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SPECIAL COMMUNICATION

Management of Concussion and Mild Traumatic Brain Injury: A Synthesis of Practice Guidelines

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Abstract

At least 3 million Americans sustain a mild traumatic brain injury (mTBI) each year, and 1 in 5 have symptoms that persist beyond 1 month. Standards of mTBI care have evolved rapidly, with numerous expert consensus statements and clinical practice guidelines published in the last 5 years. This Special Communication synthesizes recent expert consensus statements and evidenced-based clinical practice guidelines for civilians, athletes, military, and pediatric populations for clinicians practicing outside of specialty mTBI clinics, including primary care providers. The article offers guidance on key clinical decisions in mTBI care and highlights priority interventions that can be initiated in primary care to prevent chronicity.

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Traumatic brain injury (TBI) occurs when an external force to the head or body alters brain function.[1] Almost half of Americans have sustained at least 1 TBI in their lifetime.[2] There are 3-4 million new cases of TBI each year in the United States[3] and 30-50 million worldwide.[4] The TBI incidence rate has been increasing.[3,5-7] Falls are the most common cause, especially in young children and older adults.[8] The vast majority of TBIs (up to 90%)[9] are classified as "mild" (mTBI), meaning that they involve no or only a brief (<30min) loss of consciousness and period of posttraumatic amnesia (<24h).[10] Management of mTBI largely

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occurs outside of the hospital. Although the emergency department is the typical point of entry into the health care system, increasingly, patients with mTBI are first seeking medical attention from a community-based primary care provider.[11-14] Primary care providers and specialists (eg, neurologists, physiatrists, etc) unattached to a TBI-specific clinic are often relied on to provide and/or arrange early follow-up care.[15]

Traditionally, mTBI has been thought to require minimal clinical management beyond watchful waiting.[16] In response to mounting evidence that mTBI can be associated with chronic symptoms and disability,[17-20] standards for mTBI care have evolved to promote earlier and more proactive intervention.[21-24] Numerous expert agreement statements and clinical practice guidelines have been published within the last 5 years.[21-32] The present review aims to synthesize this rapidly advancing knowledge for the clinician whose primary practice is not mTBI. We provide evidence-based recommendations to guide key clinical decisions and highlight priority interventions that can be initiated by nonexpert clinicians to potentially prevent chronicity.

The recommendations in this article will generally apply across age (school-aged children through adulthood) and injury setting (trauma, sport, military), although tailoring care to each is advisable. Note that some consensus statement and guideline documents synthesized here were intended to apply only to patients with "uncomplicated" mTBI (also known as "concussion" and characterized by an absence of trauma-related intracranial abnormalities on conventional structural neuroimaging),[22,24] whereas others were intended to apply to the full spectrum of mTBI.[25-27] The recommendations outlined below can be used for patients with uncomplicated and complicated mTBI, at the clinician's discretion.

Methods

An interdisciplinary group of content experts (American Congress of Rehabilitation Medicine Brain Injury Interdisciplinary Special Interest Group Mild TBI Task Force) extracted evidence-based recommendations from the latest versions of expert consensus statements and clinical practice guidelines for school-aged children,[25,26,31] adult civilians,[23,27,32] athletes,[21,22,28,29] and military populations[24,30] with mTBI. To incorporate the most up-to-date evidence, a supplementary MEDLINE search was performed on December 14, 2018, to identify recent systematic reviews by combining mTBI-related terms with a validated search filter for systematic reviews[33] (supplemental appendix S1, available online only at http://www.archives-pmr.org/).

A narrative synthesis of the consensus statements, clinical practice guidelines, and updated evidence follows. To supplement the narrative, we identified management recommendations that were consistent across the most recent and widely cited statement or guideline for each of the following areas: adults,[27] children,[25] military,[24] and sports.[22] To be included, a management recommendation had to (1) be explicit in at least 3 of the 4 core statements or guidelines and (2) be implied by, or at least consistent with any core statement or guideline that did not recommend the strategy explicitly. Eligible management recommendations, their associated strength (using guideline-specific grading systems), and their location within the source document were extracted by 2 authors independently (N.S. and K.M.), with discrepancies resolved by a third (W.P.), and are presented in table 1.

List of abbreviations:

AMS	**altered mental status**
CT	**computed tomography**
mTBI	**mild traumatic brain injury**
SCAT5	**Sport Concussion Assessment Tool−5th Edition**
TBI	**traumatic brain injury**

Discussion

Pathophysiology

Rapid acceleration/deceleration of the brain by mechanical force can disrupt cell membrane and axonal integrity, inducing a molecular cascade.[34] Normalization of altered brain metabolism, cerebrovascular function, and network connectivity following mTBI may lag behind clinical recovery.[35] Some patients with mTBI (12%-20%) will have macrostructural intracranial injury visible on computed tomography (CT); most common are cerebral contusions (disproportionately frontal-temporal), subdural hematomas, and subarachnoid hemorrhages.[36-38] Magnetic resonance imaging studies using modern techniques such as diffusion tensor imaging suggest that microstructural pathology (eg, weakened integrity of long white matter tracts) can also be a feature of mTBI,[39] although the nature, location, time course, and clinical significance of such changes are unclear.[40-42]

Clinical presentation and diagnosis

mTBI can be challenging to diagnose in any setting because the acute signs and symptoms of altered mental status (AMS) are often subtle and transient, and available diagnostic tests (eg, CT) are not sensitive. These issues may be compounded in primary care, where patients are often first evaluated days or even weeks after an injury event and factors that mimic mTBI-like symptoms (fig 1) may have emerged. Many novel biomarkers for mTBI are under development, but none have yet been validated for diagnostic purposes.[25,58-61] A clinical interview based on patient self-report (and corroborated with medical records, when available) with physical examination remains the criterion standard for diagnosing mTBI in primary care.

Given a lack of universally accepted diagnostic criteria for mTBI, a diagnostic process that integrates the most widely used criteria[1,10,24,27] is reasonable. The critical first step should be to establish a plausible injury mechanism. The mechanism of injury must transmit sufficient biomechanical energy to disrupt brain function, recognizing there are between-person variability thresholds.[62] Blunt force trauma to the head is not required for mTBI diagnosis; in some cases, acceleration-deceleration (whiplash)[10,22] or explosion/blast forces[24] may cause an mTBI in the absence of contact between the head and another surface.

Second, the clinician should query for signs and symptoms of AMS that presented immediately following the impact. The most compelling evidence of AMS is loss of consciousness (observed period of unresponsiveness), posttraumatic amnesia (gap in memory following the impact), or confusion (eg, inability to follow commands or disorientation to time or place). By some definitions, subtler symptoms such as slowed thinking[1] or feeling

Table 1 Recommendation number/location and strength

Variable	ONF	CDC	VA/DoD	CISG
Prompt diagnostic evaluation	1.1 (A)	C	2 (Strong)	Pg. 3-4
No routine neuroimaging	1.3 (A)	1A/1B, 2 (B)	3 (Weak)	C
No clinical use of serum biomarkers	C	6 (R)	3 (Weak)	Pg. 5
Advice to rest for 1-3 d post injury	3.4 (A)*	13A (B)	C†	Pg. 5
Guidance on gradual stepwise return to preinjury activities	3.4 (A), 12.3 (A)	13B, 13D (B)	C†	Pg. 5, 7
Early education for patient/family	2.3 (A), 2.6 (A)	7A/7B (B), 12 (A)	11, 15, 22 (Weak)	C
Use validated symptom scales for initial assessment and to track recovery	4.1 (C)	5A, 10B (B)	C	Pg. 3, 4, 7
Neuropsychological assessment to investigate persistent (>30d) cognitive symptoms	9.4 (A)	19C (C)	17 (Weak)	C
Referral to specialist or higher level of care for slow to recover patients (>10-14d for adult athletes, >30d for others)	2.4 (C)	11B/15F (B)	21 (Weak)	Pg. 5

NOTE. C, consistent with but not explicitly recommended in guideline/statement.
CDC, Centers for Disease Control and Prevention Guideline on the Diagnosis and Management of Mild Traumatic Brain Injury Among Children (2019). Strength of recommendations: A, almost always should be followed; B, usually should be followed; C, may sometimes be followed; R, intervention generally should not be done outside of a research setting; U, insufficient evidence.
CISG, Consensus Statement on Concussion in Sport—the 5th International Conference on Concussion in Sport (2016). Strength of recommendations: Not applicable.
ONF, Ontario Neurotrauma Foundation Guideline for Concussion/Mild Traumatic Brain Injury & Persistent Symptoms (3rd edition; 2018). Levels of evidence: A, ≥1 randomized controlled trial, meta-analysis, or systematic review; B, ≥1 cohort comparison, case study, or other type of experimental study; C, expert opinion, experience, or consensus panel.
VA/DoD, Department of Veterans Affairs/Department of Defense Clinical Practice Guideline for the Management of Concussion-Mild Traumatic Brain Injury (2016). Strength of recommendations: Strong For, Weak For, Strong Against, Weak Against.
* Recommendation is repeated in 4.5 and 12.5.
† Detailed recommendations for clinicians regarding rest and return to activity in an active duty military setting are covered in the Defense and Veterans Brain Injury Center's (2014) Progressive Return to Activity Following Acute Concussion/Mild TBI (accessed May 2, 2019: https://dvbic.dcoe.mil/material/progressive-return-activity-following-acute-concussionmild-tbi-clinical-suite).

dazed[10] qualify as evidence of AMS. The onset of AMS typically abuts the moment of impact but may evolve over minutes.[22,63]

Third, it is important that clinicians consider potential confounding factors and determine whether these factors may explain the AMS.[1,64,65] The most common factor is probably alcohol or substance intoxication.[66,67] Other potential confounds include acute psychological stress, severe musculoskeletal pain, pulmonary or circulatory disruption, and syncope or hypoglycemia prior to a fall. People who are exposed to a psychologically traumatic event that does not involve mTBI (eg, witnessing violence) and react with panic (eg, fear of death, tachycardia, hyperventilation) can have difficulty recalling part or all of the event.[53]

Example questions for the diagnostic interview are provided in fig 2. The final step in the diagnostic process is to incorporate all available information into a probabilistic determination.[68] Equivocal evidence of AMS may warrant an mTBI diagnosis if it occurred in the context of a high-energy impact and the absence of confounding factors. The decision to rule in mTBI must be weighed against the potentially iatrogenic consequences of a false positive mTBI diagnosis, such as misdirecting treatment so that a clinically important underlying condition (eg, posttraumatic stress) is not addressed.

Postconcussion symptoms such as headache, dizziness, fatigue, irritability, and forgetfulness can support a diagnosis or trigger a diagnostic evaluation (and precautionary measures such as removal from sport)[22] but should generally not be used as the sole basis for diagnosing mTBI.[65,69] mTBI-like symptoms are commonly reported by patients with traumatic injuries not involving the head or brain,[51,70,71] patients with a variety of health conditions that often co-occur with mTBI (see fig 1), and even by healthy people[72,73]; the poor specificity of these symptoms weakens their diagnostic utility. Nevertheless, if a

Cervical strain[43–46]
Neurotological disorders[46,47]
Chronic bodily pain[48,49]
Deconditioning[50]
Analgesic medication use[51,52]
Post-traumatic stress[53,54]
Depression[55,56]
Developmental disorders (eg, ADHD)[57]

Fig 1 Conditions that can mimic or exacerbate "postconcussion" symptoms.[43-57]

Step 1. Establish Plausible Injury Mechanism.

- Ask the patient to describe the sequence of events surrounding the injury.
- Listen carefully and query as necessary for a concussive force (eg, Did your head jolt back and forth?) and its intensity (eg, From what height did you fall?).
- Distinguish the patient's personal memories from facts he or she inferred or learned from other people afterward.

Step 2. Query Signs and Symptoms.

Determine whether the patient's mental status was altered immediately after the impact. Example questions:

- Do you remember the impact and moments just after?
- Did anyone see you lay still and unresponsive right after the accident?
- Were you confused or unsure about where you were and what was happening?
- Were you able to think clearly about what to do after the accident?
- Were you able to answer questions appropriately and follow instructions from people at the scene?
- Did anyone tell you that your speech was incoherent or not making sense?

Step 3. Rule Out Confounding Factors

Check whether factors other than brain injury can account for the acute alteration in mental status. Example questions:

- Were you drinking alcohol or using drugs just before the accident?
- Did you see the impact coming? Did you think that you or others would be seriously injured or killed? Did you feel panicked or scared?
- Did you injure other parts of your body? Were you in severe pain?

Fig 2 Diagnostic Interview for Mild Traumatic Brain Injury. Abbreviation: ADHD, attention-deficit/hyperactivity disorder.

patient experiences new or worsened physical, cognitive, or emotional symptoms after a plausible mechanism of mTBI in the absence of AMS and confounding factors that might account for those symptoms (see fig 1), it would be prudent to proceed with clinical management under the assumption that the individual may have sustained an mTBI,[22] for example, by temporarily restricting the patient from safety-sensitive activities until their symptoms resolve and/or an alternative etiology is identified and addressed.

Prognosis

Recent inception cohort studies suggest that at least 1 in 5 patients with mTBI will experience symptoms that persist for longer than 1 month[17,18,20,74,75] and that recovery is frequently complicated by preexisting and comorbid health conditions.[58,76,77] Children return to school after a median of 2-4 days[78] and the median return to work time for adults is 1-2 weeks,[79] although 1 in 5 adults remain off work at 6 months post injury.[79] There is little evidence for lasting objective impairment in cognition[80] or academic performance.[78]

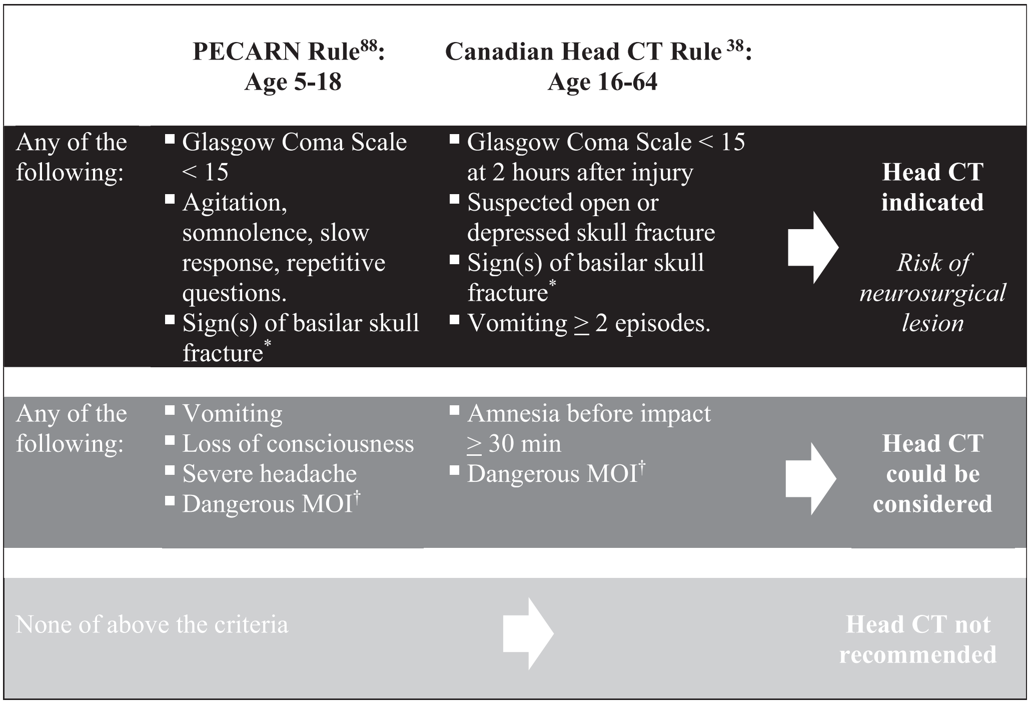
Girls and women may take longer to recover than boys and men, although this evidence is mixed.[75,81-83] History of prior mTBI(s)[75,76,84,85] and typical intracranial abnormalities on day-of-injury CT (eg, subdural hematoma)[76,86] have been inconsistent predictors of clinical outcome. The more symptoms a patient has soon after mTBI, the more symptoms they tend to have weeks and months later[81,83-85] In adults, preinjury mental health problems and postinjury psychological distress (symptoms of depression and anxiety) are robust predictors of prolonged recovery.[76,81,83,85,87]

Treatment

Early clinical management. Ruling out medical emergencies

When a primary care provider sees a patient with suspected mTBI within the first 48 hours of injury and is the first medical professional to evaluate the patient, the top priority is to rule out a neurosurgical emergency (eg, expanding intracerebral hemorrhage). The potential for cervical spine injury should be investigated by assessing neck motion or tenderness to palpation of the boney vertebral elements, airway trauma, and sensory-motor deficits. Positive examination findings warrant immediate cervical spine stabilization and trauma evaluation.

Acute neuroimaging of the brain should not be performed routinely following mild head trauma in previously healthy children and adults younger than 65 years old.[22,24-27] However, patients with certain clinical red flags are at risk for actionable neuroimaging findings (fig 3). The Canadian CT head rule[38] (or alternatives[76,77]) for adults and Pediatric Emergency Care Applied Research Network decision rule[89,90] for children were developed to guide physicians in determining the need for urgent neuroimaging after mTBI. When the clinical indication for head CT is ambiguous, it is reasonable to counsel patients and their families on the benefits and risks (eg, radiation exposure).[25] Adults older than 64 years and anticoagulated patients are at elevated risk for intracranial bleeding,[91] leading to recommendations that they be routinely scanned with CT and/or admitted to hospital for observation.[32,38] Patients with skull fracture or trauma-related intracranial abnormalities on CT have nontrivial rates of clinical deterioration (11.7%), emergency neurosurgical



Note: These decisions rules do not apply to patients with bleeding disorders or who are taking anticoagulant medication.

*Hemotympanum, "racoon" eyes, CSF otorrhea/rhinorrhea, or Battle's sign.
†Dangerous mechanism of injury includes pedestrian or bicyclist without helmet struck by vehicle, occupant ejected from motor vehicle, motor vehicle roll over, or fall from elevation ≥ 3 feet or 5 stairs.

Fig 3 Indications for urgent noncontrast computed tomography of the head after suspected mild traumatic brain injury. Abbreviation: MOI, mechanism of injury.[38,88]

intervention (3.5%), and death (1.5%), especially older adults and anticoagulated patients.[92] Signs of clinical deterioration such as reduced responsiveness, somnolence, severe and worsening headache, repeated vomiting, and emergence of focal neurologic signs warrant urgent evaluation at an emergency department.[27]

Blood-based biomarkers may have a role in preventing unnecessary CT imaging. The Scandinavian Neurotrauma Committee guidelines for adults[32] recommend that S100B values of <0.10 μg/L, if sampled within 6 hours of injury, can help rule out the need for CT in patients younger than 65 years with a Glasgow Coma Scale score of 14 or a Glasgow Coma Scale score of 15 with loss of consciousness or repeated vomiting. This approach has been empirically cross-validated.[93-95] In early 2018, the United States Food and Drug Administration approved the Banyan Brain Trauma Indicator for adults with suspected mTBI, based on evidence that low values of C-terminal hydrolase-L1 (<327pg/mL) and glial fibrillary acidic protein (<22pg/mL) within 12 hours of injury are associated with very high probability (0.996) of negative head CT.[96] C-terminal hydrolase-L1 and glial fibrillary acidic protein have not yet been incorporated into any published clinical practice guidelines. Their incremental value over clinical decision rules (eg, Canadian CT head rule[38]) is not yet known.

The relationship between mTBI and epilepsy varies with injury severity. There may be no significantly increased risk following uncomplicated mTBI (concussion)[97] but likely more than a 2-fold increased risk in children and adults with cerebral contusions, hemorrhage, or skull fracture.[98-100] Concussive convulsion, in which brief posturing or other seizure-like activity is observed immediately after impact (in 1%-2% of cases), is thought to result from a transient loss of cortical inhibition (ie, have a non-epileptogenic cause) and is not associated with prolonged recovery from mTBI or the development of posttraumatic epilepsy.[101,102] Routine seizure prophylaxis is not recommended in any mTBI clinical practice guideline.

Education

After critical medical complications are ruled out, the clinician should provide the patient (and family members and caregivers, if appropriate) with verbal and written education.[103,104] Education should include an explanation of what an mTBI is, favorable expectations for recovery, and advice about how to manage specific symptoms.[24-27] This information should be reviewed in subsequent visits as needed.[23] Quality patient-oriented education materials are available (fig 4).

Return to activity advice

Relative rest for the first 24-48 hours after an mTBI is recommended[22,25-27,105]; the goal is to alleviate symptoms and reduce metabolic demands on the brain. Complete rest, such as lying in a dark room and avoiding all sensory stimuli (eg, reading, interacting with family and friends, etc) does not accelerate recovery and is therefore not advisable.[50,105] After an initial period of relative rest and symptom stabilization, patients should be encouraged to

Centers for Disease Control and Prevention (hyperlink https://www.cdc.gov/headsup/index.html)

Defense and Veteran's Brain Injury Center (hyperlink https://dvbic.dcoe.mil/material/concussion-signs-and-symptoms-fact-sheet)

Ontario Neurotrauma Foundation (hyperlink http://mTBIsontario.org/standards/tools-resources/mTBI-information-for-patients-and-families/)

National Federation of State High School Associations (hyperlink https://nfhslearn.com/courses?searchText=Concussion)

Concussion Awareness Training Tool (hyperlink https://cattonline.com/)

Fig 4 Patient education resources.

gradually resume normal daily activities (including screen time) as tolerated.[22,25,27] This means that physical and cognitive activities can be progressively resumed at a pace that does not significantly worsen existing symptoms or generate new symptoms.[22,105] Environmental conditions with high sensory stimulation can also be gradually reintroduced. Clinicians may provide more detailed, structured guidance for a graduated activity progression with return to school,[22,26] sport[22] (table 2), or military service.[30] Students who are returning to school with residual symptoms may benefit from pragmatic accommodations[25] (table 3).

To mitigate the risk of repeated mTBI, patients should be counseled to not return to activities that involve a relatively high risk head impact exposure (eg, collision sports) until they are clinically recovered.[22,29] At present, there is no objective biomarker to determine mTBI resolution.[59] Clinical recovery from mTBI is determined by symptom resolution, normalization of physical examination findings, and tolerance for usual daily activities (including vigorous exercise for athletes).[22] Objective tests of balance and cognition, such as in the Sport Concussion Assessment Tool—5th Edition (SCAT5)[108] for patients 13 years or older and the Child SCAT5[109] for those 12 years and younger, can be used to supplement subjective symptom reporting and support return to play decision making with athletes.[22] The balance and cognitive tests within the SCAT5 are most sensitive during the first 24 hours following injury but rapidly lose sensitivity to more subtle lingering deficits thereafter. Their utility for tracking recovery beyond 3-5 days after mTBI has not been established.[110] In a setting without access to a neuropsychologist, return to play decisions should be made conservatively.[22]

Follow-up care for patients with persistent symptoms

Patients who experience moderate-severe symptoms or are unable to promptly resume their usual activities (within 1-2 weeks for adults or 2-4 weeks for children and adolescents) require more active management.[22-24] This section outlines strategies for more detailed assessment and treatment initiation for nonexpert clinicians to consider for the second clinic visit and beyond. Appropriate early intervention can mitigate symptom chronicity.

Table 2 Return to play progression[22]

Stage	Aim	Activity	Goal of Each Step
1	Symptom-limited activity	Usual daily activities that do not provoke symptoms	Gradual reintroduction to school and work
2	Light aerobic exercise	Walking or stationary biking at slow to medium pace without resistance.	Increase heart rate
3	Sport-specific exercise	Aerobic exercises such as running, sprinting, skating. Sport-specific warm-up and light drills. No head impact activities	Increase motion
4	Noncontact training drills	More intense training drills. May start progressive resistance training and weight lifting	Assess coordination, fitness, and concentration
5	Full contact practice	Participate in normal training activities including scrimmaging	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play	

NOTE. There should be at least 24 h (or longer) for each step of the progression. If any symptoms worsen during exercise, the athlete should go back to the previous step.

Investigations

Most practice guidelines discourage postacute neuroimaging in a typically recovering patient.[24-26] However, it is reasonable to obtain an imaging study if symptoms are prolonged and are not improving over the course of weeks/months to rule out other contributors to the clinical presentation (eg, chronic subdural hematoma in an older adult).

Clinicians should check for treatable causes of persistent dizziness, vision problems, sleep disturbance, and fatigue. For example, patients with persistent dizziness can be assessed for benign paroxysmal positional vertigo with the Dix-Hallpike maneuver or supine roll test.[26,27,111] A screening ocular examination may identify impairments of saccades, smooth pursuit, convergence, or accommodation.[25,26,112] If fatigue does not improve with treatment of other symptoms, consideration should be given to alternative causes of fatigue (eg, adverse medication effects, sleep apnea, anemia, hypothyroidism), with limited investigations (eg, bloodwork for metabolic and electrolyte abnormalities) as needed.[27]

Any evaluation of a patient with persistent symptoms following mTBI should include screening for anxiety and depression[24,26,27,113] because mood symptoms are common after mTBI[18,114,115] and are among the most powerful predictors of prolonged recovery.[27,72] Brief standardized self-report measures such as the Generalized Anxiety Disorder—7[116] and Patient Health Questionnaire—9[117] can facilitate screening. The best available evidence suggests that the conventional cut-off scores on these measures (total score>10[118]) do not require modification for mTBI.[119] Measures such as the Mood and Feelings

Table 3 School accommodations[106,107]

Symptom	Manifestation	Possible Accommodations
Decreased attention/ poor concentration	Has trouble focusing during lessons and assignments.	Advise a lighter work load with shorter/ modified assignments. Provide written notes of lessons.
Trouble remembering	Struggles holding instructions in mind, retaining information, and accessing new concepts. Trouble with reading comprehension and math calculations.	Provide written instructions, shorter reading assignments, and offer smaller amounts of new material to learn.
Decreased processing speed	Struggles to keep up with work demands and processes information at a slower rate.	Provide increased time for tests and/or assignments.
Cognitive fatigue	Decreased arousal.	Provide breaks throughout day as needed.
Emotional symptoms (eg, anxiety or depression)	Increased social isolation or lack of interest in participating in usual activities (eg, sports, clubs).	Provide encouragement to engage in social activities at school and outside of school. Suggest an appointment with a school counselor.
Headaches	Interferes with ability to concentrate and perform school work.	Breaks as needed in a quiet environment.
Light or noise sensitivity	Symptoms may worsen with screen time or in loud environments.	Offer written assignments vs computer-based assignments. Avoid loud settings, such as cafeteria or assemblies.
Symptom sensitivity	Symptoms worsen with cognitive and/or physical exertion.	Reduce cognitive or physical demands by providing rest breaks and completing work in small sections (ie, working to a point that does not elicit symptoms).

Questionnaire[26] may be more appropriate for children. There is substantial overlap between mental health and post-mTBI symptoms. A positive screening test result should trigger a detailed psychiatric history and review of symptoms.

Persistent subjective cognitive symptoms are often not associated with objective cognitive impairments. They can occur in the context of preexisting neurodevelopmental problems (eg, attention-deficit/hyperactivity disorder or learning disability) or present health conditions (eg, depression, pain, substance misuse) that carry substantial cognitive burden.[22,23,28,74,120] Patients who have activity-limiting cognitive symptoms beyond 1 month after mTBI may benefit from neuropsychological assessment to identify treatment recommendations and/or work or school accommodations.[25,27]

Symptom management: general approach

Follow-up primary care should target specific symptoms.[24,27] Underlying this approach is an assumption that mTBI symptoms that persist past the acute period (2 weeks for adults and 4 weeks for school-aged children and adolescents) usually do not have a single etiology. Symptoms result from a complex interplay of biopsychosocial factors, many of which are not unique to mTBI. Two key principles guide treatment. First, treatment algorithms that have a substantial evidence base in primary medical or psychiatric disorders generally do not require modification to treat symptoms that occur after an mTBI.[24,27] Second, clinicians should prioritize the treatment of symptoms that are most amenable to intervention and most likely to bring about improvement in other symptoms. Priority symptoms in the subacute to chronic stage of mTBI recovery include headaches, insomnia, anxiety, and depression.[27]

Headaches

Posttraumatic headaches do not have a unique location pattern or character but instead mimic primary headache types such as migraine, tension, cervicogenic, and those with mixed features.[121,122] Early management should include avoidance of fasting (skipping meals) and maintaining adequate hydration. During the immediate postinjury period, acetaminophen may be preferred over aspirin and certain other nonsteroidal anti-inflammatory agents that confer a slightly increased risk of hemorrhagic stroke.[123] Consider prescription medications when headaches are refractory to lifestyle interventions and occasional over-the-counter analgesics. Medication choice should be based on the primary headache type that the posttraumatic headache most closely resembles.[24,27] Algorithms for managing posttraumatic headaches are available for children[26] and adults.[27] Note that opioids, in almost all cases, should be avoided.[24,27]

Medication overuse can perpetuate posttraumatic headache.[124] Excessive use of rescue pain medications (generally >10 days a month for opiates and triptans or >15 days a month for simple analgesics) for prolonged periods should be discouraged.[27] The clinician can initiate a prophylactic bridge (eg, topiramate) along with advice to taper use of rescue medication (see here[125,126] for taper algorithms) and keep a daily headache diary (link to example diary) before referring to a specialist for medication overuse headache.[126]

Sleep disturbance

Both hypersomnia and insomnia are common after mTBI. The goal of treatment is to normalize the sleep-wake cycle. Initial management of sleep disturbance should include environmental and behavioral modifications, such as setting a regular nighttime sleep schedule, limiting daytime naps, and avoiding foods or substances that may have a stimulating effect.[25-27] If sleep disturbances become persistent, cognitive behavioral therapy is an evidence-based treatment option for primary insomnia.[24,27,127,128] Sleep medications may help to normalize the sleep schedule but should only be used on a short-term basis while implementing behavioral strategies.[24,27] Commonly used medications include tricyclic antidepressants, trazodone, and melatonin. Benzodiazepines should be avoided.[24,27] Emergent obstructive sleep apnea, catalyzed by inactivity and weight gain after the injury, should be considered before treating insomnia in adults.

Psychological distress

Patients with severe depression or anxiety disorders should be referred to a mental health provider, but mild-moderate symptoms (eg, Generalized Anxiety Disorder−7 and Patient Health Questionnaire−9 screening scores both <15) can generally be managed within primary care.[26,27] Cognitive behavioral therapy and selective serotonin reuptake inhibitors are first line treatments for depression and anxiety disorders after mTBI.[24,26,27,129] Alternative medications such as serotonin-norepinephrine reuptake inhibitors, tricyclics, trazodone, or mirtazapine may be appropriate, particularly if treating concurrent symptoms such as sleep disturbance, headache, or bodily pain. Several of these agents have antiheadache properties, extending their usefulness. Benzodiazepines for anxiety should be avoided.[26,27] In general, treatment should be initiated as soon as a patient meets diagnostic criteria for a mental health disorder (eg, ≥2 weeks of persistent depressive symptoms for major depressive disorder), and effective pharmacotherapy should be maintained for at least 6 months before considering discontinuation.

Exercise as treatment

Physical activity has pan-domain beneficial effects. Following an initial brief period symptom subsidence, aerobic exercise at insufficient intensity and duration to provoke symptoms appears safe and therapeutic.[25,27,105,130] The preinjury activity level of the patient should be considered in making exercise recommendations, but the clinician could recommend 20 minutes of aerobic exercise 5-6 times a week, initially at light intensity (no more than [220−age]×0.7 heart beats per minute) and supervised (eg, by a physical therapist) and then at home.[131]

Referral to a specialty clinic

The majority of patients with mTBI can be managed effectively in primary care and need not be referred to a specialty clinic.[24] Referral to individual medical specialists or to a specialized multidisciplinary mTBI clinic is appropriate for patients with persistent symptoms (lasting more than 4-6 weeks) that do not respond to treatment in a primary care setting.[24-27] Earlier referral may be helpful when (1) patients have a high symptom burden or known risk factors for prolonged recovery, such as a preexisting mental health disorder,[76,81] (2) patients are unable to progress with their return to activity or are attempting to return to high-stakes roles soon after injury (eg, competitive sport or university examinations), or (3) access to care is limited (eg, long waitlist times). mTBI clinics should have access to a physician and a multidisciplinary team of licensed health professionals who provide coordinated, evidence-based care.[23] Interdisciplinary treatment may include vestibular, vision-oculomotor, behavioral health, and cognitive rehabilitation interventions[26,27,132-134] that are individually tailored to a patient's symptom profile.[21]

Patients with 1-2 specific symptoms may only require individual disciplines rather than referral to a multidisciplinary clinic. For example, patients with primarily vestibular symptoms should be referred to physical therapy or otolaryngology.[26] Musculoskeletal cervical complaints may respond to multifaceted physical therapy.[105]

Pediatric considerations

There is expert consensus that management of school-aged children and adolescents with mTBI should consider that (1) recovery time might be slower than adults,[102,135] (2) child-validated symptom rating scales and assessment tools, such as the Child SCAT5[109] are most appropriate, (3) return to activity advice to prevent reinjury should include nonsport play,[136] especially in unpredictable environments (eg, schoolyard), and (4) successful return to school (ie, symptom-free during school activities with no accommodations) should precede return to sport.[22,26]

Study limitations

Narrative reviews have important limitations. The clinical practice guidelines and consensus statements we drew from had already conducted systematic searches and critical appraisals of the available evidence. We therefore considered the risk of including recommendations that were not supported by evidence or expert consensus opinion to be low. However, it is possible that author bias resulted in an incomplete or imbalanced synthesis of management recommendations. The narrower list of recommendations in table 1 represents the clinical actions with the most consistent support across statements or guidelines, as determined by independent extractors.

Conclusions

Clinicians without a specialty practice in mTBI are increasingly involved in providing and coordinating care for patients with mTBI. Careful diagnostic assessment and proactive clinical management is essential to maximizing recovery. Patient education, return to activity guidance, and symptom-targeted treatment are pillars of mTBI management in primary care.

Keywords

Brain concussion; Brain injuries, traumatic; Practice guidelines as topic; Rehabilitation; Review

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