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REVIEW ARTICLE

Systematic Review of Prognosis After Mild Traumatic Brain Injury in the Military: Results of the International Collaboration on Mild Traumatic Brain Injury Prognosis

Eleanor Boyle, PhD,[a,b] Carol Cancelliere, DC, MPH,[c,d] Jan Hartvigsen, PhD,[a] Linda J. Carroll, PhD,[e] Lena W. Holm, DrMedSc,[f] J. David Cassidy, PhD, DrMedSc[a,b,c,d]

From the [a]Institute of Sports Science and Clinical Biomechanics, Faculty of Health, University of Southern Denmark, Odense, Denmark; [b]Division of Epidemiology, Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada; [c]Division of Health Care and Outcomes Research, Toronto Western Research Institute, University Health Network, University of Toronto, Toronto, Ontario, Canada; [d]Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario, Canada; [e]School of Public Health and Alberta Centre for Injury Control and Research, University of Alberta, Edmonton, Alberta, Canada; and [f]Division of Epidemiology, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden.

Abstract

Objective: The World Health Organization Collaborating Centre Task Force on Mild Traumatic Brain Injury (MTBI) published its findings on the prognosis of MTBI in 2004. This is an update of that review with a focus on deployed military personnel.

Data Sources: Relevant literature published between January 2001 and February 2012 listed in MEDLINE and 4 other databases.

Study Selection: Controlled trials and cohort and case-control studies were selected according to predefined criteria. After 77,914 titles and abstracts were screened, 13 articles were rated eligible for this review and 3 (23%) with a low risk of bias were accepted. Two independent reviewers critically appraised eligible studies using a modification of the Scottish Intercollegiate Guidelines Network criteria.

Data Extraction: The reviewers independently extracted data from eligible studies and produced evidence tables.

Data Synthesis: The evidence was synthesized qualitatively and presented in evidence tables. Our findings are based on 3 studies of U.S. military personnel who were deployed in Iraq or Afghanistan. We found that military personnel with MTBI report posttraumatic stress disorder and postconcussive symptoms. In addition, reporting of postconcussive symptoms differed on the basis of levels of combat stress the individuals experienced. The evidence suggests a slight decline in neurocognitive function after MTBI, but this decline was in the normal range of brain functioning.

Conclusions: We found limited evidence that combat stress, posttraumatic stress disorder, and postconcussive symptoms affect recovery and prognosis of MTBI in military personnel. Additional high-quality research is needed to fully assess the prognosis of MTBI in military personnel.

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Injuries sustained in combat today differ from the injuries sustained in previous wars.[1,2] The proportion of head and neck wounds has doubled from the Vietnam War, whereas thoracic and abdominal injuries have declined.[3] This change can be explained by various factors including the use of body armor and Kevlar helmets, which have reduced life-threatening injuries to the head, chest, and abdomen. Also, advances in in-theater medical care have reduced the killed-wounded ratio to less than 1 in 10.[4] Furthermore, the use of mine-resistant ambush-protected vehicles that diminish the effects of improvised explosive devices has resulted in a reduction in fatalities from roadside explosives.[3]

Traumatic brain injury (TBI) and posttraumatic stress disorder (PTSD) are being referred to as the "signature" injuries in the current U.S. conflicts.[5] One of the most common causal agents for injuries is exposure to blasts, which can result in TBIs with

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different degrees of severity.[6] Based on the mechanism by which blast-related injuries are produced, these are classified into 4 groups.[7,8] A primary blast injury occurs when the injury is sustained from the explosive materials. A secondary blast injury results from being hit by matter thrown by the explosion or by the fragments of the weapon casing. A tertiary blast injury is the result of the individual's being thrown by the explosive blast and hitting another object such as a wall or the ground. Last, a quaternary blast injury can occur from burns, toxic fumes, and other causes not covered in the previous 3 definitions.

It has been estimated that 60% to 80% of the military personnel who are exposed to a blast acquire a TBI.[5,9] From 2000 to the first quarter of 2012, 244,217 cases of TBIs were reported among U.S. military personnel by the Defense Medical Surveillance System and the Theater Medical Data Store.[10] Slightly over 75% of the TBIs were classified as mild, and only 1.6% were penetrating head injuries. Approximately 58% of these injuries occurred in U.S. Army personnel, and the remaining injuries occurred evenly in the Navy, Marines, and Air Force. According to the Defense Medical Surveillance System, the incidence rate of mild traumatic brain injury (MTBI) between 1997 and 2007 in the U.S. military was approximately 6.6 per 1000 person-years.[11] This incidence rate significantly varies by age groups (younger have higher rates), sex (men higher than women), race (white higher than other races), rank (enlisted higher than officer), and branch of service (Army and Marines higher than other branches). The cost of care for TBI in the U.S. military population has risen from $21 million in 2003 to approximately $646 million in 2010.[12]

The majority of the prognostic research in MTBI has been conducted in the civilian population. For example, the World Health Organization Collaborating Centre Task Force on Mild Traumatic Brain Injury published the first systematic review on MTBI prognosis in 2004. It accepted only 1 article involving a military population.[13] In that study, conducted 1 year after the Gulf War, the authors found a 1.8 times greater risk of a behavioral-related discharge in military personnel who had an MTBI than in persons who were discharged without a brain injury.[14] The majority of the head injuries in that study were related to falls (31.8%) and motor vehicle collisions (30.4%); these mechanisms are similar to those seen in civilian injuries. It is unclear whether these results of the study would be generalizable to MTBIs that occurred in-theater.[15]

There are inherent differences in the combat military population and civilian population.[2] Depending on the country, military personnel might have been evaluated with predeployment health screens and physical fitness standards. All military personnel are employed at the time of injury, which may not be true in the civilian population. The prevalence of MTBI is higher in the military population than in civilian populations living in noncombat zones, and in particular, blast TBIs are higher.[16] Depending on the length of deployment and the probability of being exposed to improvised explosive devices, there is a greater chance that military personnel may experience repeated TBIs.[17] Last, standardized triage and care is provided to military personnel throughout the recovery period.[18]

List of abbreviations:

ICoMP	**International Collaboration on MTBI Prognosis**
MTBI	**mild traumatic brain injury**
PCL-C	**Posttraumatic Stress Disorder Check List—Civilian**
PTSD	**posttraumatic stress disorder**
TBI	**traumatic brain injury**

In the present study, we aimed to update and expand on the original World Health Organization Collaborating Centre Task Force on Mild Traumatic Brain Injury on the prognosis of MTBI by focusing solely on the military population. The specific objective of this study was to synthesize the best available evidence on the course and prognosis of MTBI in the military population.

Methods

The literature search and synthesis strategy has been outlined in detail elsewhere and in this issue.[19,20] In brief, using a detailed search strategy, MEDLINE, PsycINFO, Embase, CINAHL, and SPORTDiscus were searched from January 1, 2001, to February 10, 2012. In addition, the reference lists of eligible articles were screened for potentially relevant articles and members of the International Collaboration on MTBI Prognosis (ICoMP) provided titles of articles that were not found in the search strategy. Using predefined inclusion and exclusion criteria, articles were screened for eligibility. Inclusion criteria were as follows: controlled trials, cohort studies, or case-control studies; published in peer-reviewed journals; written in English, French, Swedish, Norwegian, Danish, or Spanish; and included a minimum of 30 MTBI cases of military personnel that were independent of duty status at the time of injury (ie, active duty, reservist, or veteran). Cross-sectional studies and case reports and series were excluded. In addition, cadaveric studies, biomechanical studies, and laboratory studies were excluded. Systematic reviews and meta-analyses reference lists were checked for relevant studies, but these designs were not included in our review.

MTBI was defined using criteria established by the World Health Organization Collaborating Centre Task Force on Mild Traumatic Brain Injury and the U.S. Centers for Disease Control and Prevention. It was defined as follows: (1) 1 or more of the following symptoms: confusion or disorientation, loss of consciousness for 30 minutes or less, posttraumatic amnesia for less than 24 hours, and/or other transient neurological abnormalities such as focal signs, seizure, and intracranial lesion not requiring surgery; and (2) Glasgow Coma Scale score of 13 to 15 thirty minutes postinjury or later on presentation for health care. These symptoms of MTBI must not be due to drugs, alcohol, or medications; caused by other injuries or treatment for other injuries (eg, systemic injuries, facial injuries, or intubation); caused by other problems (eg, psychological trauma, language barrier, or coexisting medical conditions); or caused by penetrating craniocerebral injury.[21] Persons with fractured skulls were included if they fit this case definition. The causal agent could not be bullet(s) and/or fragment(s) because this may have resulted in a penetrating brain injury. The Centers for Disease Control and Prevention provides an additional definition based on clinical records data. MTBI is recognized if an Abbreviated Injury Severity scale score of 2 for the head region is documented.[7] An administrative data definition for surveillance or research is also provided. Specifically, cases of MTBI are recognized among persons who are assigned certain *International Classification of Diseases, Ninth Revision, Clinical Modification*, diagnostic codes.[20]

Two reviewers independently appraised each study using a modification of the Scottish Intercollegiate Guidelines Network criteria.[22] A third reviewer was consulted if any disagreements arose between the 2 reviewers. Data from the accepted articles were extracted by 2 reviewers independently and placed into evidence tables (table 1). The evidence on prognostic factors was categorized into phases on the basis of study designs as described by Côté et al.[23] Phase I studies are hypothesis-generating