

## **Defense and Veterans Brain Injury Center: Peacetime and wartime missions**

### **INTRODUCTION**

Congress created the Defense and Veterans Brain Injury Center (DVBIC) (previously known as the Defense and Veterans Head Injury Program) in 1992 during the Persian Gulf war to integrate specialized traumatic brain injury (TBI) care, research, and education across the military and veteran medical care systems [1]. TBI is a major cause of civilian and military death and disability among Americans, particularly among males and individuals in the young adult and elderly age groups. By the mid-1990s, the annual economic costs of TBI in the civilian sector, including direct costs of medical care, work loss, and disability and lost income resulting from premature deaths due to TBI, have been conservatively estimated at \$56.3 billion [2]. This estimate was based on hospital-treated civilians with TBI during calendar year 1995 and did not include the treatment and work-loss costs for individuals with TBI who were treated in emergency departments or doctors' offices or did not receive treatment. Moreover, this estimate did not adjust for undercounts of TBI in hospitalized patients [3]. And, of course, the overwhelming costs of reduced quality of life for survivors and family members cannot be captured in economic terms.

As large a problem as TBI is in the civilian sector, it is even more a concern in military settings for several reasons. First, by virtue of the sex and age distributions of military personnel, they are at higher risk for TBI than the total civilian population, even in peacetime. Second, certain military occupations, such as parachuting, carry higher than average risks for TBI [4]. Third, war considerably increases combatants' rate of both closed and penetrating TBIs. And fourth, military personnel, like committed athletes, may underreport mild TBIs, thereby decreasing unit or team efficiency and perhaps increasing risk of further injury. One concern of policy makers over time has been ensuring that military service members and veterans receive the best possible acute and ongoing care for TBI, whether received in peacetime or in combat.

### **ROLE OF DEFENSE AND VETERANS BRAIN INJURY CENTER OVER TIME**

The DVBIC was established in response to concerns that brain injury care was fragmented in both the military and veteran care systems (as in civilian systems) and that some patients had difficulty accessing care for the chronic problems associated with TBI. The need for more clinical monitoring of and care coordination for patients after TBI was suggested in a study comparing the types of military discharges received by service members who had been

hospitalized with TBI in 1992 versus the total military discharge population. Service members who received hospital care for TBI were subsequently found to have had several times the rates of behavioral discharges (early release because of misconduct, behavior disorder, motivation problems, etc.), criminal convictions, substance abuse problems, and medical disability as the total discharge population [5]. The DVBIC was established as an integrated network of military and Department of Veterans Affairs (VA) medical centers able to ensure state-of-the-art care by experienced clinicians while developing clinical research evidence upon which to base clinical care standards. Little class I evidence for TBI treatment existed then to guide clinicians in patient care. The DVBIC conducted the first large randomized clinical trial of TBI rehabilitation [6]. Although several clinical trials have tested the efficacy of pharmacological treatments [7] and several large collaborative networks have since initiated trials of pharmacological treatments, much about TBI and TBI treatment has not yet been rigorously researched [8–11].

Today, the DVBIC network consists of 4 VA treatment centers, 3 military treatment centers, 2 community reintegration centers, 23 affiliated VA Polytrauma/TBI network sites, and a coordinating headquarters. A recent review of TBI systems of care cited the DVBIC network as the most fully developed system of care in brain injury and a health system brain injury program with “many elements of a ‘comprehensive’ system” [12]. In addition to ongoing research, clinical, and education programs within DVBIC centers, the program has undertaken a number of war-related initiatives focused on providing specialized consultation to providers in theater and at non-DVBIC clinical centers in Europe and the United States. These initiatives have often involved “training the trainers”; i.e., training medics on the detection and acute care of TBI survivors; providing treatment and referral recommendations for particular patients on telemedicine conference calls; and distributing education materials to providers, survivors, and family members on best clinical practices for the detection, evaluation, and treatment of TBI survivors. DVBIC centers have also assisted military bases by supplying training materials and directly assisting their efforts to

detect and treat returning service members with concussive injuries received in theater.

The Persian Gulf war did not result in many injuries and the intervening years of relative peace between 1992 and the Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) conflicts permitted DVBIC centers to acquire experience evaluating and treating varied TBI populations, test the efficacy of several rehabilitation strategies (cognitive rehabilitation versus home program [6], cognitive versus functional rehabilitation treatments [analysis underway]) and pharmaceutical treatments (Exelon, sertraline), and implement strategies for providing inpatient and outpatient resources to individuals with TBI needing access to care across the country. The years of experience in treating individuals injured in peacetime accidents prepared the DVBIC for the challenging mission of caring for the large influx of individuals with TBI returning from OIF/OEF. Resident training in TBI, care coordination systems, educational outreach and materials, family support groups, and routine follow-up care programs were established in the collaborating centers.

During the peacetime era of the 1990s, civilian and military rates of hospitalized TBI declined and military rates had actually fallen below civilian rates toward the end of the decade [13]. These declines have been interpreted as resulting from changes in practice patterns (milder injuries were increasingly treated outside of hospitals) and from prevention measures taken in the civilian and the military settings (seat belt laws, increased penalties for drunk driving, etc.) [13–14]. Combat increases the incidence of TBI in the military, and current conflicts are resulting in increased hospitalization rates for TBI in the military and VA populations.

Recent wars each have produced somewhat different patterns of injury. In the Vietnam war, approximately 40 percent of the 58,000 U.S. combat fatalities were due to head and neck wounds and 14 percent of individuals surviving their wounds had head injury [15]. In Operation Desert Storm, about 20 percent of those treated for wounds had head injuries [16–17]. The final assessment of mortality and morbidity patterns during the OIF/OEF years awaits analyses of trauma registries and hospitalization records.

However, certain features of the current conflicts are clear. Overall mortality rates are lower in the current conflicts than in previous wars. Improved body armor worn by military personnel is believed to help individuals survive what would have been lethal injuries in past wars. The advances in body armor may lead concomitantly to increased numbers of survivors requiring hospitalization for TBI and other injuries. Another development likely to change the percentage of diagnosed TBI in military hospitals is that more is known about the consequences and diagnosis of closed head injuries than in previous wars [18–23], so medical personnel may be detecting more of these “invisible” injuries than in past conflicts.

Many individuals medically evacuated from the OIF/OEF conflicts present with complex injuries—patients with TBI often have other injuries, including amputations, hearing and vision loss, burns, and posttraumatic stress disorder (PTSD). The required treatment and ongoing care of these complex patients have led to the recent creation of polytrauma centers at the four lead VA TBI centers, all sites in the DVBIC network. The years spent developing specialized treatments coordinated across levels of care for patients with TBI provided the foundation for the care and rehabilitation of polytrauma patients.

## SCREENING FOR TRAUMATIC BRAIN INJURY

The research, education, care coordination, and clinical care initiatives just outlined depend on the identification and evaluation of individuals with TBI. In 2003, the DVBIC convened an expert advisory board that recommended assigning top priority to the characterization of wartime TBI cohorts, in terms of both acute and long-term outcomes. The DVBIC has undertaken two initiatives to characterize these TBI cohorts: one based in medical centers and the second in large military bases.

### In-Hospital and Outpatient Screening

Forward neurosurgical care provides early intervention for penetrating and severe closed brain injuries, and casualties are expediently evacuated to the

continental United States. Walter Reed Army Medical Center (WRAMC) in Washington, DC, began receiving large numbers of medically evacuated patients by early 2003. The DVBIC clinicians found that some mild-to-moderate TBIs were being overlooked in soldiers who had received life-saving treatment for other injuries; therefore, WRAMC began to screen all war-wounded who had been exposed to injuries associated with a TBI risk: blasts, falls, motor vehicle accidents, or gunshot wounds to the head or neck. Thus, the first comprehensive TBI screening program in an at-risk hospitalized population was initiated. WRAMC was the first DVBIC center to receive large numbers of medically evacuated patients from the current war; as other DVBIC clinicians began to see large numbers of returning troops, they, too, initiated TBI screening programs. Currently, WRAMC screens all admitted active-duty personnel, reservists, and National Guard members if their injuries are associated with the risk factors for TBI.

The screening process at WRAMC consists of a clinical interview to determine whether the patient had an alteration or loss of consciousness associated with the injury and an evaluation of the patient’s current medical status, including a brief cognitive assessment. The screen also includes an evaluation for symptoms and problems typical of TBI. Some of the most common cognitive symptoms reported after mild or moderate TBI include attention and memory problems, difficulty thinking, and problems with executive functions (i.e., complex problem solving). Many patients also report symptoms such as headaches, sleep disturbances, mood swings, and personality changes following TBI. An important factor to consider is that the characteristics of TBI in the military population may differ from those in civilians. For example, many soldiers admitted to WRAMC have been exposed to blast, which may lead to different symptomatology. Also, soldiers returning from theater have a relatively high incidence of PTSD and some symptoms overlap between TBI and PTSD. The unique nature of injury and associated factors needs to be considered during the screening process.

Once the initial screen is complete, further TBI-specific DVBIC evaluations are conducted as

warranted and treatment is provided at the appropriate and practical level of care. Once medically stabilized, patients with severe TBI initially seen at one of three military medical centers are transferred for intensive rehabilitation at VA lead centers. Clinical follow-up is provided at regular intervals to patients with TBI to provide ongoing assessment and care for the chronic problems associated with their TBI. Also, TBI-specific screening has been instituted at Landstuhl Regional Army Medical Center in Germany and at various VA medical centers.

DVBIC personnel have diagnosed more than 1,700 individuals with TBI since the OIF/OEF conflicts began. Of individuals medically evacuated to WRAMC with combat injuries, 28 percent had a TBI. An analysis of the first 433 individuals with TBI seen at WRAMC helps initially characterize this growing population. Concomitant amputation occurred in 19 percent of these TBI patients, with lower-limb amputation being more common than upper-limb amputation. Mild TBI accounted for just under half of these 433 patients, while moderate and severe (including penetrating) TBI accounted for 56 percent. Penetrating TBI was seen in 12 percent of the TBI patients, while closed TBI accounted for 88 percent, confirming that closed brain injury is more common than penetrating brain injury in this war.

### **Screening at Large Military Bases**

The DVBIC began conducting TBI-specific postdeployment screening of returning troops at Fort Bragg (North Carolina) and Camp Pendleton (California) early in OIF/OEF to ensure appropriate treatment for any who may have sustained a concussion yet not sought care because of the ongoing mission while in theater. TBI screening with short self-report questionnaires has subsequently been implemented at Fort Carson (Colorado) and Fort Irwin (California). Population screening of individuals returning from OIF/OEF permits individuals to self-report alteration or loss of consciousness associated with injury in theater and report symptoms of TBI that may linger after injury [24]. Active-duty personnel, including activated National Guard members and reservists at these large military bases, have been screened. Individuals with possible TBI are identi-

fied, and those needing education and/or treatment are referred to providers. Education regarding the types and course of concussion symptoms has shown to effectively reduce morbidity [25–26]. The DVBIC provides these screening and educational programs to military and VA centers that request them.

### **TRANSLATION OF TREATMENT EFFICACY RESEARCH AND EXPERT PANEL RECOMMENDATIONS: DEVELOPMENT AND DISTRIBUTION OF CLINICAL STANDARDS**

From the inception of the DVBIC, it has concentrated on clinically relevant research and the development of clinical evaluation tools and treatment standards. The need for practical standards in the current combat setting became apparent early as troops deployed to Afghanistan and Iraq were medically evacuated for care at WRAMC. Treatment of combat-related TBI from previous wars advanced as clinicians and researchers assessed data available on wartime injuries, but new guidelines often did not become available until after the conflict ended. The DVBIC has undertaken numerous initiatives to ensure that combat-related TBI treatment will benefit from the latest developments in diagnosis and treatment. In 2004, the DVBIC held a Lessons-Learned Military TBI Conference at the Uniformed Services University of the Health Sciences in Bethesda, Maryland. Presentations by clinicians who represented various specialties and had served in Afghanistan or Iraq emphasized the need for training for closed brain injury care at all levels, especially the field-medical level.

As a result of the Lessons-Learned Military TBI Conference, the DVBIC contracted with the Brain Trauma Foundation to adapt for military use its previously published “Guidelines for prehospital management of traumatic brain injury.” The 2006 adaptation, “Guidelines for field management of combat-related head trauma,” focuses on caring for moderate to severe TBI and translates available research into recommendations for infield and hospital care of TBI received in combat. The DVBIC has widely disseminated these guidelines.

Most TBI, even among hospitalized patients, is moderate or mild [14]. Although these individuals generally require less-intensive care than patients with severe TBI, they need appropriate diagnosis, treatment, and follow-up care. The DVBIC has been engaged in providing care coordination guidelines, developing outreach programs for patients living in underserved areas, and providing education to providers. An ongoing DVBIC program developed at Camp Pendleton teaches the use of the Standardized Assessment of Concussion, a commonly used assessment in high school, collegiate, and professional sports that has been validated for use within the first 24 hours following concussion [27]. This program was videotaped to permit more widespread use. The DVBIC developed the Military Acute Concussion Evaluation to permit in-theater assessment, and providers are currently using it to triage patients into appropriate levels of care. DVBIC training teams have developed and used other TBI modules to train numerous clinicians deploying to war zones on the identification, screening, and treatment of combatants with TBI.

In July 2006, the Army issued to all its commanders a memorandum to the field outlining the features of concussion and its management, including “red flags” requiring more aggressive care. The Marines have written a similar memorandum. These memorandums were largely based on summaries provided by DVBIC regarding best care practices for concussion. In addition, a panel of mild-TBI specialists was convened in fall 2006 to discuss the state of the science and current clinical practices in diagnosis and treatment of individuals with mild TBI and how these can be applied in various military settings. Panel recommendations are being written as a white paper for dissemination and comment.

### **FOLLOW-UP CARE AND CARE COORDINATION FOR A WIDELY DISPERSED POPULATION**

The challenge of providing continued care to individuals with TBI is considerable. Ultimately, the

vast majority of those with TBI will return to their communities. Excellent specialty care centers exist to address acute and subacute recovery. Patients treated in those centers receive regular follow-up calls to assess any current unmet needs, and former patients requiring a treatment or rehabilitation boost will be returned for care to an appropriate treatment center, either a lead center or a DVBIC VA Polytrauma/TBI network site. Despite the existence of specialty care centers linked to the DVBIC network, many areas of the country are still underserved in terms of resources for TBI care, education, rehabilitation, and community reintegration. Long-term follow-up of individuals with ongoing problems associated with TBI is challenging in a widely dispersed patient population. Many small community healthcare centers, both VA and civilian, lack the expertise and resources for effectively treating and providing long-term care for TBI. As military personnel and veterans diagnosed with TBI return to their communities, distinct needs exist for (1) continuity of care from their initial military/VA hospital to their long-term healthcare provider (whether in the military, VA, or civilian healthcare sectors) via effective transfer of medical records and clinical recommendations, (2) continued access to rehabilitation and educational programs, and (3) continued education and care resources for the patients’ families and caregivers.

The DVBIC has anticipated these needs and begun to enhance a distributed network of care that monitors recovery and treats ongoing issues from TBI, which will be of paramount importance to these individuals’ community reentry. Care-coordination managers in each DVBIC site provide ongoing consultation to community care centers through telemedicine conferences, consultation, and education materials available in multimedia venues (Web site, CDs, printed materials). The care coordination required to assess and transfer these patients has been assisted by telemedicine conferences between military and VA lead sites and Landstuhl Medical Center, which is the major transfer point between combat areas and U.S. treatment facilities. In addition, DVBIC is developing a number of outreach initiatives to provide veterans and active-duty service

members access to specialty care in geographically dispersed areas.

Some major challenges in establishing these distributed networks are the availability of highly trained personnel as well as adequate financial, technical, and physical resources. To successfully realize a comprehensive distributed care network, the DVBIC and other TBI-focused organizations must continually increase public and clinician awareness of TBI. This increased awareness will be accomplished through dissemination of information to the military and civilian medical communities and Government agencies. Publicizing the advances in TBI care and research combined with technological advances in telemedicine will help the DVBIC and other TBI care networks establish and maintain the lines of communication necessary for expanding TBI programs to underserved areas.

## **ONGOING AND FUTURE RESEARCH PROGRAMS**

The foundation for successful TBI treatment and rehabilitation regimes is a sound research program. The development of continually improved treatments for TBI requires clinically relevant research projects. The DVBIC has been in the forefront of the development of class I evidence on TBI treatments. It conducted the first study evaluating the effectiveness of two rehabilitation treatments with a randomized controlled clinical trial of a large TBI sample [6]. It has recently completed a second randomized study of two approaches to TBI rehabilitation in a large sample of VA patients with moderate-to-severe TBI [28]. It will begin a randomized study of methylphenidate, a widely used pharmaceutical treatment agent, to determine whether the drug improves the ability of patients with moderate-to-severe TBI to benefit from rehabilitation in VA centers. Lastly, it is conducting two studies of pharmaceutical treatments across DVBIC centers: sertraline for treatment of postconcussive symptoms and citalopram hydrobromide for treatment of anxiety disorders associated with TBI.

In addition, the DVBIC is conducting collaborative studies to investigate the sensitivity and specificity of various screening and diagnostic tools in the area of TBI. Improved tools are needed to more reliably and validly identify TBI in treated and untreated populations at risk for TBI, including military personnel in combat settings. These initiatives include research on the screening tools described earlier, which will lead to better-defined methods of TBI screening and diagnosis. Additionally, anatomical (magnetic resonance imaging/diffusion tensor imaging) and functional (positron emission tomography) imaging studies are further elucidating the neurological consequences of TBI. Biomarker studies are also examining the biological and genetic factors involved in brain injury and recovery.

DVBIC research has relevance for both the military and civilian populations. Ongoing and future projects are particularly important to military personnel involved in the current conflicts. The etiology of TBI in OIF/OEF is different than in past military conflicts or in the civilian sector, which must be considered in research efforts. Blast exposure has come to be recognized as one of the most prominent causes of injury in OIF/OEF. Also, as mentioned previously, many soldiers are returning with multiple injuries; polytrauma makes the diagnosis and treatment of TBI even more difficult. Little is known about the exact neurological consequences of blast or the challenges involved with treating TBI concurrently with other injuries. Innovative research aimed at understanding the mechanisms of blast-related TBI is required as well as the integration of knowledge gained from such research into acute care, long-term care, rehabilitation, and educational programs.

## **CONCLUSIONS**

The DVBIC network has been vigorously providing high-quality care to service members and retirees in lead military and VA treatment centers and developing and disseminating practice guidelines and provider education programs to promote high-quality TBI care for military and veteran populations. The lead centers are well-regarded specialty

sites engaged in providing excellent evaluation and treatment of both war-wounded and non-combat-injured patients with TBI. The DVBIC cannot treat all individuals with TBI in the military and VA populations. However, it has developed extensive research and education programs and TBI care coordination and follow-up networks to support and improve the provision of state-of-the-art care throughout the military and veteran populations.

The challenges of providing and maintaining systems of care that can adequately treat and support varied and dispersed TBI patient populations are considerable. Interest and concern about returning active-duty service members injured in OIF/OEF have led to increased research and clinical care resources. The challenge will be to develop systems of care that provide excellent long-term care for individuals with chronic TBI-related problems and associated injuries and provide care for individuals injured in future peacetime accidents. How will continued care be provided to the individual with chronic, complex problems related to TBI and other injuries who relocates to a rural area far from any TBI specialty center? Continued resources will clearly be required, as will new programs targeted at chronic, dispersed TBI populations. Program evaluation should be a requirement for any new program funded with Government dollars, since care dollars may shrink once the incidence of combat injuries declines. The development of new tools, such as innovative screening and diagnostic tools, is needed to enhance the management of less-severely injured patients with periodic healthcare requirements related to TBI. Research and program development targeting the reintegration of TBI survivors into the community needs to be a focus. Return to work after TBI is often challenging after civilian injury. What happens when TBI survivors have serious associated injuries, PTSD, or a gap in their careers when activated to duty? The DVBIC has been in the forefront of developing networks capable of conducting class I research studies of TBI treatments and translating research findings and clinical care practice into improved standards of care for TBI survivors. As a result, the DVBIC is uniquely positioned to support and coordinate the expansion of specialized medical

care that combatants with TBI require and to provide tools for TBI screening in hospitalized and nonhospitalized personnel with TBI. About 22 percent of troops returning to Fort Carson from deployment had a TBI [29]. Future projects include continued translation of medical research findings into care guidelines, research on the long-term outcomes of TBI survivors from the Iraq and Afghanistan conflicts, and collaborations with outside investigators and clinicians on TBI identification and treatment received in the current combat environment. The initiatives directed at combat-related TBI together with other ongoing DVBIC programs will continue to lead to improvements in the level of care provided to military, veteran, and ultimately, civilian TBI populations. In the past, TBI was a hidden, poorly understood injury with often devastating consequences for survivors and family members. Along with important collaborators in the Centers for Disease Control and Prevention, National Institute on Disability Rehabilitation Research, and various academic centers, the DVBIC has helped bring needed attention and resources to this area and provided leadership for improved identification and treatment of TBI survivors in the military and veteran healthcare systems.

## REFERENCES

1. Salazar AM, Zitnay GA, Warden DL, Schwab KA. Defense and Veterans Head Injury Program: Background and overview. *J Head Trauma Rehabil.* 2000; 15(5):1081–91. [\[PMID: 10970929\]](#)
2. Thurman DJ. The epidemiology and economics of head trauma. In: Miller LP, Hayes RL, Newcomb JK, editors. *Head trauma: Basic, preclinical, and clinical directions.* New York (NY): Wiley-Liss; 2001. p. 327–47.
3. Moss NE, Wade DT. Admission after head injury: How many occur and how many are recorded? *Injury.* 1996;27(3):159–61.
4. Ivins BJ, Schwab KA, Warden D, Harvey LT, Hoilien MA, Powell CO, Johnson CS, Salazar AM. Traumatic brain injury in U.S. Army paratroopers: Prevalence and character. *J Trauma.* 2003;55(4): 617–21. [\[PMID: 14566111\]](#)

5. Ommaya AK, Salazar AM, Dannenberg AL, Ommaya AK, Chervinsky AB, Schwab KA. Outcome after traumatic brain injury in the U.S. military medical system. *J Trauma*. 1996;41(6):972–75. [PMID: 8970548]
6. Salazar AM, Warden DL, Schwab KA, Spector J, Braverman S, Walter J, Cole R, Rosner MM, Martin EM, Ecklund J, Ellenbogen RG. Cognitive rehabilitation for traumatic brain injury: A randomized trial. Defense and Veterans Head Injury Program (DVHIP) Study Group. *JAMA*. 2000;283(23):3075–81. [PMID: 10865301]
7. Neurobehavioral Guidelines Working Group, Warden DL, Gordon B, McAllister TW, Silver JM, Barth JT, Bruns J, Drake A, Gentry T, Jagoda A, Katz DI, Kraus J, Labbate LA, Ryan LM, Sparling MB, Walters B, Whyte J, Zapata A, Zitnay G. Guidelines for the pharmacologic treatment of neurobehavioral sequelae of traumatic brain injury. *J Neurotrauma*. 2006;23(10):1468–1501. [PMID: 17020483]
8. Carroll LJ, Cassidy JD, Peloso PM, Borg J, von Holst H, Holm L, Paniak C, Pépin M, WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. Prognosis for mild traumatic brain injury: Results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med*. 2004;(43 Suppl):84–105. [PMID: 15083873]
9. Borg J, Holm L, Cassidy JD, Peloso PM, Carroll LJ, von Holst H, Ericson K, WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. Diagnostic procedures in mild traumatic brain injury: Results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med*. 2004;(43 Suppl):61–75. [PMID: 15083871]
10. Comper P, Bisschop SM, Carnide N, Tricco A. A systematic review of treatments for mild traumatic brain injury. *Brain Inj*. 2005;19(11):863–80. [PMID: 16296570]
11. Chestnut RM, Carney N, Maynard H, Patterson P, Mann NC, Helfand M. Rehabilitation for traumatic brain injury. Evidence report number 2 (Contract 290-97-0018 to Oregon Health Sciences University). Rockville (MD): Agency for Health Care Policy and Research; 1999.
12. Cope DN, Mayer NH, Cervelli L. Development of systems of care for persons with traumatic brain injury. *J Head Trauma Rehabil*. 2005;20(2):128–42. [PMID: 15803037]
13. Ivins BJ, Schwab KA, Baker G, Warden DL. Hospital admissions associated with traumatic brain injury in the U.S. Army during peacetime: 1990s trends. *Neuroepidemiology*. 2006;27(3):154–63. [PMID: 17035692]
14. Thurman D, Guerrero J. Trends in hospitalization associated with traumatic brain injury. *JAMA*. 1999; 282(10):954–57. [PMID: 10485680]
15. Schwab KA, Ivins B, Salazar AM. Brain injury, epidemiological issues. In: Aminoff MJ, Daroff RB, editors. *Encyclopedia of the neurological sciences*. Boston (MA): Academic Press; 2003. p. 438–45.
16. Leedham CS, Blood CG, Newland C. A descriptive analysis of wounds among U.S. Marines treated at second-echelon facilities in the Kuwaiti theater of operations. *Mil Med*. 1993;158(8):508–12. [PMID: 8414070]
17. Carey ME. Analysis of wounds incurred by U.S. Army Seventh Corps personnel in Corps hospitals during Operation Desert Storm, February 20 to March 10, 1991. *J Trauma*. 1996;40(3 Suppl):S165–69. [PMID: 8606402]
18. Warden D. Military TBI during the Iraq and Afghanistan wars. *J Head Trauma Rehabil*. 2006;21(5): 398–402. [PMID: 16983225]
19. McCrory P, Johnston K, Meeuwisse W, Aubry M, Cantu R, Dvorak J, Graf-Baumann T, Kelly J, Lovell M, Schamasch P. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *Br J Sports Med*. 2005;39(4): 196–204. [PMID: 15793085]
20. Kay T, Harrington DE, Adams R, Anderson T, Berrol S, Cicerone K, Dahlberg C, Gerber D, Goka R, Harley P, Hilt J, Horn L, Lehmkuhl D, Malec J. Definition of mild traumatic brain injury. *J Head Trauma Rehabil*. 1993;8(3):86–87.
21. Guskiewicz KM, McCrea M, Marshall SW, Cantu RC, Randolph C, Barr W, Onate JA, Kelly JP. Cumulative effects associated with recurrent concussion in collegiate football players: The NCAA Concussion Study. *JAMA*. 2003;290(19):2549–55. [PMID: 14625331]
22. Collins MW, Lovell MR, Iverson GL, Cantu RC, Maroon JC, Field M. Cumulative effects of concussion in high school athletes. *Neurosurgery*. 2002; 51(5):1175–81. [PMID: 12383362]
23. Iverson GL, Gaetz M, Lovell MR, Collins MW. Cumulative effects of concussion in amateur athletes. *Brain Inj*. 2004;18(5):433–43. [PMID: 15195792]
24. Schwab KA, Baker G, Ivins B, Sluss-Tiller M, Lux W, Warden D. The Brief Traumatic Brain Injury Screen (BTBIS): Investigating the validity of a self-report

- instrument for detecting traumatic brain injury (TBI) in troops returning from deployment in Afghanistan and Iraq. *Neurology*. 2006;66(5 Suppl 2):A235.
25. Ponsford J, Willmott C, Rothwell A, Cameron P, Kelly AM, Nelms R, Curran C. Impact of early intervention on outcome following mild head injury in adults. *J Neurol Neurosurg Psychiatry*. 2002;73(3):330–32. [PMID: 12185174]
26. Mittenberg W, Tremont G, Zielinski RE, Fichera S, Rayls KR. Cognitive-behavioral prevention of post-concussion syndrome. *Arch Clin Neuropsychol*. 1996;11(2):139–45. [PMID: 14588914]
27. McCrea M, Kelly J, Randolph C. Standardized assessment of concussion: Manual for administration, scoring, and interpretation. Alexandria (VA): Brain Injury Association; 1997.
28. Vanderploeg RD, Collins RC, Sigford B, Date E, Schwab KA, Warden D, Defense and Veterans Brain Injury Center Veterans Health Administration study planning group. Practical and theoretical considerations in designing rehabilitation trials: The DVVIC cognitive-didactic versus functional-experiential treatment study experience. *J Head Trauma Rehabil*. 2006;21(2):179–93. [PMID: 16569991]
29. Cavallaro G. A sort of homecoming: War and PCS orders: Carson helps brigade cope. *Army Times*. 2005 Sep 5.
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