldwell JA, Caldwell JL, Thompson LA, Lieberman HR. Fatigue and its management in the workplace. Neurosci Biobehav Rev. 2019;96:272-89. doi: 10.1016/j.neubiorev.2018.10.024.

254. Ali A, Morfin J, Mills J, Pasipanodya Elizabeth C, Maas Yvonne J, Huang E, et al. Fatigue After Traumatic Brain Injury: A Systematic Review. The Journal of head trauma rehabilitation. 2021. doi:

255. Nguyen S, McKay A, Wong D, Rajaratnam SM, Spitz G, Williams G, et al. Cognitive Behavior Therapy to Treat Sleep Disturbance and Fatigue After Traumatic Brain Injury: A Pilot Randomized Controlled Trial. Arch Phys Med Rehabil. 2017;98(8):1508-17 e2. doi: 10.1016/j.apmr.2017.02.031.

256. Raikes AC, Dailey NS, Shane BR, Forbeck B, Alkozei A, Killgore WDS. Daily Morning Blue Light Therapy Improves Daytime Sleepiness, Sleep Quality, and Quality of Life Following a Mild Traumatic Brain Injury. J Head Trauma Rehabil. 2020;35(5):E405-E21. doi: 10.1097/HTR.0000000000000579.

257. DeGraba TJ, Williams K, Koffman R, Bell JL, Pettit W, Kelly JP, et al. Efficacy of an Interdisciplinary Intensive Outpatient Program in Treating Combat-Related Traumatic Brain Injury and Psychological Health Conditions. Front Neurol. 2020;11:580182. doi: 10.3389/fneur.2020.580182.

258. Rytter HM, Westenbaek K, Henriksen H, Christiansen P, Humle F. Specialized interdisciplinary rehabilitation reduces persistent post-concussive symptoms: a randomized clinical trial. Brain Inj. 2019;33(3):266-81. doi: 10.1080/02699052.2018.1552022.

259. Thastum MM, Rask CU, Naess-Schmidt ET, Tuborgh A, Jensen JS, Svendsen SW, et al. Novel interdisciplinary intervention, GAIN, vs. enhanced usual care to reduce high levels of post-concussion symptoms in adolescents and young adults 2-6 months post-injury: A randomised trial. EClinicalMedicine. 2019;17:100214. doi: 10.1016/j.eclinm.2019.11.007.

260. Le Sage N, Chauny JM, Berthelot S, Archambault P, Neveu X, Moore L, et al. Post-Concussion Symptoms Rule: Derivation and Validation of a Clinical Decision Rule for Early Prediction of Persistent Symptoms after a Mild Traumatic Brain Injury. J Neurotrauma. 2022;39(19-20):1349-62. doi: 10.1089/neu.2022.0026.

261. Rice SM, Parker AG, Rosenbaum S, Bailey A, Mawren D, Purcell R. Sport-Related Concussion and Mental Health Outcomes in Elite Athletes: A Systematic Review. Sports Med. 2018;48(2):447-65. doi: 10.1007/s40279-017-0810-3.

262. Hellewell SC, Beaton CS, Welton T, Grieve SM. Characterizing the Risk of Depression Following Mild Traumatic Brain Injury: A Meta-Analysis of the Literature Comparing Chronic mTBI to Non-mTBI Populations. Front Neurol. 2020;11:350. doi: 10.3389/fneur.2020.00350.

263. Bryan CJ, Clemans TA, Hernandez AM, Rudd MD. Loss of consciousness, depression, posttraumatic stress disorder, and suicide risk among deployed military personnel with mild traumatic brain injury. J Head Trauma Rehabil. 2013;28(1):13-20. doi: 10.1097/HTR.0b013e31826c73cc.

264. Haarbauer-Krupa J, Taylor CA, Yue JK, Winkler EA, Pirracchio R, Cooper SR, et al. Screening for Post-Traumatic Stress Disorder in a Civilian Emergency Department Population with Traumatic Brain Injury. J Neurotrauma. 2017;34(1):50-8. doi: 10.1089/neu.2015.4158.

265. Chang HK, Hsu JW, Wu JC, Huang KL, Chang HC, Bai YM, et al. Risk of attempted suicide among adolescents and young adults with traumatic brain injury: A nationwide longitudinal study. J Affect Disord. 2019;250:21-5. doi: 10.1016/j.jad.2019.02.059.

266. Donders J, Darland K. Psychometric properties and correlates of the PHQ-2 and PHQ-9 after traumatic brain injury. Brain Inj. 2017;31(13-14):1871-5. doi: 10.1080/02699052.2017.1334962.

267. Karr JE, Iverson GL, Huang SJ, Silverberg ND, Yang CC. Perceived Change in Physical, Cognitive, and Emotional Symptoms after Mild Traumatic Brain Injury in Patients with Pre-Injury Anxiety or Depression. J Neurotrauma. 2020;37(10):1183-9. doi: 10.1089/neu.2019.6834.

268. Langer LK, Alavinia SM, Lawrence DW, Munce SEP, Kam A, Tam A, et al. Prediction of risk of prolonged post-concussion symptoms: Derivation and validation of the TRICORDRR (Toronto Rehabilitation Institute Concussion Outcome Determination and Rehab Recommendations) score. PLoS Med. 2021;18(7):e1003652. doi: 10.1371/journal.pmed.1003652.

269. Brett BL, Kramer MD, Whyte J, McCrea MA, Stein MB, Giacino JT, et al. Latent Profile Analysis of Neuropsychiatric Symptoms and Cognitive Function of Adults 2 Weeks After Traumatic Brain Injury: Findings From the TRACK-TBI Study. JAMA Netw Open. 2021;4(3):e213467. doi: 10.1001/jamanetworkopen.2021.3467.

270. Doroszkiewicz C, Gold D, Green R, Tartaglia MC, Ma J, Tator CH. Anxiety, Depression, and Quality of Life: A Long-Term Follow-Up Study of Patients with Persisting Concussion Symptoms. J Neurotrauma. 2021;38(4):493-505. doi: 10.1089/neu.2020.7313.

271. Moriarty H, Robinson KM, Winter L. The additional burden of PTSD on functioning and depression in veterans with traumatic brain injury. Nurs Outlook. 2021;69(2):167-81. doi: 10.1016/j.outlook.2020.11.003.

272. Popov N, Mercier LJ, King R, Fung T, Debert CT. Factors Associated with Quality of Life in Adults with Persistent Post-Concussion Symptoms. Can J Neurol Sci. 2022;49(1):109-17. doi: 10.1017/cjn.2021.53.

273. Ramanathan-Elion DM, Baydoun HA, Johnstone B. Psychological predictors of functional outcomes in service members with traumatic brain injury. Brain Inj. 2020;34(9):1183-92. doi: 10.1080/02699052.2020.1793387.

274. Vikane E, Froyland K, Naess HL, Assmus J, Skouen JS. Predictors for Psychological Distress 2 Months After Mild Traumatic Brain Injury. Front Neurol. 2019;10:639. doi: 10.3389/fneur.2019.00639.

275. Zachar-Tirado CN, Donders J. Clinical utility of the GAD-7 in identifying anxiety disorders after traumatic brain injury. Brain Inj. 2021;35(6):655-60. doi: 10.1080/02699052.2021.1895315.

276. Kennedy SH, Lam RW, McIntyre RS, Tourjman SV, Bhat V, Blier P, et al. Canadian Network for Mood and Anxiety Treatments (CANMAT) 2016 Clinical Guidelines for the Management of Adults with Major Depressive Disorder: Section 3. Pharmacological Treatments. Can J Psychiatry. 2016;61(9):540-60. doi: 10.1177/0706743716659417.

277. Little A, Byrne C, Coetzer R. The effectiveness of cognitive behaviour therapy for reducing anxiety symptoms following traumatic brain injury: A meta-analysis and systematic review. NeuroRehabilitation. 2021;48(1):67-82. doi: 10.3233/NRE-201544.

278. Mikolic A, Polinder S, Retel Helmrich IRA, Haagsma JA, Cnossen MC. Treatment for posttraumatic stress disorder in patients with a history of traumatic brain injury: A systematic review. Clin Psychol Rev. 2019;73:101776. doi: 10.1016/j.cpr.2019.101776.

279. Zhang A, Borhneimer LA, Weaver A, Franklin C, Hai AH, Guz S, Shen L. Cognitive behavioral therapy for primary care depression and anxiety: a secondary meta-analytic review using robust variance estimation in meta-regression. J Behav Med. 2019;42(6):1117-41. doi: 10.1007/s10865-019-00046-z.

DRAFT

280. Seligman LD, Ollendick TH. Cognitive-behavioral therapy for anxiety disorders in youth. Child Adolesc Psychiatr Clin N Am. 2011;20(2):217-38. doi: 10.1016/j.chc.2011.01.003.
281. Lewinsohn P, Clarke G, Hops H, Andrews J. Cognitive-behavioural treatment for depressed adolescents. Behavior Therapy. 1990;21(4):385-401. doi:
282. Ponsford J, Lee NK, Wong D, McKay A, Haines K, Alway Y, et al. Efficacy of motivational interviewing and cognitive behavioral therapy for anxiety and depression symptoms following traumatic brain injury. Psychol Med. 2016;46(5):1079-90. doi: 10.1017/S0033291715002640.
283. Cuthbert K, Parsons EM, Smith L, Otto MW. Acceptability of telehealth CBT during the time of COVID-19: Evidence from patient treatment initiation and attendance records. J Behav Cogn Ther. 2022;32(1):67-72. doi: 10.1016/j.jbct.2022.01.001.
284. Jak AJ, Jurick S, Crocker LD, Sanderson-Cimino M, Aupperle R, Rodgers CS, et al. SMART-CPT for veterans with comorbid post-traumatic stress disorder and history of traumatic brain injury: a randomised controlled trial. J Neurol Neurosurg Psychiatry. 2019;90(3):333-41. doi: 10.1136/jnnp-2018-319315.
285. Acabchuk RL, Brisson JM, Park CL, Babbott-Bryan N, Parmelee OA, Johnson BT. Therapeutic Effects of Meditation, Yoga, and Mindfulness-Based Interventions for Chronic Symptoms of Mild Traumatic Brain Injury: A Systematic Review and Meta-Analysis. Appl Psychol Health Well Being. 2021;13(1):34-62. doi: 10.1111/aphw.12244.
286. Ackland PE, Greer N, Sayer NA, Spoont MR, Taylor BC, MacDonald R, et al. Effectiveness and harms of mental health treatments in service members and veterans with deployment-related mild traumatic brain injury. J Affect Disord. 2019;252:493-501. doi: 10.1016/j.jad.2019.04.066.
287. Bedard M, Felteau M, Marshall S, Cullen N, Gibbons C, Dubois S, et al. Mindfulness-based cognitive therapy reduces symptoms of depression in people with a traumatic brain injury: results from a randomized controlled trial. J Head Trauma Rehabil. 2014;29(4):E13-22. doi: 10.1097/HTR.0b013e3182a615a0.
288. Kreutzer JS, Marwitz JH, Sima AP, Mills A, Hsu NH, Lukow HR, 2nd. Efficacy of the resilience and adjustment intervention after traumatic brain injury: a randomized controlled trial. Brain Inj. 2018;32(8):963-71. doi: 10.1080/02699052.2018.1468577.
289. Novakovic-Agopian T, Posecion L, Kornblith E, Abrams G, McQuaid JR, Neylan TC, et al. Goal-Oriented Attention Self-Regulation Training Improves Executive Functioning in Veterans with Post-Traumatic Stress Disorder and Mild Traumatic Brain Injury. J Neurotrauma. 2021;38(5):582-92. doi: 10.1089/neu.2019.6806.
290. Thomas RE, Alves J, Vaska Mlis MM, Magalhaes R. Therapy and rehabilitation of mild brain injury/concussion: Systematic review. Restor Neurol Neurosci. 2017;35(6):643-66. doi: 10.3233/RNN-170761.
291. Silverberg ND, Cairncross M, Brasher PMA, Vranceanu AM, Snell DL, Yeates KO, et al. Feasibility of Concussion Rehabilitation Approaches Tailored to Psychological Coping Styles: A Randomized Controlled Trial. Arch Phys Med Rehabil. 2022;103(8):1565-73 e2. doi: 10.1016/j.apmr.2021.12.005.
292. Shirvani S, Davoudi M, Shirvani M, Koleini P, Hojat Panah S, Shoshtari F, Omidi A. Comparison of the effects of transcranial direct current stimulation and mindfulness-based stress reduction on mental fatigue, quality of life and aggression in mild traumatic brain injury patients: a randomized clinical trial. Ann Gen Psychiatry. 2021;20(1):33. doi: 10.1186/s12991-021-00355-1.
293. Lovell MR, Collins MW, Iverson GL, Field M, Maroon JC, Cantu R, et al. Recovery from mild concussion in high school athletes. Journal of neurosurgery. 2003;98(2):296-301. doi:
294. Schatz P, Pardini JE, Lovell MR, Collins MW, Podell K. Sensitivity and specificity of the ImPACT Test Battery for concussion in athletes. Arch Clin Neuropsychol. 2006;21(1):91-9. doi: 10.1016/j.acn.2005.08.001.
295. Broshek DK, Kaushik T, Freeman JR, Erlanger D, Webbe F, Barth JT. Sex differences in outcome following sports-related concussion. J Neurosurg. 2005;102(5):856-63. doi: 10.3171/jns.2005.102.5.0856.
296. Braun M, Tupper D, Kaufmann P, McCrea M, Postal K, Westerveld M, et al. Neuropsychological assessment: a valuable tool in the diagnosis and management of neurological, neurodevelopmental, medical, and psychiatric disorders. Cogn Behav Neurol. 2011;24(3):107-14. doi: 10.1097/WNN.0b013e3182351289.
297. Van Patten R, Iverson GL. Examining associations between concussion history, subjectively experienced memory problems, and general health factors in older men. Clin Neuropsychol. 2023;37(1):119-40. doi: 10.1080/13854046.2021.1991481.
298. Broggi M, Ready RE. Academic skills, self-perceptions, and grades in university students with a history of multiple concussions: The mediating roles of processing speed and psychological symptoms. Clin Neuropsychol. 2022;36(8):2188-204. doi: 10.1080/13854046.2021.1958924.
299. Crocker LD, Jurick SM, Thomas KR, Keller AV, Sanderson-Cimino M, Hoffman SN, et al. Mild traumatic brain injury characteristics do not negatively influence cognitive processing therapy attendance or outcomes. J Psychiatr Res. 2019;116:7-13. doi: 10.1016/j.jpsychires.2019.05.022.

300. Hwang PH, Nelson LD, Sharon JD, McCrea MA, Dikmen SS, Markowitz AJ, et al. Association Between TBI-Related Hearing Impairment and Cognition: A TRACK-TBI Study. J Head Trauma Rehabil. 2022;37(5):E327-E35. doi: 10.1097/HTR.0000000000000735.

301. Jurick SM, Crocker LD, Merritt VC, Sanderson-Cimino ME, Keller AV, Glassman LH, et al. Independent and Synergistic Associations Between TBI Characteristics and PTSD Symptom Clusters on Cognitive Performance and Postconcussive Symptoms in Iraq and Afghanistan Veterans. J Neuropsychiatry Clin Neurosci. 2021;33(2):98-108. doi: 10.1176/appi.neuropsych.20050128.

302. Schneider ALC, Huie JR, Boscardin WJ, Nelson L, Barber JK, Yaffe K, et al. Cognitive Outcome 1 Year After Mild Traumatic Brain Injury: Results From the TRACK-TBI Study. Neurology. 2022;98(12):e1248-e61. doi: 10.1212/WNL.0000000000200041.

303. Stenberg J, Karr JE, Terry DP, Haberg AK, Vik A, Skandsen T, Iverson GL. Change in self-reported cognitive symptoms after mild traumatic brain injury is associated with changes in emotional and somatic symptoms and not changes in cognitive performance. Neuropsychology. 2020;34(5):560-8. doi: 10.1037/neu0000632.

304. Van Patten R, Keith C, Bertolin M, Wright JD. The effect of premorbid attention-deficit/hyperactivity disorder on neuropsychological functioning in individuals with acute mild traumatic brain injuries. J Clin Exp Neuropsychol. 2016;38(1):12-22. doi: 10.1080/13803395.2015.1091064.

305. Disner SG, Kramer MD, Nelson NW, Lipinski AJ, Christensen JM, Polusny MA, Sponheim SR. Predictors of Postdeployment Functioning in Combat-Exposed U.S. Military Veterans. Clin Psychol Sci. 2017;5(4):650-63. doi: 10.1177/2167702617703436.

306. Terry DP, Brassil M, Iverson GL, Panenka WJ, Silverberg ND. Effect of depression on cognition after mild traumatic brain injury in adults. Clin Neuropsychol. 2019;33(1):124-36. doi: 10.1080/13854046.2018.1459853.

307. Saksvik SB, Smevik H, Stenberg J, Follestad T, Vik A, Haberg A, et al. Poor sleep quality is associated with greater negative consequences for cognitive control function and psychological health after mild traumatic brain injury than after orthopedic injury. Neuropsychology. 2021. doi: 10.1037/neu0000751.

308. Garcia A, Reljic T, Pogoda TK, Kenney K, Agyemang A, Troyanskaya M, et al. Obstructive Sleep Apnea Risk Is Associated with Cognitive Impairment after Controlling for Mild Traumatic Brain Injury History: A Chronic Effects of Neurotrauma Consortium Study. J Neurotrauma. 2020;37(23):2517-27. doi: 10.1089/neu.2019.6916.

309. Pagulayan KF, O'Neil M, Williams RM, Turner AP, Golshan S, Roost MS, et al. Mental Health Does Not Moderate Compensatory Cognitive Training Efficacy for Veterans With a History of Mild Traumatic Brain Injury. Arch Phys Med Rehabil. 2017;98(9):1893-6 e2. doi: 10.1016/j.apmr.2017.04.009.

310. Velikonja D, Ponsford J, Janzen S, Harnett A, Patsakos E, Kennedy M, et al. INCOG 2.0 Guidelines for Cognitive Rehabilitation Following Traumatic Brain Injury, Part V: Memory. J Head Trauma Rehabil. 2023;38(1):83-102. doi: 10.1097/HTR.0000000000000837.

311. Cooper DB, Bunner AE, Kennedy JE, Balldin V, Tate DF, Eapen BC, Jaramillo CA. Treatment of persistent post-concussive symptoms after mild traumatic brain injury: a systematic review of cognitive rehabilitation and behavioral health interventions in military service members and veterans. Brain Imaging Behav. 2015;9(3):403-20. doi: 10.1007/s11682-015-9440-2.

312. Fure SCR, Howe EI, Andelic N, Brunborg C, Sveen U, Roe C, et al. Cognitive and vocational rehabilitation after mild-to-moderate traumatic brain injury: A randomised controlled trial. Ann Phys Rehabil Med. 2021;64(5):101538. doi: 10.1016/j.rehab.2021.101538.

313. Samuelson KW, Engle K, Abadjian L, Jordan J, Bartel A, Talbot M, et al. Cognitive Training for Mild Traumatic Brain Injury and Posttraumatic Stress Disorder. Front Neurol. 2020;11:569005. doi: 10.3389/fneur.2020.569005.

314. Storzbach D, Twamley EW, Roost MS, Golshan S, Williams RM, O'Neil M, et al. Compensatory Cognitive Training for Operation Enduring Freedom/Operation Iraqi Freedom/Operation New Dawn Veterans With Mild Traumatic Brain Injury. J Head Trauma Rehabil. 2017;32(1):16-24. doi: 10.1097/HTR.0000000000000228.

315. Twamley EW, Jak AJ, Delis DC, Bondi MW, Lohr JB. Cognitive Symptom Management and Rehabilitation Therapy (CogSMART) for veterans with traumatic brain injury: pilot randomized controlled trial. J Rehabil Res Dev. 2014;51(1):59-70. doi: 10.1682/JRRD.2013.01.0020.

316. Twamley EW, Thomas KR, Gregory AM, Jak AJ, Bondi MW, Delis DC, Lohr JB. CogSMART Compensatory Cognitive Training for Traumatic Brain Injury: Effects Over 1 Year. J Head Trauma Rehabil. 2015;30(6):391-401. doi: 10.1097/HTR.0000000000000076.

317. Schweizer TA, Baker AJ. Tackling the concussion epidemic: Springer International Publishing; 2022.

318. Ferris LM, Kontos AP, Eagle SR, Elbin RJ, Clugston JR, Ortega J, Port NL. Optimizing VOMS for identifying acute concussion in collegiate athletes: Findings from the NCAA-DoD CARE consortium. Vision Res. 2022;200:108081. doi: 10.1016/j.visres.2022.108081.

319. Mucha A, Collins Michael W, Elbin RJ, Furman Joseph M, Troutman-Enseki C, DeWolf Ryan M, et al. A Brief Vestibular/Ocular Motor Screening (VOMS) Assessment to Evaluate Concussions. The American Journal of Sports Medicine. 2014;42(10):2479-86. doi: 10.1177/0363546514543775.
320. Whitney SL, Eagle SR, Marchetti G, Mucha A, Collins MW, Kontos AP, Investigators CC. Association of acute vestibular/ocular motor screening scores to prolonged recovery in collegiate athletes following sport-related concussion. Brain Inj. 2020;34(6):840-5. doi: 10.1080/02699052.2020.1755055.
321. Yorke AM, Smith L, Babcock M, Alsalaheen B. Validity and Reliability of the Vestibular/Ocular Motor Screening and Associations With Common Concussion Screening Tools. Sports Health. 2017;9(2):174-80. doi: 10.1177/1941738116678411.
322. Barnett BP, Singman EL. Vision concerns after mild traumatic brain injury. Curr Treat Options Neurol. 2015;17(2):329. doi: 10.1007/s11940-014-0329-y.
323. Simpson-Jones ME, Hunt AW. Vision rehabilitation interventions following mild traumatic brain injury: a scoping review. Disabil Rehabil. 2019;41(18):2206-22. doi: 10.1080/09638288.2018.1460407.
324. Hilton MP, Pinder DK. The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo. Cochrane Database Syst Rev. 2014(12):CD003162. doi: 10.1002/14651858.CD003162.pub3.
325. Soberg HL, Andelic N, Langhammer B, Tamber AL, Bruusgaard KA, Kleffelgaard I. Effect of vestibular rehabilitation on change in health-related quality of life in patients with dizziness and balance problems after traumatic brain injury: A randomized controlled trial. J Rehabil Med. 2021;53(4):jrm00181. doi: 10.2340/16501977-2823.
326. Wong CK, Ziaks L, Vargas S, DeMattos T, Brown C. Sequencing and Integration of Cervical Manual Therapy and Vestibulo-oculomotor Therapy for Concussion Symptoms: Retrospective Analysis. Int J Sports Phys Ther. 2021;16(1):12-20. doi: 10.26603/001c.18825.
327. Langevin P, Fremont P, Fait P, Dube MO, Bertrand-Charette M, Roy JS. Cervicovestibular Rehabilitation in Adults with Mild Traumatic Brain Injury: A Randomized Clinical Trial. J Neurotrauma. 2022;39(7-8):487-96. doi: 10.1089/neu.2021.0508.
328. Galeno E, Pullano E, Mourad F, Galeoto G, Frontani F. Effectiveness of Vestibular Rehabilitation after Concussion: A Systematic Review of Randomised Controlled Trial. Healthcare (Basel). 2022;11(1). doi: 10.3390/healthcare11010090.
329. Han BI, Song HS, Kim JS. Vestibular rehabilitation therapy: review of indications, mechanisms, and key exercises. J Clin Neurol. 2011;7(4):184-96. doi: 10.3988/jcn.2011.7.4.184.
330. Schlemmer E, Nicholson N. Vestibular Rehabilitation Effectiveness for Adults With Mild Traumatic Brain Injury/Concussion: A Mini-Systematic Review. Am J Audiol. 2022;31(1):228-42. doi: 10.1044/2021_AJA-21-00165.
331. Santhanam P, Meehan A, Orrison WW, Wilson SH, Oakes TR, Weaver LK. Central auditory processing disorders after mild traumatic brain injury. Undersea Hyperb Med. 2019;46(3):261-9. doi:
332. Knoll RM, Herman SD, Lubner RJ, Babu AN, Wong K, Sethi RKV, et al. Patient-reported auditory handicap measures following mild traumatic brain injury. Laryngoscope. 2020;130(3):761-7. doi: 10.1002/lary.28034.
333. Mercier LJ, Batycky J, Campbell C, Schneider K, Smirl J, Debert CT. Autonomic dysfunction in adults following mild traumatic brain injury: A systematic review. NeuroRehabilitation. 2022;50(1):3-32. doi: 10.3233/NRE-210243.
334. Pertab JL, Merkley TL, Cramond AJ, Cramond K, Paxton H, Wu T. Concussion and the autonomic nervous system: An introduction to the field and the results of a systematic review. NeuroRehabilitation. 2018;42(4):397-427. doi: 10.3233/NRE-172298.
335. Mez J, Daneshvar DH, Abdolmohammadi B, Chua AS, Alosco ML, Kiernan PT, et al. Duration of American Football Play and Chronic Traumatic Encephalopathy. Ann Neurol. 2020;87(1):116-31. doi: 10.1002/ana.25611.
336. Katz DI, Bernick C, Dodick DW, Mez J, Mariani ML, Adler CH, et al. National Institute of Neurological Disorders and Stroke Consensus Diagnostic Criteria for Traumatic Encephalopathy Syndrome. Neurology. 2021;96(18):848-63. doi: 10.1212/WNL.0000000000011850.
337. Iverson GL, Castellani RJ, Cassidy JD, Schneider GM, Schneider KJ, Echemendia RJ, et al. Examining later-in-life health risks associated with sport-related concussion and repetitive head impacts: a systematic review of case-control and cohort studies. Br J Sports Med. 2023;57(12):810-21. doi: 10.1136/bjsports-2023-106890.
338. McCrory P, Meeuwisse W, Johnston K, Dvorak J, Aubry M, Molloy M, Cantu R. Consensus Statement on Concussion in Sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. Br J Sports Med. 2009;43 Suppl 1:i76-90. doi: 10.1136/bjsm.2009.058248.
339. Weiler R, Blauwet C, Clarke D, Dalton K, Derman W, Fagher K, et al. Concussion in para sport: the first position statement of the Concussion in Para Sport (CIPS) Group. Br J Sports Med. 2021;55(21):1187-95. doi: 10.1136/bjsports-2020-103696.

340. Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G, et al. AGREE II: advancing guideline development, reporting and evaluation in health care. CMAJ. 2010;182(18):E839-42. doi: 10.1503/cmaj.090449.

DRAFT