

# Visual Dysfunctions and Traumatic Brain Injury

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# Poll question

## Choose one answer



- Which occupational area best describes your TBI-related practice?
  - Primary Care
  - Physical Medicine
  - PT/OT
  - Eye Care
  - Vision Rehabilitation

# TBI Statistics



- In 2014,<sup>1</sup> about 2.87 million TBI-related emergency department (ED) visits, hospitalizations, and deaths occurred in the United States
- From 2006 to 2014, the number of TBI-related emergency department visits, hospitalizations, and deaths increased by 53%.

<sup>1</sup> Centers for Disease Control and Prevention (2019). Surveillance Report of Traumatic Brain Injury-related Emergency Department Visits, Hospitalizations, and Deaths—United States, 2014. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services.

# DoD TBI Totals Worldwide 2000-2018



## DoD Numbers for Traumatic Brain Injury Worldwide – Totals

2000 - 2018 Q1

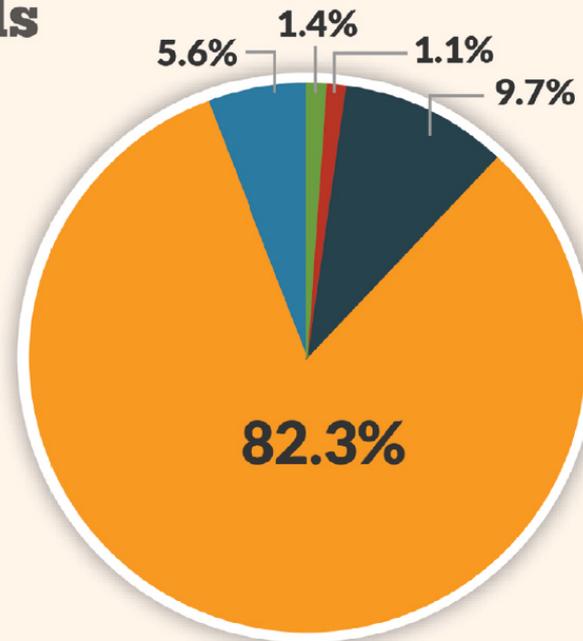
Penetrating	5,215
Severe	4,067
Moderate	37,424
Mild	315,897
Not Classifiable	21,344

**Total - All Severities 383,947**

Source: Defense Medical Surveillance System (DMSS), Theater Medical Data Store (TMDS) provided by the Armed Forces Health Surveillance Center (AFHSB)

Prepared by the Defense and Veterans Brain Injury Center (DVBIC)

*\*Percentages do not add up to 100% due to rounding*



2000 - 2018 Q1, as of June 21, 2018

<https://dvbic.dcoe.mil/dod-worldwide-numbers-tbi>

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## **Visual Deficits and Dysfunctions Associated with Traumatic Brain Injury: A Systematic Review and Meta-Analysis**

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Optom Vis Sci. 2019 Aug;96(8):542-555

# Objectives



To conduct a systematic review and meta-analysis to determine the prevalence rates of accommodative dysfunction, convergence insufficiency, visual field loss, and visual acuity loss in TBI patients without concomitant eye injury.

# Literature Review vs Systematic Review



Literature Review	Systematic Review
Study question can be general and not well defined	Study question is well defined and focused
Publications are searched randomly, “pick and choose” approach; using only few databases	Publications are searched using established methodology; using several large databases
Papers are reviewed without any procedural restrictions	Publications are reviewed using an established procedure; strict inclusion and exclusion criteria are applied; two or more researchers to establish inter-rater reliability
A writer gives a subjective interpretation of the data	Data is analyzed using referenced methodology; the bias, strength of evidence, etc. are considered in the analysis



# Meta-Analysis



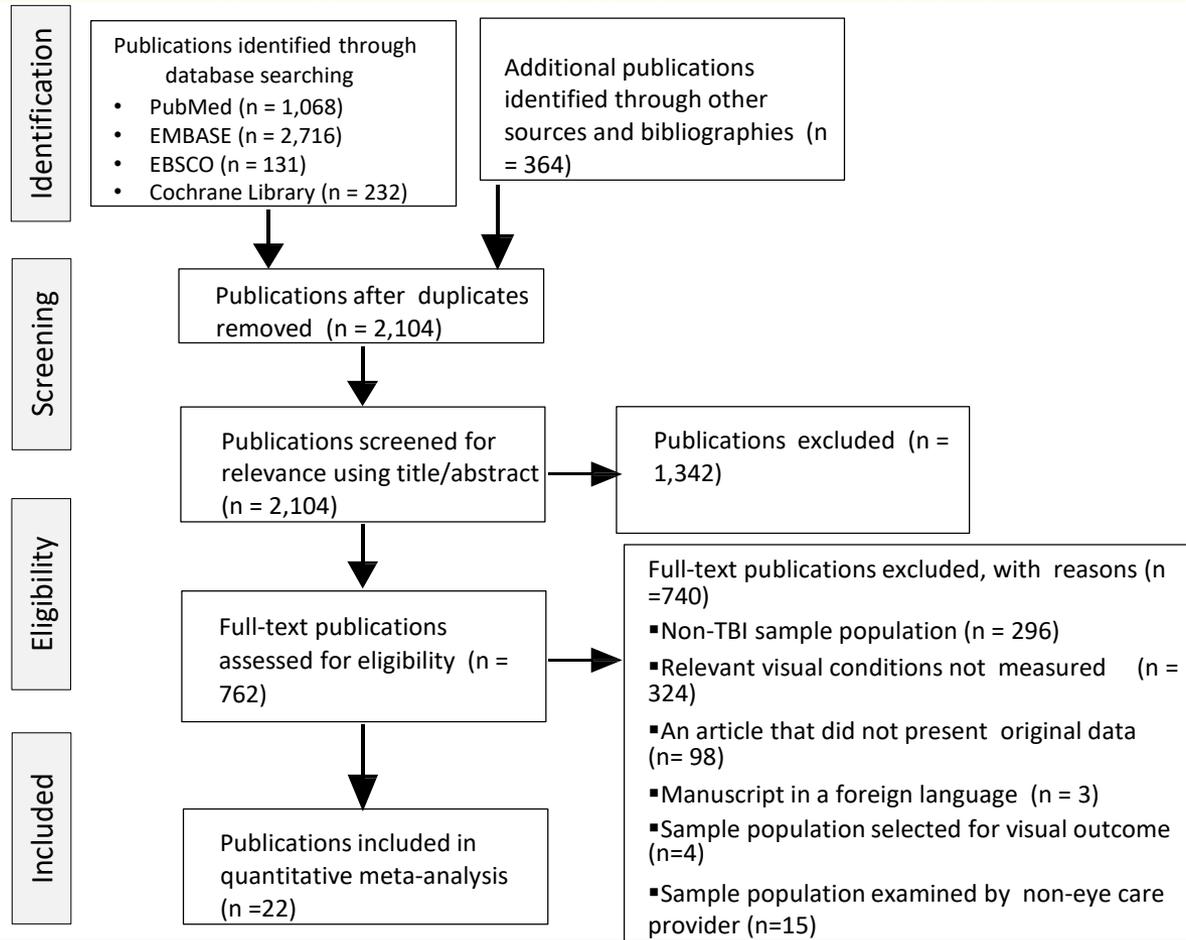
- Meta-analysis is a set of techniques used “to combine the results of a number of different reports into one report to create a single, more precise estimate of an effect” (Ferrer, 1998). The aims of meta-analysis are “to increase statistical power; to deal with controversy when individual studies disagree; to improve estimates of size of effect, and to answer new questions not previously posed in component studies” (Hunter and Schmidt, 1990)

# Inclusion and Exclusion Criteria



Inclusion Criteria	Exclusion criteria
TBI diagnosis by a trained medical professional	Single case designs
Screening/diagnostic testing for visual dysfunctions by an eye care provider	The sample population artificially selected for one of the visual outcomes
Published in English in a peer-reviewed journal with full text available	The sample population previously diagnosed with a chronic (or other) eye condition
Accommodation was measured in non-presbyopic TBI populations	Brain injury unrelated to trauma
	TBI and/or visual outcomes were self-reported or otherwise not clinically diagnosed

# Flow diagram of the systematic literature search process according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)



# Statistical Analysis



- All statistical analyses were conducted using R statistical software (3.4.2) and its 'meta' and 'metafor' package.
- Prevalence rates were calculated by dividing the number of individuals with TBI diagnosed with the visual outcome by the total number of individuals diagnosed with TBI.
- Subgroup analysis was performed for four moderators: (1) study design (prospective versus retrospective) (2) TBI severity (3) diagnostic criteria and (4) Risk of Bias (RoB)

# Prevalence of Visual Dysfunctions in TBI Patients



Visual dysfunction	Accommodative Dysfunction	Convergence Insufficiency	Visual Field Loss	Visual Acuity
Total patient count	1,271	2,140	2, 106	1,333
Prevalence 95% CI	<b>42.85%</b> 31.1-54.7	<b>36.3%</b> 28.2 – 44.9	<b>18.2%</b> 10.6 – 27.1	<b>0%</b> 0.0 – 1.1
Heterogeneity, <sup>1,2</sup>	91.35%	89.94%	92.67%	62.2%
Prevalence, no TBI control (lit.)	5.8% – 32.4%	4.2% – 31.4%	0% - 3%	<1%

# Prevalence of Visual Field Loss in Moderate-to-Severe TBI Compared to Mild TBI



TBI Severity	Moderate to Severe TBI	Mild TBI
Prevalence 95% CI	<b>39.8%</b> 29.8 – 50.3	<b>6.6%</b> 6.9 – 34.2

- The prevalence of accommodative dysfunction and convergence insufficiency did not differ in patients with moderate-to-severe compared to mild TBI
- Only one study of moderate-to-severe TBI data was available for accommodative dysfunction

# Other Moderating Variables and Their Relationship with Visual Outcome Prevalence



- In addition to TBI severity, the studies were evaluated on the association of the prevalence rates with RoB, diagnostic criteria, and study design (prospective versus retrospective)
- No singular factor accounted for a statistically significant portion of the heterogeneity
- The screening/diagnostic criteria for the visual dysfunctions varied significantly between different studies (e.g. diagnostic cut offs for the NPC varied from 6-12.7 cm)
- Many studies had incomplete data on the demographics, TBI severity, mechanism of injury, etc.



# Conclusions



- Accommodative dysfunction and convergence insufficiency are the most prevalent of the four visual outcomes examined in this study, followed by the visual field loss.
- The relatively low prevalence of visual acuity loss due to neurologic consequences of TBI and in the absence of eye injury suggests that the test for visual acuity, the most commonly performed measure of the visual system, is an insufficient stand-alone surrogate for overall visual health.
- Heterogeneity was one of the major limitations of this study with no one single factor but rather a combination of several factors responsible for it.
- A carefully constructed prospective trial with a large sample and consistent evaluation techniques will have a tremendous impact on the field and will address the various limitations outlined above.

# Poll question

## Choose one answer



- What is your knowledge and skill level regarding post-TBI eye/vision-related effects?
  - Exclusively
  - Heavily
  - Occasionally
  - Rarely
  - Never



# Clinical Impact- Near Distance Visual Dysfunctions

- Accommodation and Convergence are frequently affected after TBI of any severity and have the potential to affect reading and other near visual tasks
  - ❑ Accommodative Dysfunction (AD) affects focusing to reading and other near target distances.
  - ❑ Convergence Insufficiency (CI) reduces the ability to turn the eyes inwardly to near (reading) distances, thus affecting ability to maintain single vision at near.



<https://www.dvidshub.net/image/5576874/usns-comfort-crew-treats-patients-peru-medical-sites>

# Symptoms of Near Visual Dysfunctions

- Visual blurring at near visual distances
- Doubling of vision at near visual distances
- Losing your place while reading
- Inability to sustain reading and other near visual tasks
- Sensitivity to light



<https://www.dvidshub.net/search/?q=5737568&view=grid>

# TBI-related Visual Dysfunctions Can Affect Rehabilitation and Reintegration



- Because visual acuity is usually normal after TBI, patients may often be unaware of visual dysfunctions and attribute difficulties with reading and other symptoms to co-morbid conditions, such as PTSD, or psychosocial factors.
- Referral to an Eye Care Provider can help manage these problems using:
  - Lenses
  - Prisms
  - Visual Rehabilitation

# Visual Field Defects After TBI

- Less frequent than Accommodation and Convergence Problems
- More common with increasing TBI Severity
- Reading and mobility symptoms
- Requires Neurological Assessment/management
- Requires specific rehabilitation



<https://www.dvidshub.net/image/884840/warfighter-eye-center>

# Other TBI-Associated Oculomotor Dysfunctions

- Smooth Pursuit Dysfunction
- Saccadic Dysfunction
- Muscle Paresis
- Heterophoria
  - Lateral
  - Vertical



<https://www.dvidshub.net/image/1744212/scott-air-force-base-optometry>

# Ask About and Look for Ocular Trauma

- TBI can be associated with eye trauma that is not realized by the patient.
- Vision Acuity may be normal
- The injury may be occult and may pre-dispose the patient to future vision loss
- Referral to eye care may be important
- Iridodialysis (iris disinsertion) due to eye trauma predisposes the individual to future glaucoma



Source: Won I. Kim, MD COL MC USA

# Summary



- TBI is commonly associated with Accommodative and/or Convergence problems that may affect rehabilitation and reintegration
- History of reading problems, especially sustained reading, is common
- Visual Acuity is not a good screen since it is often normal.
- Visual field defects are also common
- Saccadic/pursuit eye movements can be affected
- Eye muscle paralysis can occur
- Both frank and occult eye injuries may occur
- Referral to Eye Care is important
- Referral by eye care providers to TBI care providers is important for patients with these vision conditions who may have experienced TBI but may not have been fully worked up



# VCE Clinical Recommendations



- CR for the Eye Care Provider Eye and Vision Care Following Blast Exposure and/or Possible TBI
- CR for the Eye Care Provider Assessment and Management of Oculomotor Dysfunctions Associated with TBI
- CR for the Eye Care Provider Rehabilitation of Patients with Visual Field Loss Associated with Traumatic or Acquired Brain Injury

**CLINICAL RECOMMENDATION FOR THE EYE CARE PROVIDER ASSESSMENT AND MANAGEMENT OF OCULOMOTOR DYSFUNCTIONS ASSOCIATED WITH TRAUMATIC BRAIN INJURY**

**Introduction and Background**  
Several types of visual dysfunctions are common consequences of traumatic brain injury (TBI).<sup>1</sup> Blast injury, generating injuries and blunt trauma may result in structural damage to the eye, or lesions or swelling in the brain that can interfere with visual pathways. These injuries can lead to visual disturbances that can have a significant functional impact on the lives of Service members and Veterans.<sup>2</sup> Between 2000 and Q1 of 2016, over 347,062 TBIs were diagnosed in U.S. forces, with nearly 83 percent categorized as mild TBIs (mTBI).<sup>3</sup> To improve the treatment of Service members and Veterans and to help identify patients who may benefit from rehabilitation, it is important to increase awareness of all aspects of visual dysfunction associated with TBI. One of the most common forms of visual dysfunction following mTBI is oculomotor dysfunction.

**Clinical Recommendation**  
This clinical recommendation is designed to help guide the assessment, management and rehabilitation of patients with oculomotor dysfunction associated with TBI. It assumes a comprehensive exam including an ocular health, visual evoked refractometry and/or dry eye test performed by an optometrist or ophthalmologist.<sup>4</sup> These recommendations include what can assess and detect the most common oculomotor dysfunctions associated with TBI. Rehabilitation procedures also included in order to provide guidance for treatment.

**Overview of Evaluation and Rehabilitation of Oculomotor Dysfunction**  
The algorithm displayed in Figure 1 outlines the clinical decision points in the eye care provider's assessment for patients with oculomotor dysfunction procedures. While well-established rehabilitation procedures exist for oculomotor dysfunction and techniques that represent specific procedures for the TBI population,<sup>5</sup> this recommendation was reviewed by a board of experts and includes tests and procedures for assessment, evaluation, referral and rehabilitation consistent with current practices for the assessment with current practices for the assessment.

**Disclaimer:** This recommendation and the associated clinical applications are not intended to constitute a standard practice when caring for a patient.

**Water Read National Military Medical Center**  
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Revised Date: 13 December 2015

**CLINICAL RECOMMENDATION FOR THE EYE CARE PROVIDER EYE AND VISION CARE FOLLOWING BLAST EXPOSURE AND/OR POSSIBLE TRAUMATIC BRAIN INJURY**

**Introduction and Background**  
The use of explosive devices is a common method of attack in military conflicts and can result in complex injuries to these involved. Blast waves, shrapnel and blunt force can result in structural damage to the eye itself and cause lesions or swelling in the brain that may interfere with vision.<sup>1,2</sup> Over 307,283 new cases of traumatic brain injury (TBI) have been reported in U.S. forces from 2000 through 2014 Q2.<sup>3</sup> Data suggest that as many as 75 percent of patients experiencing a TBI may also have associated visual dysfunctions, with additional cases of eye injuries caused by blast exposure.<sup>4</sup> The resulting visual dysfunctions can have a significant functional impact on the lives of Service members and Veterans.<sup>5,6</sup> To improve patient outcomes, it is important to increase awareness and establish recommendations for the management of eye injuries and visual dysfunctions associated with TBI and blast exposure.

**Clinical Recommendation**  
This clinical recommendation is designed to help guide eye care providers (optometrists and ophthalmologists) treat patients with eye and vision problems following a possible TBI or blast exposure. The recommendations include tests to help eye care providers screen and assess for the most common ocular injuries as well as visual dysfunctions caused by, or associated with TBI. Management, rehabilitation and referral considerations are also provided for specific medical conditions and TBI-related visual dysfunctions. These recommendations should not replace sound clinical judgment or standard practice when caring for a patient.

**Summary of Algorithm of Care**  
The "Algorithm for Eye and Vision Care Following Blast Exposure and/or Possible TBI" (Figure 1) is intended to assist eye care providers evaluate, manage and refer patients presenting with eye or vision problems following a possible TBI or blast exposure. The process begins when a Service member or Veteran presents to an eye care provider as the result of a self-referral or referral from another provider. The algorithm includes recommended eye and vision tests for a basic exam as well as questions to obtain a TBI-related history. It also includes medical conditions that indicate the need for either urgent or non-urgent care management or referral to specialty care. This algorithm covers the recommended evaluation, management and rehabilitation procedures for the initial eye care assessment and is not intended to be used for long-term care.

**Figure 1. Algorithm for Eye and Vision Care Following Blast Exposure and/or Possible Traumatic Brain Injury**

Flowchart steps:  
 1. Service member or Veteran with history of blast exposure and/or possible TBI presents to eye care provider.  
 2. Conduct basic eye/vision exam (Table 1).  
 3. Gather additional TBI-related history (Table 2).  
 4. Conduct supplemental testing for oculomotor dysfunction (Table 3).  
 5. Are urgent medical eye care needs present? (Table 4).  
 6. Are nonurgent medical eye care needs present? (Table 5).  
 7. Are TBI related visual dysfunctions present? (Table 6).  
 8. Exit algorithm; provide ongoing care.  
 9. Urgent medical eye care management (Table 4).  
 10. Consider referral for specialized care (Table 4).  
 11. Non-urgent medical eye care management (Table 5).  
 12. Consider referral for specialized care (Table 5).  
 13. Urgent management or rehabilitation for TBI-related visual dysfunctions (Table 6).  
 14. Consider referral for specialized care (Table 6).  
 15. Urgent medical eye care needs: Conditions including possible ocular, orbital nerve or structural brain injury, which may be sight- or life-threatening, that require immediate management by the eye care provider and/or referral to more specific specialized care.  
 16. Non-urgent medical eye care needs: Potentially chronic eye or visual conditions for which management by the eye care provider or referral to more specific specialized care may be addressed over a course of time.

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Revised Date: 24 November 2015

# CR Pocket Cards

Developed as a portable tool for responders in theater, the **Clinical Recommendation Reference Card** offers a concise representation of the main points of the CR, including the algorithm of care along with tables of evaluation questions, urgent and non-urgent medical conditions, and evaluation and management recommendations for oculomotor dysfunctions.

**Eye Care and Visual Dysfunction Following Possible Traumatic Brain Injury: Assessment, Management, Rehabilitation and Referral**

The algorithm is intended to assist eye care providers (ophthalmologist and optometrist) with the evaluation, assessment and referral of patients presenting with eye or vision problems following blast exposure and/or possible traumatic brain injury. This algorithm covers the recommended care and is not intended to be used for long-term care; standard practice when caring for a patient.

**Figure 1: Algorithm of Care**

**Table 1: Testing, Evaluation, Management and Referral Considerations for Conditions which May Require Urgent Medical Eye Care**

Condition/Presentation	Additional Testing and Evaluation	Management Considerations	Referral Considerations
<b>Acute Trauma</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye pain</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye redness</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye discharge</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye swelling</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye tearing</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye itching</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye pain, redness, discharge, swelling, tearing, itching</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye pain, redness, discharge, swelling, tearing, itching, and vision loss</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye pain, redness, discharge, swelling, tearing, itching, and vision loss, and acute eye trauma</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye pain, redness, discharge, swelling, tearing, itching, and vision loss, and acute eye trauma, and acute eye trauma</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>
<b>Acute eye pain, redness, discharge, swelling, tearing, itching, and vision loss, and acute eye trauma, and acute eye trauma, and acute eye trauma</b>	<ul style="list-style-type: none"> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> <li>Visual evoked potentials</li> <li>Visual evoked myography</li> </ul>	<ul style="list-style-type: none"> <li>OP control</li> <li>Antibiotics</li> <li>Orbital decompression</li> <li>Antibiotic coverage</li> </ul>	<ul style="list-style-type: none"> <li>Ophthalmologist</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> <li>Ophthalmology care</li> </ul>



**Algorithm of Care for the Ophthalmologist and Optometrist: EYE AND VISION CARE FOLLOWING BLAST EXPOSURE AND/OR POSSIBLE TRAUMATIC BRAIN INJURY**

**Supplemental Testing for Oculomotor Dysfunction**

Distance cover test – unilateral and alternate (free eye)

Near cover test – unilateral and alternate (free eye)

Versions (EOMs) and/or pursuits\*\*

Accommodation

Saccades

Near point of convergence (NPC)

Repeated NPC (any method)

\*Goodson G, Mathisen G. (2013). Oculomotor dysfunction following traumatic brain injury: a review of the literature. *Journal of Rehabilitation Research* 75:7-16.

\*\*not already completed as part of the exam

**Condition/Presentation**

**Acute Proptosis**

- Compartment syndrome
- Orbital cellulitis/abscess
- Retrolbulbar hemorrhage
- Thyroid related

**Management Considerations**

- Prophylactic antibiotics
- Antibiotics
- Orbital decompression
- Antibiotic coverage

**Referral Considerations**

- Ophthalmologist
- Ophthalmology care
- Ophthalmology care
- Ophthalmology care

**Figure 1: Algorithm of Eye and Vision Care Following Blast Exposure and/or Possible TBI**

Flowchart showing decision steps for eye and vision care following blast exposure and/or possible TBI. Key steps include: 'Is there a foreign body in the eye?', 'Is there acute eye pain, redness, discharge, swelling, tearing, itching, and vision loss?', 'Is there acute eye trauma?', 'Is there acute eye trauma, and acute eye trauma?', 'Is there acute eye trauma, and acute eye trauma, and acute eye trauma?'. Decision points lead to either 'Urgent medical eye care (Table 1)' or 'Non-urgent medical eye care (Table 2)'. A final step asks 'Is there acute eye trauma, and acute eye trauma, and acute eye trauma, and acute eye trauma?' leading to 'Urgent medical eye care (Table 1)' or 'Non-urgent medical eye care (Table 2)'.

# Patient Brochure

## Vision Problems Associated With Traumatic Brain Injury



Developed as an educational tool for patients to learn the signs and symptoms of TBI-related vision problems.

### INTRODUCTION

Changes in vision can occur following blast exposure, eye injury, concussion or a traumatic brain injury (TBI). People affected by these problems may not be immediately aware of the impact on their vision, because some injuries are subtle or may be overlooked in the presence of other more obvious combat trauma to other parts of the body. Being aware of the symptoms and changes in the eye and vision is crucial to maximizing recovery from vision problems of all causes.

**Did you know?**

- According to the National Institute of Neurological Disorders and Stroke, approximately 1.4 million people experience a TBI annually.
- An estimated 23.3% of people with TBI are thought to experience vision impairments and/or visual dysfunctions that can hinder the person's success in school or at work.\*
- Research shows more than half of the human brain is devoted directly or indirectly to vision, making brain injury an important cause of vision impairment.†

\*Wierasz, T, et al. (2012). Concurrent Vision Dysfunctions in Concussion/Insufficiency With Traumatic Brain Injury. *Optometry and Vision Science*, 89(12), 1700-1711.

†HTT Research. "Brain Processing of Visual Information." (1996, December). <http://www.optica.nrl.edu/1996/visualprocessing>



### COMMON CAUSES OF EYE INJURY & TBI-RELATED VISION PROBLEMS

Common causes include:

- Blast exposure
- Falls
- Blunt force
- Assaults
- Car accidents

Goodrich and Martinsen\* developed a list of recommended questions to obtain a detailed ocular history for a Service member or Veteran who has been exposed to a blast or sustained an eye or head injury, including:

- Have you noticed a change in your vision since your injury?
- Do you bump into objects and walls more now than before your injury?
- Have you had any double vision since your injury?
- Have you noticed a change in your ability to read since your injury?

\*Goodrich G., Martinsen, G. (2018). Development of a mild traumatic brain injury-specific vision screening protocol: a Delphi study. *Journal of Rehabilitation Research & Development*, 55(8), 757-768.

Many visual dysfunctions can be improved through these commonly recommended treatments:

- Prescription glasses or contact lenses
- Pharmacotherapy (medication management)
- Prisms
- Oculomotor therapy
- Vision therapy
- Surgery

### CONCLUSION

Eye/head trauma or exposure to a blast can result in both obvious and subtle injuries to the eye or in the brain resulting in both immediate and/or longer term vision loss and visual dysfunction. If you have been exposed to a blast and/or suspect you may have sustained a TBI, it is important to closely monitor your vision and eye health. If you have experienced any change in vision, visit an eye care provider (optometrist or ophthalmologist).

### OTHER RESOURCES

Defense and Veterans Brain Injury Center  
<http://dvbicc.doe.mil>

BrainLine Military  
[www.BrainLineMilitary.org](http://www.BrainLineMilitary.org)

- Cataract
- Nystagmus (involuntary eye movements)
- Dry eye syndrome
- Low vision
- Trouble focusing
- Blurred vision
- Eye strain
- Frequent headaches
- Difficulty reading
- Sensitivity to light
- Night blindness



VISION CENTER OF EXCELLENCE

### VISION PROBLEMS ASSOCIATED WITH TRAUMATIC BRAIN INJURY

Walter Reed National Military Medical Center  
610 Piccadilly Pike, Suite 1403-A  
Bethesda, Maryland 20889  
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## **Incidence and Temporal Presentation of Visual Dysfunction following Diagnosis of Traumatic Brain Injury, Active Component, U.S. Armed Forces, 2006-2017**

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# Inclusion and Exclusion Criteria



- Data for 2006-2017 were obtained from the Defense Medical Surveillance System (DMSS), a longitudinal administrative data warehouse (171 868 cases of mTBI and 18 237 cases of moderate/severe TBI)
- Data were limited to recorded diagnostic codes and demographic values
- Each TBI case was matched to another active component military member (control) who had never been diagnosed with TBI or ocular trauma during their service

Inclusion Criteria	Exclusion criteria
TBI diagnosis	Any type of ocular trauma at any time during military service
At least two medical encounters for the same visual dysfunction within one year	Diagnosis for any visual dysfunction before TBI incident date

# Multivariable Poisson Regression Models for Visual Dysfunction Outcome\*

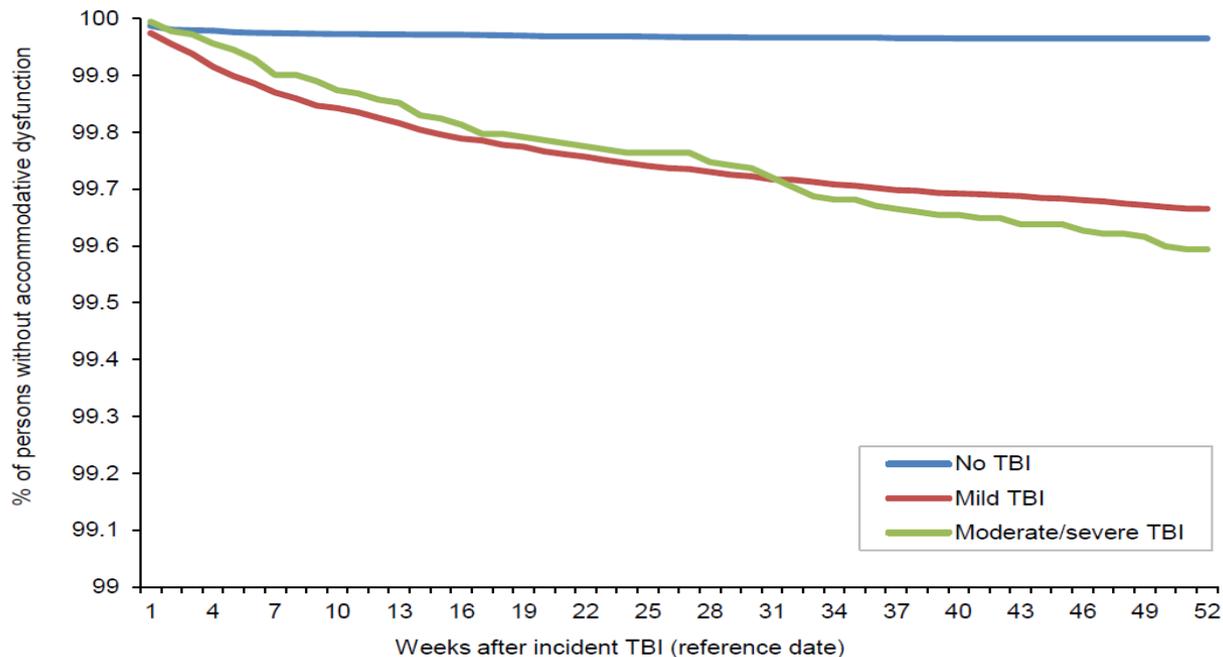


Visual dysfunction	Adjusted Incidence Rate (AIR)	95% CI	P-value
Accommodative Dysfunction			
Mild TBI vs no TBI	3.58	2.70-4.76	<0.0001
Moderate/severe TBI vs no TBI	4.68	3.29-6.66	<0.0001
Convergence Insufficiency			
Mild TBI vs no TBI	3.98	3.09-5.13	<0.0001
Moderate/severe TBI vs no TBI	5.64	4.16-7.65	<0.0001

\* All models adjusted for service, sex, race/ethnicity, age, rank, military occupation, and deployment history

# Survival Curves for Accommodative Dysfunction

**FIGURE 1.** Percentage of individuals without incident accommodative dysfunction diagnosis during the 1-year follow-up period, by TBI cohort, 2006–2018

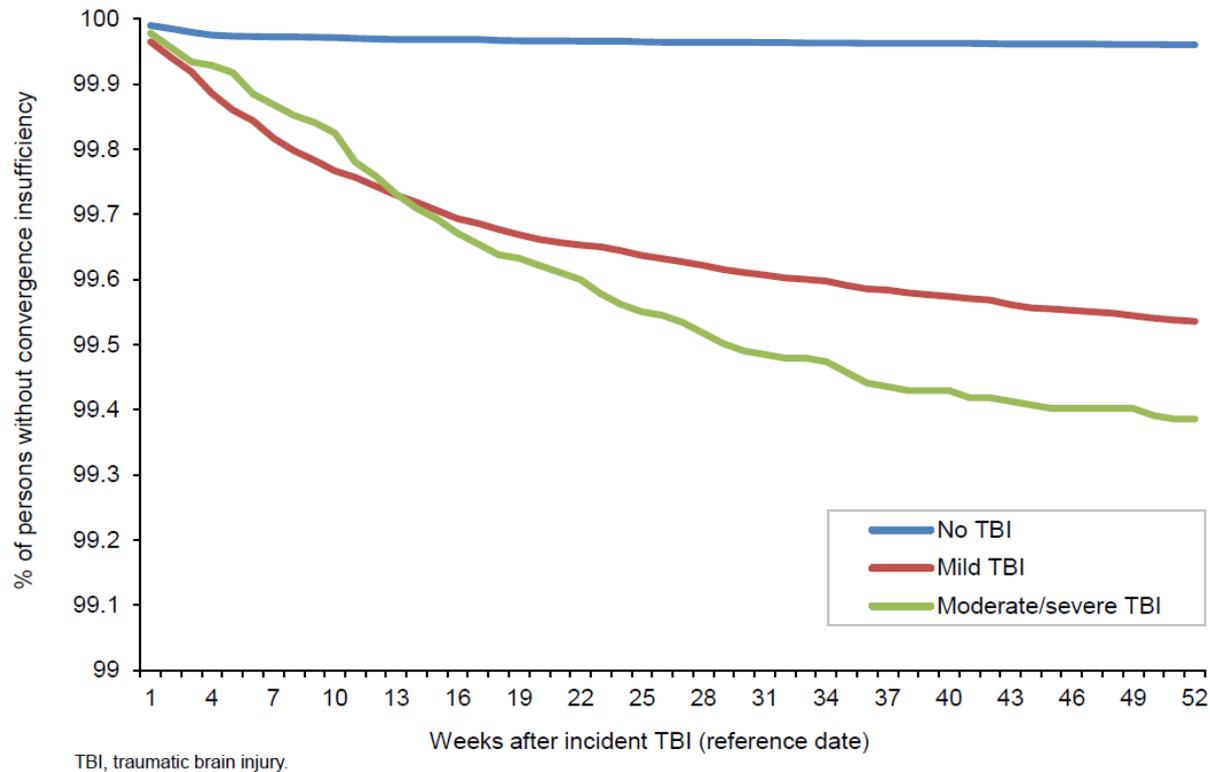


TBI, traumatic brain injury.

# Survival Curves for Convergence Insufficiency



FIGURE 2. Percentage of individuals without incident convergence insufficiency diagnosis during the 1-year follow-up period, by TBI cohort, 2006–2018



# Conclusions



- Service members with mild or moderate/severe TBI have significantly higher AIRs of AD and CI compared to service members with no TBI
- AD or CI could be diagnosed soon after the initial TBI diagnosis and this diagnosis was rendered at any time up to the limit of this study (52 weeks)
- Providing primary care providers with standardized screening instruments and referral guidelines for visual dysfunctions after TBI would increase evaluations by eye care providers
- Eye care providers diagnosing AD and CI in service members should seek a history of TBI which may not have been documented
- The development and dissemination of standard documentation and coding guidelines for visual dysfunctions following TBI is expected to improve surveillance and monitoring efforts for these important conditions and facilitate continuity of care for affected service members



# VCE/Uniformed Services University TBI Delphi Consensus Project



- Goal: To seek consensus from a broad panel of subject matter experts (SMEs) on the following questions:
  - What visual functions can be affected as a result of TBI;
  - What tests are recommended for both screening and specialized eye care examination post-TBI;
  - How these tests should be performed (including normative values)
- SMEs panel:
  - Ophthalmology, Optometry, Neurology, Audiology, Low Vision and Blind Care Rehabilitation, Physical Therapy, Physiatry, Occupational Therapy; Sports Medicine
  - VA, DoD, civilian

# Vision Center of Excellence/ Uniformed Services University TBI Delphi Consensus Project



Photo courtesy VCE



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# QUESTIONS?



# Poll question

## Choose one answer



- How useful was presented information for your TBI-related activities?
  - Very useful
  - Somewhat useful
  - Not very useful