Driving Following Traumatic Brain Injury: Clinical Recommendations

Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury

Driving Evaluations after Traumatic Brain Injury Conference

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Purpose: To provide clinical recommendations to healthcare professionals within the Military Health System regarding the assessment of the ability to drive following traumatic brain injury, regardless of severity.

Working Group Members:

CDR James Blankenship, Dr. Joseph Bleiberg, LT Tara Cozzarelli, Ms. Elin Schold Davis, Mr. Glenn Digman, COL Mary Erickson, MAJ Allison Franklin, Ms. Allison Hastings, Ms. Katherine Helmick, MAJ C. Alan Hopewell, Dr. Henry Lew, Dr. Cate Miller, LTC Craig Myatt, Dr. Tom Novack, CDR Jerry O'Toole, CPT Tammy Phipps, Dr. Heather Powell, Dr. Joel Scholten, Dr. Maria Schultheis, Dr. Sonya Sconiers, Ms. Kimberly Singer, Dr. Carl Soderstrom, COL Barbara Springer, MAJ Matthew St. Laurent, Dr. Wendy Stav, Dr. Erica Stern, Mr. John Vaughter, Mr. William Wenninger, Col Christopher Williams

Introduction

Safe operation of a motor vehicle is a complex task requiring interaction of operational, cognitive, and higher executive functions (Yale et al., 2003) and perceptual abilities (Coleman et al., 2002). The physical ability to control a vehicle does not equate to being able to drive safely (Leon-Carrion et al., 2005). The literature describes driving performance in the context of a hierarchical structure. At the operative level the driver must possess basic driving skills which include braking speed, lateral position control (meaning how well drivers maintain their lane position) and gap judgment. At the tactical level the driver makes judgments about other road users and makes adjustments in speed and distances that require complex cognitive control. Tactical driving also requires a self-awareness of one's cognitive functioning and driving performance. At the strategic level, the driver makes decisions such as which route to take before actual driving (Michon, 1979).

A neurological insult, such as a traumatic brain injury (TBI), can compromise this complex interplay of functions. Diffuse and local damage caused by TBI can adversely impact driving by not only causing physical impairments but also impaired perception, cognition, and motor processing (Brouwer et al., 2002). Visuospatial difficulties, neglect, reduced psychomotor speed, slowed reaction time, impaired visuoconstructive ability (the ability to accurately construct objects), reduced visual scanning and executive dysfunction are some of the impairments that may impede safe driving (Schanke & Sundet, 2000). Driving performance deficits associated with TBI-related neurocognitive impairments have been found in the areas of reaction time, visuomotor ability and perceptual and cognitive skills (Schneider & Gouvier, 2005).

It is estimated that 40% to 80% of individuals with varying degrees of cognitive impairment resulting from TBI return to driving after their injury (Lew et al., 2005) often without formal evaluation of ability to drive (Coleman et al., 2002; Schneider & Gouvier, 2005). The degree of risk for motor vehicle crashes after brain injury, however, is not consistent throughout the literature (Coleman et al., 2002). A study by Novack et al., (2006) found that a small number of drivers with severe TBI were at a greater risk of road traffic crashes than would be expected under normal driving conditions. Another study indicated that the relative risk of motor vehicle crashes in those with severe TBI and in a coma lasting at least 48 hours is 2.3 times higher than in uninjured individuals (Formisano et al., 2005). Contrary to this, other studies failed to find an increased risk of crash or citation when compared with other types of patients (Coleman et al., 2002) or healthy controls (Schultheis et al., 2002). For example, while patients with TBI were more likely to receive a citation, a similar increase was observed among patients

without brain injury who had fractures (Coleman et al., 2002). Research indicates that individuals with TBI who complete a comprehensive driving evaluation reintegrate into the driving community without increased risk for accident (Rapport et al., 2006; Schultheis et al., 2002).

Driving is of considerable importance in today's society. Cessation of driving is one of the most functionally disabling consequences of TBI (Rapport et al., 2006). While it is considered a privilege, driving, for many individuals, is an essential component to independence, community interaction, and access to work, shopping, and healthcare (Berger et al., 2000; Rapport et al., 2006). Among individuals with brain injuries, cessation of driving has been related to difficulties in employment, higher incidence of depression, poor social integration and inability to engage in activities outside of the home (Schultheis et al., 2007). Prohibition of driving a motor vehicle can have serious limiting effects on an individual's life and may impact the individual's family.

Healthcare professionals face the difficult tasks of assessing and making a recommendation as to whether a patient is medically fit to drive. In some instances, the healthcare professional's basic lack of knowledge and formal training to make such a recommendation confound this task (Yale et al., 2003). Physicians are often unaware of driving medical restrictions (Steier et al., 2003) as well as state regulations for reporting medical conditions to the department of motor vehicles. These restrictions and regulations vary from state to state. Currently 51 separate sets of regulations for licensing procedures exist across the states and the District of Columbia. Nine states (CA, DE, GA, NJ, NV, PA, OR, UT, WV) currently require some level of physician reporting after diagnosis of certain medical conditions, while others have procedures for voluntary reporting. Variability exists in states' visual criteria and renewal procedures with some states allowing mail-in licensure renewals. Physicians and other healthcare providers may find themselves in conflicting roles advocating for patients and maintaining confidentiality of the patient-physician relationship while simultaneously responsible to protect public safety.

Clinicians currently face a growing population of Wounded Warriors with TBI. Recent reports from the Department of Defense (DoD) indicate that service members sustained 146,118 TBIs from 2000 to March 2009, with approximately 79% of those injuries being mild. These numbers are inclusive of those injuries sustained in Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) as well as those injuries not sustained during OEF/OIF operations. The DoD defines mild TBI by loss of consciousness zero to 30 minutes, alteration of consciousness less than 24 hours, or post-traumatic amnesia less than 24 hours (Assistant Secretary of Defense, 2007). In the civilian population, a substantial

majority of those patients with mild TBI (75-90%) have symptoms that are transient and self-limiting, with apparent full recovery occurring within minutes to several weeks following injury (Levin et al., 1997). However, approximately 5%-15% of persons with mild TBI do not show the expected rapid and uneventful recovery and have persistent symptoms and/or functional limitations (Iverson et al., 2006; Ruff et al., 1996). There is strong consensus in the literature that persistent mild TBI symptoms include cognitive and emotional sequelae that can result in significant functional impairment and disability. In a study conducted of a brigade combat team returning from Iraq, 22.8% had clinician confirmed TBI. Of these, 7.5% of the post-deployment soldiers reported three or more somatic and/or neuropsychiatric symptoms to include headache, dizziness, balance problems, memory problems and irritability as compared with 2.9% of those post-deployment soldiers without TBI (Terrio et al, 2009).

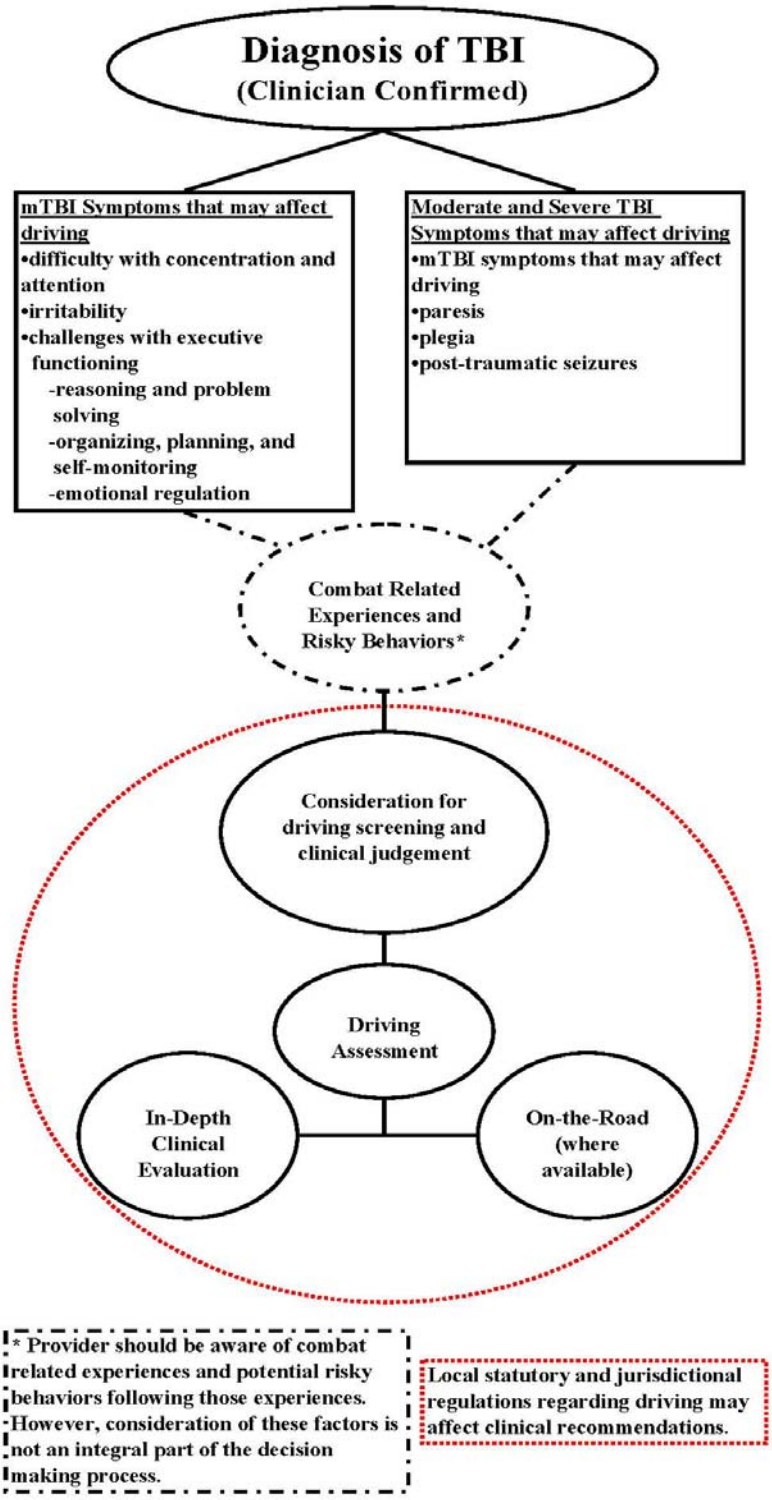
The consideration of fitness to drive following TBI has typically been reserved for more serious brain injuries where there are long periods of alteration or loss of consciousness (Brouwer et al., 2002). While it is evident that the moderate and severe TBI populations are likely to experience or are at risk for developing symptoms that affect fitness to drive such as paresis, plegia, or post-traumatic seizures, the chronic mild TBI population may be at an unrecognized increased safety risk while driving. They may experience symptoms that could potentially affect fitness to drive such as challenges with executive functioning, difficulty concentrating, or irritability. Furthermore, findings from other clinical populations with mild cognitive impairment (i.e., ADHD, Multiple Sclerosis) provide supporting evidence that even the presence of mild impairments in these domains can result in difficulties with driving performance (Schultheis et al., 2001, Schultheis et al., 2002, Barkley et al., 2002).

The medical literature and lay press recently raised concerns about service members' driving habits, regardless of TBI sustainment. Killgore and colleagues reported that service members with specific combat-related experiences may experience a greater willingness to engage in risky behaviors due to an elevated sense of invincibility. These high-risk activities include driving fast, driving aggressively and taking dangerous shortcuts (Killgore et al, 2008). A recent article in USA TODAY (Zoroya, 2009) reported on Stern and colleagues' study of a company of Minnesota National Guard soldiers. That study found that tactical driving behaviors employed by service members in Iraq and Afghanistan to avoid ambushes or roadside bombs, may place returning troops at risk on roads at home. The study revealed that approximately 25% of OIF veterans admitted to driving down the middle of an American road or running a stop sign, behaviors commonly practiced while deployed in order to maintain safety.

Given the recent reports of driving behaviors in combat veterans and the possibility that the mild TBI population may be at an unrecognized increased safety risk while driving, persons with all severities of TBI should receive consideration for an assessment of fitness to drive. To address this patient and public safety issue, the Defense Centers of Excellence (DCoE) for Psychological Health and Traumatic Brain Injury established a steering committee including members from the Department of Defense (DoD) and Department of Veterans Affairs (VA) with expertise in TBI nursing, neurology, neuropsychology, kinesiotherapy, occupational therapy, physical therapy, and physical medicine and rehabilitation. This steering committee concluded that they needed a one-day consensus conference to develop clinical recommendations for the Services, where none exist, and to address the issues of driving screening and assessment following a TBI. DCoE convened a one-day Driving Evaluations after Traumatic Brain Injury Conference on 28 July 2009 and included 30 subject matter experts from the DoD, the VA, civilian rehabilitation centers and academia. The steering committee selected the civilian subject matter experts. This document is a direct result of that conference.

The purpose of this document is to provide clinical recommendations to healthcare professionals within the Military Health System (MHS) regarding the evaluation of ability to drive following TBI, regardless of severity, as illustrated in Figure 1. The intent of such evaluation is not to prevent individuals from driving, but rather to ensure that those who have sufficiently recovered have the opportunity to safely drive government and privately owned vehicles (POVs) in accordance with federal and state guidelines (Department of Defense, 2007).

Figure 1: TBI Driving Evaluation Process



Methodology

Conference attendees were divided into two groups: 1) Screening and 2) Assessment based on specialty of background to include neuropsychologists, kinesiotherapists, occupational therapists, physical therapists, physiatrists, neurologists, general practitioners, clinical psychologists, research psychologists, and nurses reflecting a multidisciplinary approach to the consensus process. In addition, the United States Special Operations Command participated. Participants considered the published literature and the Service-specific requirements and needs as well as resource limitations.

Specific topics for discussion by these groups are displayed in Table 1.

TABLE 1: Screening and Assessment Groups Seed Questions

Screening	Who should receive consideration for initial driving screening so as to define the target population? How should an individual receive a referral for an initial screening for fitness to drive? Who can perform this screening? What areas/functions should a clinician evaluate as part of a driving screening?
Assessment	Who should receive a referral for a comprehensive driving assessment? Who can perform a comprehensive driving assessment? What areas/functions should a clinical evaluate as part of the comprehensive driving assessment?

Driving Screening

The purpose of the initial screening process is to assist in identifying those patients who may require a more time-intensive and costly driving assessment. A provider should consider fitness to drive in any patient with a history of a TBI, regardless of severity level. Although clinicians should consider a driving screening for every patient with a TBI, it is important to note that not all individuals will actually require this. Table 2 details the symptoms and other concerns that warrant strong consideration for screening an individual for fitness to drive. Clearly, if other clinical concerns are present, the provider may also consider screening the patient for fitness to drive.

TABLE 2: Symptoms and other Concerns that may Warrant Administration of Driving Screening

Visual disturbances
Auditory disturbances
Insomnia/Excessive daytime somnolence
Dizziness/vertigo
Cognitive changes
Attention
Memory
Executive functioning
Social pragmatics (reduced social sensitivity, difficulties with emotion and impulse control, and difficulty comprehending "nonverbal" social cues)
Substance abuse
Emotional dyscontrol
Driving violations or crashes
Neuromuscular dysfunction
Medications with side effects that may affect fitness to drive
Command/family request
Comorbid conditions that may confound fitness to drive

It is not uncommon for a family member or friend of a TBI patient to express concern about a loved one's ability to drive or driving performance. This collateral information can be of value to the clinician evaluating the patient. The family member or friend may notice subtle changes in behaviors that may not be apparent during a clinical visit. Communication with the patient, family and Command, if appropriate, is essential. All should understand the purpose of a driving screening and assessment – to identify those patients who may have problems safely operating a motor vehicle and ensure those who have sufficiently recovered the opportunity to do so.

There are a variety of screening tools and approaches that are useful in the driving screening process. The consensus panel does not recommend one tool or approach over another. The consensus panel recommended key domains for evaluation listed in Table 3. The consensus panel agreed that clinicians and other healthcare professionals familiar with the TBI population and familiar with the designated evaluative domains can quickly screen patients. It should be noted that given the extent of polytrauma often seen in Wounded Warriors with TBI, the presence of other physical injuries may require additional evaluations.

TABLE 3: Domains of a Driving Screening

Domain	Description*
Visual acuity	Near and far visual acuity
Visual fields	Binocular and peripheral vision
Memory	Crystallized (long-term), short-term and working memory
Visual perception	Ability to organize visual stimuli. Can also include visual attention.
Visual processing	Ability to organize visual stimuli into recognizable forms
Visuospatial skills	Ability to know where visual stimuli exist in space
Selective and divided attention	Selective attention: ability to prioritize stimuli and focus on only the most important in order to attend to urgent stimuli (such as traffic signs) while not being distracted by irrelevant ones (such as roadside ads). Divided attention: ability to focus on the multiple Stimuli involved in most driving tasks.
Executive skills (including judgment, decision making, insight and awareness)	Required to analyze driving-related stimuli and formulate appropriate driving decisions. Executive skills allow a driver to appropriately make the decision to stop at a red light, or stop at a green light if a pedestrian is in the path of the vehicle.
Motor and sensory function	Includes muscle strength and endurance, range of motion of the extremities, trunk, and neck and proprioception
Coordination	Psychomotor coordination
Pain	May include, but not limited to, musculoskeletal and joint pain and headaches or migraines
Fatigue	May range from drowsiness to extreme or excessive fatigue

*****As described in the American Medical Association Physician's Guide to Assessing and Counseling Older Drivers

A clinician can use the information gained through the screening process to determine if a patient may benefit from a more comprehensive driving assessment (locally at a military treatment facility or in the community). Results of the screening may also assist the clinician to determine if the patient's driving privileges should be restricted prior to further assessment. The clinician should familiarize himself/herself with the reporting requirements of the patient's licensing state to determine if he/she should report the patient to the state department of motor vehicles (either by physician or self report). The American Medical Association (AMA) offers a useful summary of salient driving regulations within each jurisdiction (http://www.ama-assn.org/ama1/pub/upload/mm/433/chapter8.pdf) with a revised document expected in the near future. While expert clinical opinion and review of the scientific literature are the basis for the clinical recommendations contained in this document, the clinician may need to modify the clinical recommendations according to local statutory and legal considerations. Additionally, the physician may want to consider the guidelines published by the American Medical Association regarding reporting of medically impaired drivers to licensing agencies. The clinician should review results and recommendations following the driving screening with the patient and other individuals as appropriate (i.e., family, Command) and thoroughly document in the patient's medical record having done so.

Driving Assessment

A driving assessment is an extremely useful clinical service to help thoroughly and comprehensively evaluate an individual's fitness to drive. This section describes the basic elements of a driving assessment, the clinical qualifications necessary to conduct driving assessments, and the use of driving assessments to guide treatment planning directed towards the eventual achievement of successful driving.

Driving assessments can be lengthy and complex procedures. These assessments are best reserved for those patients whose driving screening results raise concerns. There are two broad components of a driving assessment; 1) an in depth clinical assessment and 2) an on-the-road assessment. Neither of these assessments is uniformly standardized across clinicians, facilities, or jurisdictions, but there is general agreement regarding assessment of visual, motor, sensory, and cognitive functions. For example, the AMA "Physicians Guide to Assessing and Counseling Older Drivers" (http://www.ama-assn.org/ama/pub/physician-resources/public-health/promoting-healthy-lifestyles/geriatric-health/older-driver-safety/assessing-counseling-older-drivers.shtml) recommends examination of motor, sensory, and cognitive

domains substantially similar to those recommended by the Association for Driver Education Specialists (ADED) "Best Practices for the Delivery of Driver Rehabilitation Services" (ADED; http://www.driver-ed.org/files/public/ADED_Best_Practices_2009_Edition.pdf) and the American Occupational Therapy Association (AOTA) “Occupational Therapy Practice Guidelines for Driving and Community Mobility for Older Adults.” “The Handbook for the Assessment of Driving Capacity” (Schultheis et al., 2009) includes a chapter specific to driving and TBI and recommends evaluation of the above-mentioned domains in addition to general personality and attitudinal factors.

While statutory requirements typically place the burden of responsibility for action upon physicians, the consensus panel decided that any healthcare provider credentialed by DoD can make a referral for a driving assessment. Concomitant with that, the panel agreed that all DoD healthcare providers consider driving ability and driving safety as a part of their routine clinical assessment of persons with TBI.

There is no single, universally agreed-upon credential determining qualifications for performing driving assessments. Clinicians of diverse disciplines and backgrounds are eligible to receive the requisite training for ADED certification. Further, a clinician need not be ADED certified to perform driver assessment and rehabilitation. For example, the Department of Veterans Affairs has an internal training program for driving evaluators and the American Occupational Therapy Association has standards and criteria for designating occupational therapists as competent to provide driving assessment and training resulting in Specialty Certification in Driving and Community Mobility (SCDCM). While formal certifications such as those mentioned above are optimal, the consensus panel recommended the following as a minimum: a DoD defined healthcare provider who has a minimum of two years of clinical experience with the population under evaluation (TBI patients) and has received significant advanced training and education in the field of driver rehabilitation.

The consensus panel agreed that the elements described in Table 4 are the most appropriate to evaluate when conducting a comprehensive driving assessment. Those aspects of the elements evaluated during the driving screening are more thoroughly evaluated during the driving assessment.

TABLE 4: Elements Evaluated as Part of Comprehensive Driving Assessment

Element	Details
Medical & Driving History	Frequency of driving Usual location of driving Driving history pre and post injury Self-reported violations/crashes Verification of valid driver's license
Vision	Visual field Visual acuity Contrast sensitivity Depth perception
Cognitive	Orientation Visual perception Verbal comprehension Constructional ability Memory Calculation skills Reasoning/judgment Visual attention Visual scanning/visual search Processing speed Mental flexibility Executive functioning (including judgment, decision making, insight and awareness) Directed attention Sign recognition/road knowledge
Motor	Complex reaction time Musculoskeletal screen Mobility Strength Endurance Range of motion Sensation Balance Coordination Tone Aids/transfers
Performance (to include some form of	On the road

behavioral observation checklist to summarize/record the on-road observations)	Parking lot Residential Commercial Highway Simulation (if available) Parking lot Residential Commercial Highway Including potential crash situations

While driving simulators can be beneficial, there is great variability in the simulation systems currently offered. Most of the commercially available systems have not been validated in the TBI population and there remains great debate regarding which driving simulation performance measures are relevant to predicting actual driving performance. However, the use of virtual reality, as in the case of some driving simulators, also has the potential to be used as an assessment and rehabilitation tool for specific impairments resulting from TBI.

As previously mentioned, statutory and jurisdictional regulations determine physician requirements regarding reportable medical conditions. Should such report result in suspension of a patient's driving license, many jurisdictions require medical evidence for reinstatement of the driving license. The clinical recommendations contained in this document may also be useful in providing objective information to assist physicians to discharge these responsibilities.

A traumatic brain injury, regardless of severity, can impact an individuals' ability to drive and drive safely. This document serves to increase awareness among clinicians of this patient and public safety issue, encouraging consideration of driving ability and driving safety as a part of the routine clinical assessment of TBI patients. The clinical recommendations offered to the Military Health System in this document are one strategy with which to evaluate safe return to driving following TBI. Further research and information are needed to determine the scope of this safety issue as it relates to Service members and veterans with a history of TBI as well as Service members and veterans with a history of TBI and combat-related experiences. Furthermore, Service members returning from combat zones without a diagnosis of TBI but with reported risk-taking driving behaviors warrants additional study. This document provides the foundation for future discussions regarding driver rehabilitation and other associated issues as we gain additional information from the Services and the literature.

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