

Assessment and Management of Visual Dysfunction Associated with Mild Traumatic Brain Injury

Introduction and Background

More than 253,000 traumatic brain injuries (TBI) have occurred in the military from 2000 through the second quarter of 2012¹. During the height of combat, the numbers of service members who sustained a TBI increased by approximately 10,000 per quarter² and the majority of these (80-85 percent) have been classified as mild TBI (mTBI). Although most patients with mTBI recover completely within three months of injury, a small subset of individuals experience persistent symptoms and difficulty in rehabilitation, particularly in the setting of co-occurring disorders.^{3, 4} Visual dysfunction is a common co-occurring disorder of mTBI and has a significant functional impact on the lives of affected service members and veterans.^{2, 3} Two of the most common forms of visual dysfunction following mTBI are oculomotor dysfunctions and visual field loss.^{4, 5, 6}

Visual dysfunction associated with mTBI can be the result of direct trauma to the eye and orbit as well as from neurologic injury following concussion, blast exposure or other head trauma. The human

visual system is highly complex and vulnerable at numerous points to concussive events. This clinical recommendation is intended to offer the medical primary care provider (PCP) an approach to identifying patients with mTBI who may benefit from further eye or vision evaluation and care, as well as recommendations on minimum vision testing. The recommendations are based on a review of current published literature as well as the proceedings of a February 2012 expert panel convened by the Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury (DCoE) and the Departments of Defense and Veterans Affairs' (VA) Vision Center of Excellence (VCE) that included clinical subject matter experts representing the military services, VA, DCoE, VCE and academia. This clinical practice recommendation was developed with the participation of representatives from VA and the Defense Department's TBI Quad Services Cell, which includes TBI representation from the Air Force, Army, Marine Corps and Navy.

Clinical Recommendation

This clinical recommendation is designed to assist providers in the diagnostic process. It provides pathways for specialty referrals for patients complaining of visual disturbances following mTBI. Included in this document is the clinical algorithm that addresses red and yellow flags, identifying comorbidities, basic visual assessment and referral options.

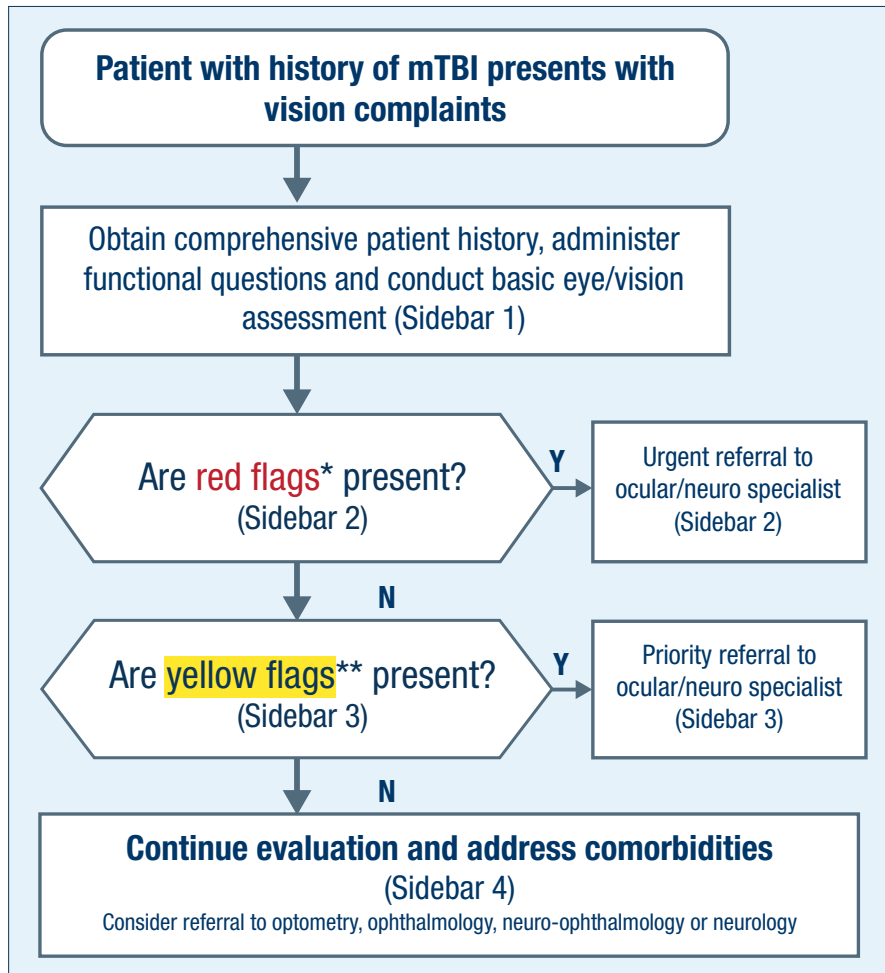
Physical Examination

A comprehensive primary care examination for complaints of visual disturbances should include a comprehensive patient history, a functional questionnaire/survey and a basic eye/vision assessment. Due to the nature of visual dysfunction and the complexity of comorbid conditions potentially involved, to fully assess the visual dysfunction the same diagnostic approach can be used regardless of the date of injury or onset of symptoms.

In the primary care setting, a patient presenting with a suspected concussion and vision complaints should be evaluated with a comprehensive history and appropriate screening physical examination as outlined in **Figure 1** on the following page.



Figure 1: Clinical Algorithm



***Red Flags:** Signs and symptoms of potential ocular, cranial nerve or structural brain injury which may cause sight and/or life threatening outcomes, thus requiring urgent referral or consultation.

****Yellow Flags:** Issues that require follow up. Common visual symptoms that may occur following concussion or blast exposure which may be related to trauma or premorbid/comorbid conditions.

Table 1 provides information related to concussion/mTBI history, specific visual symptoms, mechanism(s) and details of injury/exposure, associated injuries and comorbidities. Patients with visual defects are not always aware of changes in visual function.

Table 1: Comprehensive Patient History (Sidebar 1A)

Concussion/mTBI history*	
Specific visual symptoms and their clinical course	
Mechanism(s) and details of injury/potential exposure	<ul style="list-style-type: none"> ▪ Blast ▪ Blunt ▪ Penetrating ▪ Sports injury ▪ Damage to eye glasses/protective equipment
Associated injuries	<ul style="list-style-type: none"> ▪ Tympanic membrane rupture ▪ Facial laceration or fractures
Comorbidities	see Table 6

*See VA/DoD Clinical Practice Guidelines for Management of Concussion/mild TBI

Table 2 lists common functional vision questions such as difficulties or changes over time with reading, watching television, using the computer, etc., that the PCP can ask to assist the patient in identifying certain vision problems that may be interfering with patient's everyday activities.

Table 2: Functional Vision Questions to Consider (Sidebar 1B)

▪ “Have you experienced any change in vision?”
▪ “Do you ever experience blurred vision (far or near?)”
▪ “Do you ever experience double vision?”
▪ “Have you experienced any vision loss?”
▪ “Do you ever experience sensitivity to light or glare?”
▪ “Do you see equally with each eye?”
▪ “Do you experience problems with balance or dizziness?”***
▪ “Do you have difficulty maintaining clear vision for extended time periods?”
▪ “Do you have problems reading across a page or computer screen?”
▪ “Do you get a headache when reading or using a computer?”
▪ “Have you experienced any changes to visual habits such as cell phone/texting use, driving, video games, etc?”
▪ “Do you see better if you tilt or turn your head?”
▪ “When do you notice visual problems?”
▪ “What were you doing when you noticed the visual problem?”

**See DCoE Clinical Recommendation for the Assessment and Management of Dizziness Associated with Mild TBI

Table 3 outlines a basic eye/vision assessment, which includes an external orbit and eye exam, visual acuity, monocular confrontation fields, pupils, eye movements and nystagmus evaluations. A slit lamp exam (biomicroscopy), if available, is recommended.

Table 3: Basic Eye/Vision Assessment (Sidebar 1C)

Basic Eye/Vision Assessment*	
Visual acuity	<ul style="list-style-type: none"> Distance (right, left, together) Near card (right, left, together)
Monocular confrontation fields	<ul style="list-style-type: none"> Four quadrant finger counting (each eye)
Pupils	<ul style="list-style-type: none"> Size/equality Direct response to light Swinging flashlight test
Eye movements	<ul style="list-style-type: none"> Eye tracking (horizontal and vertical)
Nystagmus	<ul style="list-style-type: none"> Primary position Gaze evoked
External exam	<ul style="list-style-type: none"> Inspection Consider lid eversion for foreign body sensation Direct illumination of anterior segment
Slit lamp exam	If available

*Optional PCP Oculomotor Dysfunction Assessment

Test	Result	Referral
Letter test at distance monocularly	Difficulty reading letters at 20/40 level	Optometry/ Ophthalmology
Cover/uncover test	Eye movement observed or patient reports target movement (vertical or diagonal only)	
Near letter test** monocularly	Difficulty reading letters at 20/40 level	
Near letter test** binocularly	Difficulty reading letters at 20/40 level or monocular performance better than binocular	

** Perform near letter test at the standard distance of 40 cm (16 in) and consider moving the target up to 20 cm (8 in) to evaluate accommodative amplitude on patients under age 40

Initial assessment includes evaluation for clinical red flags, i.e., signs and symptoms of potential ocular, cranial nerve or structural brain injury which may cause sight and/or life threatening outcomes or conditions, and require urgent referral to another specialty. **Table 4** lists red flags that would necessitate urgent referral in cases of monocular or binocular vision loss or decline, diplopia, abnormal pupils, abnormal external eye exam, abnormal visual behavior to include eye movements, acute ocular symptoms such as severe eye pain, flashes and/or floaters, severe photophobia or other evidence of trauma. Factors to consider in determining urgency of referral will include clinical progression or stability and severity of signs and symptoms, as well as the presence of significant associated conditions and comorbidities. Facility and community capabilities will impact the optimal referral decision for a particular patient, such as whether to refer to neurology, neurosurgery, maxillofacial surgery, optometry, ophthalmology and/or neuro-ophthalmology.

Table 4: Red Flags and Referral to Specialist (Sidebar 2)

Red Flag	Specific Red Flags	Referral (Facility-specific)
Vision loss or decline	<ul style="list-style-type: none"> ▪ Monocular/binocular ▪ Field loss/scotomas ▪ Transient 	Ophthalmology/Optometry
Diplopia	<ul style="list-style-type: none"> ▪ Double vision 	Ophthalmology/Neurology/Optometry/ Neuro-ophthalmology
Abnormal pupils	<ul style="list-style-type: none"> ▪ Anisocoria (non-physiologic) ▪ Afferent pupillary defect ▪ Impaired reactivity ▪ Irregular shape 	Ophthalmology/Neurology/Optometry/ Neuro-ophthalmology
Abnormal external exam	<ul style="list-style-type: none"> ▪ Ptosis ▪ Proptosis ▪ Subconjunctival hemorrhage ▪ Hyphema ▪ Foreign body 	Ophthalmology/Optometry
Trauma	<ul style="list-style-type: none"> ▪ Ocular (including eyelid) ▪ Facial ▪ Polytrauma/moderate-severe TBI 	Neurosurgery/Ophthalmology/Oral Surgery/Maxillofacial (Plastic) Surgery/ Otolaryngology/Optometry
Abnormal eye movements	<ul style="list-style-type: none"> ▪ Restricted gaze ▪ Uncoupled eye movements ▪ Nystagmus 	Ophthalmology/Neurology/Optometry/ Neuro-ophthalmology
Abnormal visual behavior	<ul style="list-style-type: none"> ▪ Bumping into things ▪ Lack of visual recognition 	Ophthalmology/Neurology/Optometry
Acute ocular symptoms	<ul style="list-style-type: none"> ▪ Severe eye pain ▪ Flashes and/or floaters ▪ Severe photophobia 	Ophthalmology/Optometry

The PCP evaluation continues with screening for clinical yellow flags listed in **Table 5** that would require a specialty referral but not in an urgent manner. The referral may also depend on availability of services in the facility. A priority referral to optometry, ophthalmology, neurology or neuro-ophthalmology is recommended in these cases. Again, facility and community capabilities will determine the optimal referral pathway for the PCP.

Table 5: Yellow Flags and Referral to Specialist (Sidebar 3)

Yellow Flag	Specific Yellow Flags	Referral (Facility-specific)
Visual dysfunction	<ul style="list-style-type: none"> ▪ Eyestrain, blurred vision, difficulty focusing, ocular fatigue, difficulty reading, impaired depth perception ▪ Problem with sustained vision tasks ▪ Photophobia without associated headache ▪ Color deficit 	Optometry/Ophthalmology
Neurologic symptoms	<ul style="list-style-type: none"> ▪ Uncontrolled headache with photophobia ▪ Dizziness/vertigo ▪ Visual neglect (right- or left-sided) 	Neurology/Neuro-ophthalmology
Physical exam finding	<ul style="list-style-type: none"> ▪ Abnormal head posture/eye alignment or head turn (possibly compensating for visual problems) 	Optometry/Ophthalmology/ Neurology/Neuro-ophthalmology

Assessment of Comorbid Conditions

Although most service members recover fully from mild TBI/concussion, multiple comorbidities may persist.⁷ The PCPs should be aware of and continue to evaluate the patient for comorbid conditions following mTBI. Worsening symptoms over time may also be considered a red flag. If, over time, a vision problem is still suspected, a referral may be necessary to optometry, ophthalmology, neuro-ophthalmology and/or neurology. Certain comorbidities listed in **Table 6** may also be the cause or result of visual dysfunction. A list of the patient’s current medication should also be evaluated as that may play a role in the symptomatology for visual dysfunctions.⁸ Therefore, in addition to being addressed during the patient history, it is important to re-address comorbidities and prescribed medications that may contribute to vision problems. Examples of most common drugs associated with vision problems include antihistamines, anticholinergics, digitalis derivatives, antimalarial drugs, corticosteroids, erectile dysfunction drugs, phenothiazines, thiorazine, indomethacin and many others. Providers should consult professional drug information from the U.S. Food and Drug Administration.

Table 6: Continued Evaluation and Comorbidities (Sidebar 4)

Comorbidities	<ul style="list-style-type: none"> ▪ Migraine ▪ Sleep disturbance ▪ Chronic pain ▪ Additional injuries/illnesses ▪ Medication side effects/drug interactions ▪ Mood disorders ▪ Posttraumatic stress disorder (PTSD)
Medications	Evaluate

Additional Information

In many military settings, the highest level of eye care specialist available within a desirable timeframe will be a general ophthalmologist or optometrist. The Army Office of the Surgeon General has developed a provider manual “Managing Vision Disorders after Traumatic Brain Injury: A Guide for Military Optometrists.”⁹

The testing procedures outlined below provide a comprehensive framework and set of tools for the eye care provider to thoroughly assess a patient with oculomotor dysfunction. Using testing procedures contained in this manual as a guide, it is recommended that mTBI functional vision exams be performed by eye care providers as outlined below in **Table 7**.

Table 7: Suggested Minimum Testing for Visual Dysfunction Screening by an Eye Care Provider (Optometrist/Ophthalmologist)

Oculomotor Parameter	Minimum Testing	Auxiliary Testing
Eye alignment	<ul style="list-style-type: none"> Cover/uncover test 	<ul style="list-style-type: none"> Modified Thorington test
AC/A Ratio*	<ul style="list-style-type: none"> Cover test at distance and near (unilateral and alternate) 	<ul style="list-style-type: none"> Modified Thorington test
Fusional vergence	<ul style="list-style-type: none"> Step vergence testing Vergence facility testing 	
Convergence amplitude	<ul style="list-style-type: none"> Near point of convergence 	<ul style="list-style-type: none"> Repeated measures
Accommodative amplitude	<ul style="list-style-type: none"> Push-up method 	<ul style="list-style-type: none"> Push-away Minus lens test Repeated measures
Accommodative facility	<ul style="list-style-type: none"> Monocular accommodative facility 	
Eye movements	<ul style="list-style-type: none"> Developmental eye movement test (DEM) 	<ul style="list-style-type: none"> Readalyzer Visagraph
Binocular vision	<ul style="list-style-type: none"> Stereopsis Suppression 	

*AC/A Ratio = accommodative convergence/accommodation ratio

Conclusion

This clinical recommendation is based on a review of the literature and consensus of expert opinion. It is intended to provide an algorithmic approach with procedural recommendations pertaining to the screening and referral processes for patients with possible visual dysfunction. These recommendations are not a substitute for existing guidance or clinical judgment. It includes recommendations for functional questions and basic assessment procedures a PCP can use to screen for visual dysfunction. Distinctions are made between red and yellow flags that indicate whether a referral is considered “urgent” or a “priority.” The algorithm also provides recommendations for continued management and care for ongoing comorbidities and continued symptoms of visual dysfunction following mTBI. Furthermore, it also includes recommendations for minimum testing procedures to assist the PCP and eye care provider in screening and definitively diagnosing visual dysfunctions that may be the result of or aggravated by mTBI. As with all clinical decisions, field and operational circumstances may at times require deviation from these recommendations.

References

1. Defense Medical Surveillance System and the Theater Medical Data Store (DMSS-TMDS). (2012). Prepared by the Armed Forces Health Surveillance Center. www.dvbic.org/dod-worldwide-numbers-tbi
2. Dougherty, A. L., MacGregor, A. J., Han, P. P., Heltemes, K. J., & Galameau, M. R. (2011). Visual dysfunction following blast-related traumatic brain injury from the battlefield. *Brain Injury*, 25(1), 8-13. doi:10.3109/02699052.2010.536195
3. Stelmack, J. A., Frith, T., Van Koeveering, D., Rinne, S., & Stelmack, T. R. (2009). Visual function in patients followed at a Veterans Affairs Polytrauma Network site: An electronic medical record review. *Optometry*, 80(8), 419-424.
4. Kapoor, N., & Ciuffreda K. J. (2011). Vision problems. In J. M. Silver, T. W. MacAllister, & S. C. Yudofsky (Eds.), *Textbook of traumatic brain injury* (pp. 363-373). (2nd ed.). Arlington, VA: American Psychiatric Publishing.
5. Brahm, K. D., Wilgenburg, H. M., Kirby, J., Ingalla, S., Chang, C.-Y., & Goodrich, G. L. (2009). Visual impairment and dysfunction in combat-injured servicemembers with traumatic brain injury. *Optometry and Vision Science*, 86(7), 817-825.
6. Cockerham, G. C., Goodrich, G. L., Weichel, E. D., Orcutt, J. C., Rizzo, J. F., Bower, K. S., et al. (2009). Eye and visual function in traumatic brain injury. *Journal of Rehabilitation Research and Development*, 46(6), 811-818.
7. Terrio, H., Brenner, L. A., Ivins, B. J., Cho, J. M., Helmick, K., Schwab, K., et al. (2009). Traumatic brain injury screening: Preliminary findings in a US Army brigade combat team. *The Journal of Head Trauma Rehabilitation*, 24(1), 14-23. doi:10.1097/HTR.0b013e31819581d8
8. Han, M.H., Craig S.B., Rutner D., et al. (2008). Medications prescribed to brain injury patients: a retrospective analysis. *Optometry* 79, 252-258.
9. Scheiman, M. (2011). *Understanding and managing vision disorders after traumatic brain injury: A guide for military optometrists*. Office of the Surgeon General. Washington, DC.