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Physical Therapy Recommendations for Service Members With Mild Traumatic Brain Injury

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Mild traumatic brain injuries (MTBIs) are of increasing concern in both the military and civilian populations as the potential long-term effects and costs of such injuries are being further recognized. Injuries from conflicts in Afghanistan and Iraq have increased public awareness and concern for TBI. The Proponency Office for Rehabilitation and Reintegration, Office of the Surgeon General, US Army tasked a team of physical and occupational therapists to assemble evidence-informed guidelines for assessment and intervention specific to MTBI. Given the paucity of specific guidelines for physical therapy related to MTBI, we focused on literature that dealt with the specific problem area or complaint of the Service member following MTBI. Recommendations, characterized as practice standards or practice options based on strength of evidence, are provided relative to patient/client education, activity intolerance, vestibular dysfunction, high-level balance dysfunction, posttraumatic headache, temporomandibular disorder, attention and dual-task performance deficits, and participation in exercise. While highlighting the need for additional research, this work can be considered a starting point and impetus for the development of evidence-based practice in physical therapy for our deserving Service members. **Keywords:** *mild traumatic brain injury*, *military personnel*, *physical therapy*, *practice guidelines*

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THE wars in Afghanistan and Iraq, Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF), have resulted in increasing numbers of military members who have survived blasts of explosive devices or other trauma, with varying degrees of traumatic brain injury (TBI) as a consequence.[1,2] The numbers of Afghanistan/Iraq veterans who have sustained a mild traumatic brain injury (MTBI) are estimates only. Clinician-confirmed TBIs reported to the Defense and Veterans Brain Injury Center (DVBIC) are approximately 48,000 as of summer 2009 (DVBIC data per the permission of Health Affairs, unpublished data September 19, 2009). The verification of this number is difficult, given that DVBIC has no way of capturing the number of Service members with MTBI who do not present for care. About 12% of 2235 respondents to a postal survey of military personnel following deployment to conflicts in Iraq or Afghanistan reported neurological symptoms consistent with MTBI.[3] Other estimates are that 20% of the approximately 1.6 million Service members who have been deployed, or more than 300,000 US veterans of these wars, have sustained a MTBI.[4] According to the preliminary findings of a TBI screening, 22.8% of soldiers in a brigade combat team ($n = 3973$) returning from Iraq had clinician-confirmed TBI.[5]

Mild traumatic brain injuries are of increasing concern in both the military and civilian populations as

the potential long-term effects and costs of such injuries are being further recognized.[4] To facilitate the highest quality care for warriors and their families, the Proponency Office for Rehabilitation and Reintegration (PR&R) was established in May 2007 at the Office of the Army Surgeon General for the purpose of advancing best practices, policy, and research related to the care of injured Service members. One initiative of the PR&R was to task a 5-member team of physical and occupational therapists (military and civilian) to critically review clinical care and rehabilitative research and to develop an evidence-informed Clinical Management Guidance of physical and occupational therapy assessment and intervention recommendations (OT/PT MTBI CMG) for wounded warriors with MTBI. The purpose of this article is to provide a summary of process of development and to share specific recommendations for PT practice with Service members who sustain MTBI. Occupational therapy recommendations have been published previously.[6]

METHODS

To identify best practices, the team of therapists reviewed existing MTBI-related, evidence-based reviews and guidelines,[7–9] contacted TBI centers for evidence-based protocols, reviewed literature related to physical and occupational therapy assessment and intervention of the commonly reported symptoms of acute MTBI and postconcussive syndrome (PCS), and convened a 1-day summit of multidisciplinary experts from military, Veterans Affairs, and civilian sectors to provide input on developing recommendations (November 2007). The 4-month project resulted in a draft document, titled *Clinical Practice Guidance: Occupational Therapy and Physical Therapy for Mild Traumatic Brain Injury* (January 1, 2008), that was updated in June 2009 (version 2) with the addition of guidelines[10,11] or pertinent research that had been released in the interim.

Specific literature on PT intervention for MTBI is limited. The sports concussion literature provides guidance on the immediate evaluation of concussion and a graded return to sport[12] that has been adapted to some extent for in-theater return-to-duty decision making.[8,11] To devise evidence-informed recommendations for PT assessments and interventions, we focused on literature that dealt with the specific problem area or complaint of the Service member. Examples include specific treatment of benign paroxysmal positional vertigo,[13] posttraumatic headache (PTH),[14] and balance deficits caused by unilateral vestibular hypofunction[15] that are common symptoms that co-occur with MTBI. Research is beginning on the use of PT assessments and interventions specifically with Service members with MTBI from OEF/OIF.[16] Additional information was culled from the assessment and intervention literature for persons with more severe TBI.[17,18]

Within each problem area, we provided background information based on available literature and then summarized practice recommendations for assessment and intervention. Given the paucity of specific literature to guide recommendations for Service members with MTBI, we chose to characterize recommendations as either a practice standard or a practice option along the lines of the work by Cicerone and colleagues.[19] Practice standards were supported by existing MTBI guidelines and/or published evidence-based reviews concerning the specific problem area.[10,14] Practice options did not have such support but were consistent with current theory, literature, and/or expert opinion. Whenever feasible, the work group followed the International Classification of Functioning, Disability, and Health (ICF) model and described problem areas in terms of body structure/body function, activity, or participation limitations. Therapists are encouraged to consider all levels of the ICF in assessing and intervening with Service members or civilians with MTBI. At this point, there are no global objective measures for what constitutes recovery from a MTBI; thus, the determination of fitness for return to duty or successful rehabilitation and reintegration into civilian life is a challenge.

The guidance documents were written to cover the environments of care to include battlefield, combat support hospitals, Landstuhl Regional Army Medical Center, inpatient military medical treatment facilities within the Continental United States (CONUS), outpatient care in military, Veterans Affairs, and civilian settings, and the lifetime care of Service members and veterans. This article omits information related to in-theater determination of a Service member's ability to return to duty. The reader is referred to the 6/09 Guidance document on acute management of MTBI[8] for information in this area.

In this article, we use the term *Service member* to include active duty, reservists, National Guard, and veterans in all branches of the military. The proposed audience for these OT/PT MTBI CMG recommendations is therapists at military medical treatment facilities, Veterans Administration hospitals and clinics, and any civilian therapists who are involved in the care of Service members or veterans. The information provided might also have a place in the care of civilians who sustain a MTBI as a result of sport, violence, motor vehicle accident, or other precipitating factor.

MTBI DEFINITION AND COURSE

Definitions of MTBI were reviewed for inclusion in the guidance documents. A number of definitions of MTBI exist, with no consistent consensus on the

TABLE 1 *Department of Defense definition of traumatic brain injury*

A traumatic brain injury is "...a traumatically induced structural injury and/or physiological disruption of brain function as a result of an external force that is indicated by new onset or worsening of at least one of the following clinical signs, immediately following the event:
- Any period of loss of or a decreased level of consciousness;
- Any loss of memory for events immediately before or after the injury;
- Any alteration in mental state at the time of injury (confusion, disorientation, slowed thinking, etc);
- Neurological deficits (weakness, loss of balance, change in vision, praxis, paresis/plegia, sensory loss, aphasia, etc) that may or may not be transient;
- Intracranial lesion."[24(p1)]

specifics of the diagnostic criteria[20–22] (Department of Defense [DOD]; released October 1, 2007). The most commonly used definitions of MTBI are similar, however, with variations in the duration of unconsciousness or length of posttraumatic amnesia.[23] For the CMG document, the updated definition by the DOD was selected (memorandum released on October 1, 2007) (Table 1).

The severity of TBI is stratified, with MTBI being further characterized as meeting 1 or more of the following criteria:
- loss of consciousness for 0 to 30 minutes;
- alteration of consciousness/mental state for a moment or up to 24 hours; and
- posttraumatic amnesia for less than 24 hours.

The use of the Glasgow Coma Scale is not included in the DOD definition, although other definitions include an initial Glasgow Coma Scale score of 13 to 15 in their description of MTBI.[20] One important point of this DOD endorsed definition of MTBI is that it does not require loss of consciousness to be classified as a TBI. The range for MTBI is from an injury involving a few seconds of confusion to a more extensive injury involving up to 30 minutes of unconsciousness and hours of posttraumatic amnesia. Rarely, following a MTBI is physical structural damage seen on computed tomographic scans or magnetic resonance imaging.[25] Some newer visualization techniques (functional magnetic resonance imaging, positron emission tomography scans, and diffusion tensor imaging) are showing promise in their ability to characterize the structural damage of MTBI.

Initial symptoms of MTBI often include headache, dizziness and balance issues, nausea and vomiting, sleep disturbances, sensitivity to noise and light, slowed thinking and reaction time, memory problems, irritability, depression, and visual changes.[23] The symptoms of MTBI are thought to result from the metabolic dysfunction of neuronal cells.[25] In MTBI, this cellular dysfunction is often reversible. Very mild injury may be completely and rapidly reversible, whereas more significant injuries may demonstrate slower but still complete recovery.[26] More severe trauma (moderate and severe TBI) with considerable force can result in permanent damage to cells and lead to cell death.

Concussion or MTBI (the terms are used as synonyms in this article) may go undiagnosed in the presence of more visible injuries from improvised explosive devices or other causes of blast injury. Some Service members with MTBI do not report symptoms until later in their medical care, or until after deployment. Mild traumatic brain injury may not be evident until after medical crises of severe concomitant injuries are resolved. Some Service members do not report their symptoms at the time of injury out of concern that their more severely injured comrades receive the focus of battlefield medical care or because of the stress of combat or the fear of being removed from their military unit. Some Service members do not recognize their deficits in the highly regimented daily life in a deployed setting. In their postdeployment screening study, Terrio and colleagues[5] reported that for some Service members, memory problems and irritability were first identified after the acute phase, possibly when they were faced with challenging novel tasks and/or feedback from loved ones.

The majority of patients who sustain a concussion/MTBI will have full-symptom resolution within days to weeks. In general, 80% to 90% of persons with concussion or MTBI fully recover, usually in less than 3 months.[27] Verbal and written educational information about MTBI symptoms (headache, difficulties with memory, and/or attention) and coping strategies, as well as reassurance of the expectation for full recovery, can help people understand their symptoms and reduce anxiety and other complaints.[28–30]

Another 10% to 20% of persons with MTBI do not recover within 3 months and may have PCS. This group, sometimes referred to as the "miserable minority" may continue to report symptoms for months to years.[27,31,32] The prolonged symptoms of PCS may include headaches, dizziness, depression, irritability, fatigue, and cognitive complaints. The etiology of the PCS is not clear. One explanation is that these people have sustained microscopic brain damage that is responsible (in part) for the physical, cognitive, and emotional sequelae of MTBI.[33] Others suggest that PCS is likely not a neurological condition stemming from MTBI.[34] Ruff[27] summarized the arguments regarding the etiology of PCS by saying postconcussive disorder can be caused by (1) neuropathology, (2) psychopathology, (3)

secondary gain in the form of consciously reduced effort or malingering, and (4) any combination thereof.

It has been argued that many of the symptoms attributed to MTBI may in fact result from posttraumatic stress disorder (PTSD) and that focus on MTBI may result in treatment that may be inappropriate.[2,35] While many symptoms (memory, attention, and concentration issues, irritability, and sleep disturbances) are common to both PTSD and MTBI, other symptoms are more often unique to one etiology over the other. The DVBIC working group in its Clinical Practice Guideline and Recommendations[8] on the acute management of MTBI in military operational settings provides a comparison of symptoms between MTBI and acute stress reaction/PTSD. Symptoms that typically distinguish MTBI include nausea and/or vomiting (at the time of incident), chronic headache, visual changes/disturbances, and balance and vestibular issues. Symptoms typically unique to acute stress reaction/PTSD include "flashbacks" and psychological distress with cues that symbolize the traumatic event. It is vital that therapists recognize that these diagnoses can coexist, especially in Service members who have sustained their injuries in OEF/OIF. Differences in the mechanisms and circumstances of MTBI sustained in combat settings, both physically and emotionally, are complicating recovery for many Service members.[2] As well, cumulative effects from multiple concussions sustained over several tours of duty may affect the frequency and severity of PCS.

A complex overlap of MTBI, depression, and PTSD may exist in a Service member who sustained injuries in a war zone. The OT/PT work group chose to focus our recommended assessments and interventions on specific symptom complaints, functional deficits, and activity restrictions that may be helped by physical therapist expertise. Once again, the importance of the interdisciplinary team and the physical therapist's knowledge of the appropriate time for referral are especially crucial in this population. With PT intervention to improve dizziness, headache, temporomandibular joint pain, or balance issues, a Service member may become more able to focus on and be receptive to interventions for PTSD or depression. The goal is to return the Service member to daily life activities and participation without limitations including an appropriate return to duty. Civilians with MTBI have similar goals of full activity and participation without limitations in civilian living.

PHYSICAL THERAPY PRACTICE RECOMMENDATIONS

Specific recommendations for PT assessment and intervention are made in the following areas:

- patient/client education;
- activity intolerance;
- vestibular dysfunction;
- high-level balance dysfunction;
- post traumatic headache;
- temporomandibular disorder (TMD);
- attention and dual-task performance deficits; and
- participation in exercise.

After a review of background information, we present the practice recommendations in Appendix Table 1 along with a notation on the strength of our recommendation as a practice standard or practice option and a notation on the ICF classification of the assessment/intervention area. Two areas are identified as belonging to the sphere of practice of any healthcare professional. One is a recommendation to measure long-term outcome involving a measure of participation. Since there is no existing specific measure of participation and reintegration into a military lifestyle, therapists are encouraged to use a global measure (such as a version of the 36-Item Short Form Health Survey) until a military participation measure is developed. In addition, a global recommendation is made for patient/client education that may be provided by any healthcare professional. Physical therapists play an important role in the delivery of this patient/Service member education about care and recovery following MTBI.

Patient/client education

Most experts recommend the early provision of verbal and written educational information about MTBI symptoms (headache, difficulties with memory and/or attention, etc), as well as reassurance that symptoms are likely to recover over a period of weeks or a few months.[27–30] Because military members may not identify MTBI symptoms until days to weeks to months after onset, physical therapists should be aware of the important reassuring effect of education about typical sequelae of MTBI and the time course (typically <3 months) of recovery. The PR&R has created a series of downloadable/printable MTBI-related patient education handouts that are available at their Web site (http://www.armymedicine.army.mil/prr/edtraining.html).

Activity intolerance

A slow progression for return to duty is recommended, similar to guidelines for return to play following sports concussion.[12] Rest is encouraged until symptom free and then a daily stepwise progression is followed. Intensity of activity should be decreased with any symptom return. Studies in rats suggest that exercise in the first 7 days after concussion is detrimental to the formation of neurotrophic factors and other molecules that enhance brain plasticity and improve cognitive status following brain injury.[36] Metabolic and physiologic changes in the brain postconcussion may worsen during physical or

cognitive exertion, with alterations in cerebral blood flow.[37] Exercise in the short-term postconcussive period may increase brain metabolic requirements at the specific time when brain metabolism is compromised. Certainly, the activity requirements of full combat duty can be of high intensity, given the heavy physical loads of rucksacks and safety equipment. Consideration should also be given to slowly progress exertion in general fitness programs or "working out" as may be undertaken by a Service member in-theater. Exercise programs provided by therapists for Service members with musculoskeletal injuries may require modification if MTBI is also identified.

Vestibular dysfunction

Dizziness is a common symptom in patients with MTBI or PCS,[38] often related to deficits in the vestibular system. Vestibular deficits that arise in conjunction with MTBI can have complex etiologies; therefore, treatment is individualized and made specific to current understanding of etiological origins, as much as possible. Vestibular damage caused by blast injuries is not yet fully understood (TBI Task Force Report).[39] The recommendations for the CMG presume damage similar to that resulting from MTBI in a civilian population, although this may not consistently be the case.[16,40]

Two types of vestibular dysfunction that can occur following a MTBI, benign paroxysmal positional vertigo of the posterior canal or lateral canal and unilateral vestibular hypofunction, were identified by the OT/PT workgroup and expert consultants as deficits that can be assessed and treated by a general practice PT in a war zone or stateside medical facility.[10,13] Episodic dizziness that is associated with migraine headache was also considered an appropriate diagnosis for intervention by a general practice therapist when circumstances require it. Service members who do not respond to initial treatment or those with other more complex etiologies such as perilymphatic fistula, bilateral vestibular hypofunction, and Ménière's disease, or other etiologies for dizziness complaints, should be referred for further specialty evaluation (an ear, nose, and throat physician or a neurologist who specializes in this area) and for treatment by therapists with specialized vestibular training.

High-level balance dysfunction

Impaired balance following concussion in sport is one of the signs used to restrict return to play for athletes[12] and has been recommended for use as a restrictive sign for return to duty for soldiers.[8] Persons with concussion or MTBI may complain of imbalance (postural instability) or unsteadiness during walking. Complaints of dizziness, vertigo, and blurred vision are common following damage to the peripheral vestibular system.[13] In this context, blurred vision can be caused by reduced gaze stability during head or body movement.

Multiple measures, both subjective and objective, of balance or postural instability are recommended for persons with dizziness and balance issues following MTBI.[13,41,42] Assessments of high-level mobility important for "participation" in leisure, sporting, and social activities[18] as well as a standardized measure of gait abilities[43–45] and gross strength[46] are recommended.

Patients with MTBI often complain of balance impairment and feelings of postural instability even when there is no evidence of a neurological deficit on a standard clinical examination. In such cases, computerized dynamic posturography may reveal abnormalities in postural responses to changing sensory conditions and perturbations that are not easily detected on clinical examination.[47] Given that the symptoms of imbalance or postural instability can strongly influence a person's quality of life, a measure of confidence in balance, and its impact on a person's life, is also important.[45,48–51]

Balance retraining programs improve symptoms in military personnel with dizziness associated with TBI.[50,52] Balance retraining programs should include progressively more challenging tasks and environments[42] including sports and martial arts activities to make them relevant for Service members. In addition, posturography platforms can be used in treatment situations to provide practice in adjusting to altered platform stability and sensory conditions.[52]

Furthermore, high-level balance dysfunction may be more evident after the Service member has been stressed by exercise or intense work. Therapists should be aware of the need to increase task challenges progressively and monitor perception of exertion accordingly.

Posttraumatic headache

Posttraumatic headache is defined as a headache that occurs within 1 week after regaining consciousness or within 1 week of head trauma.[53] Most headaches resolve within 6 to 12 months and are associated with cervical muscle tenderness and postural abnormalities. Lew et al[53] found that many patients with PTH presented clinically with symptoms similar to tension headache (37%), migraine (29%), and cluster headaches (6%–10%). The number of individuals who develop PTH following a MTBI usually ranges from 30% to 50%.[54] In a recent survey of army infantry soldiers, 3 to 4 months after return from a yearlong deployment in Iraq, about 30%, who had been injured with loss of consciousness, also described headache as a disability affecting their overall health.[2]

While the type and quality of headache may be different for a Service member exposed to blast injury,

a consistent means to assess level of pain and the functional impact of headache is recommended. Clinicians are encouraged to use a standardized approach for a musculoskeletal evaluation including that of the cervical spine. Neck pain, TMDs, and shoulder pain are common complaints reported in conjunction with MTBI, all of which contribute to PTH. Headache assessment includes both general measures of the frequency, severity, and limitations caused by headache pain and condition-specific measures that are used to determine the disability and its severity related to the neck, jaw, and headache.[55–58]

Pharmacologic treatment is common for headache, as is its use preventatively. This type of treatment is not typically within the scope of civilian PT practice but may be in the purview or responsibility of the military physical therapist. Physical therapy interventions with the strongest evidence in the treatment of PTH include a multimodal approach of specific training in exercise and postural retraining, stretching and ergonomic education, and manipulation and/or mobilization in combination with exercise.[14,59] Patient education regarding PTH and appropriate exercise program handouts are effective intervention techniques. Unique to headache is the inclusion of education regarding environmental triggers for headache.[60]

Temporomandibular disorders

Temporomandibular disorders as well as neck and shoulder pain complaints are commonly seen in conjunction with MTBI and may be contributing to the headaches.[61] Common symptoms of TMD can include ear pain and stuffiness, tinnitus, dizziness, neck pain, and headache. Common impairments found in persons with TMD include joint mobility restrictions, muscle length limitations, as well as postural limitations and neuromuscular deficits. These TMD complaints are also seen in the general population, so they may be a preexisting condition in Service members with MTBI. The prevalence of at least 1 sign of TMD is reported in 40% to 75% of adults in the United States.[62] While up to 40% of those who experience signs/symptoms of TMD show spontaneous resolution of their symptoms,[62] patients with posttraumatic TMD may differ to a small extent from those with nontraumatic disorders on reaction time testing, neuropsychological testing, and clinical testing of TMD.[63] A physical assessment of the temporomandibular joint and surrounding musculature as well as a measure of functional limitation brought on by TMD is recommended.[64–66]

No studies specifically address intervention for TMDs that occur as a result of MTBI. Systematic reviews suggest symptom management of TMD is best applied by a multimodal approach.[62,67–69] The majority of those with TMD respond to symptom management techniques and education, but for those who experience chronic pain, referral and collaboration with dentists and/or a multidisciplinary chronic pain center may be needed.

Attention and dual-task performance deficits

Persons with MTBI frequently complain of imbalance and unsteady or slow walking, which may become even more pronounced when they attempt to do more than 1 task at a time.[70,71] They may also report a problem with speed and/or accuracy when simultaneous tasks are attempted. These deficits may be particularly devastating for a deployed Service member in a war zone. Clinical measures that assess dual-task costs[72] involving relevant tasks are recommended. Intervention strategies should involve functional skills for balance, gait, and cognitive tasks[73,74] trained in progressively more challenging dual-task conditions.

Participation in exercise

Exercise may improve mood and aspects of health status in individuals with TBI.[75] Physical activity that results in increased cardiovascular fitness may improve cognitive status, including attentional control.[76] The effects of dizziness, imbalance, and overall fatigue may render it less likely that Service members post-MTBI will maintain their accustomed level of fitness. One role of physical therapists is to encourage active lifestyles and to provide recommendations for Service members whose injuries do not allow participation in previous fitness, sport, and leisure activities. It is important to assess Service members' current participation in aerobic and strengthening exercises, including specifically the frequency and duration of their participation. In addition, therapists should determine a Service member's ability to self-monitor exercise intensity. The American College of Sports Medicine and the American Heart Association have published updated guidelines on the frequency and duration of exercise for all healthy adults.[77]

SUMMARY

This article describes the PT recommendations of the *Clinical Practice Guidance: Occupational and Physical Therapy for Mild Traumatic Brain Injury* (draft version 2, June 2009), outlining evidence-informed PT assessment and intervention for Service members with MTBI. With this review, we hope to enhance the rehabilitation and reintegration of Service members and veterans returning from OEF/OIF and provide recommendations that may enhance the care of the more than 1 million Americans[22] who sustain a MTBI yearly. Service members not previously screened for MTBI may present to community-based healthcare systems and physical therapists in many settings may well be called upon to offer appropriate

care. With therapists' knowledge of rehabilitation teams, appropriate referral patterns, and best practice in PT, the quality of lives of these men and women will be enhanced.

To reiterate, with the exception of patient/client education, our work group found very little specific evidence for PT assessment and intervention for persons with MTBI, especially given the complexities of injury sustained in a war zone. We have summarized guidelines for the assessment of specific impairments that follow MTBI. Many of the recommendations for intervention are at best based on existing practice conventions, highlighting the need for extensive research. We hope this document can be an impetus for the enhancement of evidence-based practice for our deserving Service members. Further expansion of this work is in progress in the development of an OT/PT MTBI toolkit to summarize available evidence including the instructions for use of specific measurement tools and intervention techniques.

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Appendix

APPENDIX TABLE 1 *Physical therapy recommendations for Service members with mild traumatic brain injury*[a]

Area of Concern	Assessment Recommendations	Intervention Recommendations
∗ International Classification of Functioning, Disability, and Health + Strength of recommendation		

Need for education
∗ Activity and participation
+ Practice standard[30,78,79]
	No specific recommendations made for assessment of Service member's ability to receive educational information. May additionally need to educate comrades or family members.	*Educate about MTBI:*
		• Reassure about the usual time course for resolution of symptoms
		• Need for a graded return to activity
		• "Red flags" if acute (see DVBIC)[8,11]
		  • Any loss of consciousness
		  • Amnesia/memory problems
		  • Confusion
		  • Unusual behavior/combative
		  • Unequal pupils
		  • Seizures
		  • Repeated vomiting
		  • Double vision
		  • Worsening headache
		  • Weakness
		  • Cannot recognize people or disoriented to place
		  • Unsteady on feet
		  • Abnormal speech

Limited activity tolerance ∗ Activity and participation + Practice option	Use symptom reoccurrence, symptom checklists, and neurocognitive assessments to monitor tolerance to intervention[8,11]	• Use DVBIC guidelines[8,11] for acute management of MTBI • Advocate for early rest following MTBI, with slow return to activity • Athletic and risky activities resume only after symptoms resolve at rest and with physical exertion
Vestibular dysfunction ∗ Body structure/body function + Practice standard[10]	*To determine presence of BPPV use:* • 5-question subtest of DHI[80] • Dix-Hallpike Test (posterior SCC)[13] • Supine Roll Test (lateral SCC)[13] • Use full DHI if time allows *To identify UVH use:* • Dynamic visual acuity testing, computerized or clinical • Head-impulse testing • Dizziness Handicap Inventory (DHI)	*If posterior SCC BPPV:* • Canalith repositioning procedure[10] *If horizontal (lateral) SCC BPPV:* • Barbeque roll maneuver[10] *If UVH:* • Vestibular rehabilitation including gaze stability exercise and balance/gait activities[15] *If migraine-associated dizziness*[49,81]: • Vestibular rehabilitation including gaze stability exercises and balance/gait activities

(*continues*)

APPENDIX TABLE 1 *Physical therapy recommendations for Service members with mild traumatic brain injury*[a] (continued)

Area of Concern	Assessment recommendations	Intervention recommendations
	If medical diagnosis of migraine-associated dizziness: • Standard vestibular assessment, including DHI, and testing for BPPV and UVH[49] *If not responding to treatment or for complex patients:* • Refer for specialized testing and intervention	Plan for memory problems, so compliance worksheet or instruction of others may be necessary for exercise adherence.
High-level mobility skill limitations ∗ Body structure/body function and activity + Practice standard (if part of vestibular rehabilitation program, practice option for other imbalance)	*Serial standardized assessments used to track changes with intervention, consider:* • Simple Balance Test (Single Leg Stance,[82] Balance Error Scoring System,[83] etc) • High-level Mobility Assessment Tool[84,85] (HiMAT) • Gait velocity[43] • Functional Gait Assessment[45] • Computerized dynamic posturography[47] • Activity-specific Balance Confidence Scale[48] • Obstacle course, timed or errors • Five times Sit-to-Stand Test[46] *If complicated patient consider:* • Balance Evaluation Systems Test[86] (BESTest)	*If a balance or postural instability problem is identified, a progressive balance activity program is indicated:* • General strengthening and stretching • Habituation exercises • Exercise to promote vestibular compensation • Gaze stability exercises • Balance and gait training • Endurance training • Enhance use of sensory inputs for balance control • Training on dynamic posturography if available • Progressive skill challenges (head turns, varied terrain, carrying objects, and altered surface conditions) • Sports-specific skills training (run, obstacle course, train carrying loads, eye-hand coordination sports)
Posttraumatic headache ∗ Body structure/body function (if HA becomes chronic, it may include activity and participation) + Practice option[14]	*Use a standardized approach, including:* • Numeric or visual analog pain scale that assesses pain intensity and/or pain limitation within a consistent time frame. • Recording the number/type of headaches within a consistent time frame. • Recording the amount and type of headache-related medications under a standard context.	*Education of Service members with MTBI about:* • Dangers associated with taking over-the-counter medications *not* prescribed by medical personnel. • "Red flags" (see DVBIC)[8,11] • Triggers for headache (ie, caffeinated beverages, lack of sleep, stress, etc) *A multimodal approach to intervention is recommended to address physical deficits (including movement related disabilities, postural deficits and muscle tenderness) including*[14]: (*continues*)

APPENDIX TABLE 1 *Physical therapy recommendations for Service members with mild traumatic brain injury*[a] (continued)

Area of Concern	Assessment recommendations	Intervention recommendations
	Condition specific measures should be used to determine disability and severity of disability related to neck/jaw/headache including: • Neck Disability Index,[58,87] • Jaw Functional Limitation Scale,[65,88] and/or • Headache Disability Inventory.[56,89,90] *Serial assessment used to track patient reported changes with intervention* • Patient-specific Functional Limitation Scale[57]	• Self-care instruction • Stretching /strengthening exercise • Manual therapy • Application of therapeutic modalities
Temporomandibular Disorders (*TMD*) ∗ Body structure/body function + Practice standard	*Conduct a standard assessment of temporomandibular joint mechanics and symptom occurrence, consider using:* • Temporomandibular Index[64,66] *Condition-specific measures should be used to determine disability and severity of disability related to the jaw including:* • Jaw Functional Limitation Scale[65,88] *Serial assessment used to track patient reported changes with intervention:* • Patient-specific Functional Limitation Scale[57] *If specialized services are warranted:* • Refer to dental services when needed and if available	*Symptom management of TMD is best applied using a multimodal approach including*[67,68]: • Self-care instruction • Postural retraining • Stretching exercise • Manual therapy • Application of therapeutic modalities *As warranted:* • Referral and collaboration with dentists (occlusal splints, evaluation of intracranial sources of pain) and/or a multidisciplinary chronic pain center
Attention and dual-task performance deficits ∗ Activity and participation + Practice option[72]	*Consider a measure that includes dual-task performance:* • The Walking and Remembering Test[91] • Functional Gait Assessment[45] • Manual Timed Up and Go Test[92] *Use calculation of relative dual-task cost*[72] *under relevant single- and dual-task conditions*	Design individualized intervention strategies, begin with simple interventions and move to progressively more complex environments and progressively more difficult multitasking conditions. *Consider:* • Recreational sport activities involving multiple task performance such as: • Golf • Bowling • Tennis • Racquetball • Ping-pong

(*continues*)

APPENDIX TABLE 1 *Physical therapy recommendations for Service members with mild traumatic brain injury*[a] (continued)

Area of Concern	Assessment recommendations	Intervention recommendations
		• Dancing • Yoga • Tai chi • Critical common military tasks requiring accuracy and speed such as: • Packing a rucksack or parachute • Assembling a weapon • Donning/doffing a gas mask/suit while timed • Map reading while moving on uneven terrain
Participation in exercise ∗ Activity and participation + Practice option[77]	Use a survey or questionnaire with a Likert-type scale to determine the Service member's current level of participation in aerobic and strengthening exercises. *Assess Service member's ability to:* • Self-assess resting and exercise HR • Accurately use RPE scale to determine perception of exercise intensity *Screen for factors that may affect exercise prescription*	*Instruct Service member on:* • Frequency and duration of aerobic and strengthening exercise based on guidelines by the American College of Sports Medicine and the American Heart Association[77] while recognizing any person-specific limitations or residual MTBI-related symptoms. • Rationale for lifetime exercise • Means to monitor exercise frequency using logbook or calendar • Train in self-monitoring techniques for HR or RPE or provide information on metabolic equivalent of specific exercise types
Outcome assessment—participation ∗ Participation + Practice option	Long-term outcomes measuring participation provide information on individual patient and program evaluation outcomes. No recommendation for a specific evaluation of participation is made at this time, as no specific measure assesses reintegration into military lifestyle. *Consider:* • 36-Item Short Form Health Survey[93] • Community Integration Questionnaire	

Abbreviations: BPPV, benign paroxysmal positional vertigo; DHI, Dizziness Handicap Inventory; DVBIC, Defense and Veterans Brain Injury Center; HR, heart rate; MTBI, mild traumatic brain injury; RPE, rate of perceived exertion; SCC, semicircular canals; TMD, temporomandibular disorder; UVH, unilateral vestibular hypofunction.

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