

## Traumatic Brain Injury in the Military

Brian Peterson

Graduated Spring 2009, Dept. of History, University of Colorado at Colorado Springs

### Abstract

Although it is agreed that Traumatic Brain Injury (TBI) is not a newly discovered injury in either military or civilian medical science, the frequency of incidents during the past 7 ½ years of combat operations in Afghanistan and Iraq have cast a bright light on the subject. Definitions of TBI are most frequently recognized by starting from the idea that a specific event has caused a deviation in brain function. A diagnosis based on multiple factors will lead to classifications of TBI varying from mild to severe. The most common variable that exists in all forms of TBI is blast. Blast is undoubtedly what makes military and civilian cases of TBI divisible. Injury related to blast is categorized as resulting in a primary, secondary, tertiary, or quaternary blast injury, which is calculated by the relationship of the Soldier and the explosion. The mildest forms of TBI, normally defined as closed head injuries resulting from a primary blast are easy to diagnose in individuals that appear dazed or confused. Complexities begin to emerge in diagnosis when another gross injury, naturally, takes precedence. These cases can often be missed initially and then discovered later on during follow up care. The home station apparatus for diagnosis has significantly improved over the past few years, but inconsistencies become more frequent the further diagnosis is made from the point of an event. While significant progress has been made to help returning veterans deal with TBI, much is left to understand about the injury and care structures that continue to work to support veterans.

### Acronyms

DVBIC - Defense and Veterans Brain Injury Center  
FOB - Forward Operation Base  
GWOT - Global War on Terrorism  
OEF - Operation Enduring Freedom  
OIF - Operation Iraqi Freedom  
PPE - Personal Protective Equipment  
TBI - Traumatic Brain Injury

### Introduction

#### *What Is TBI?*

Having been recognized relatively recently as the predominant injury of troops returning from deployments as part of the Global War on Terrorism (GWOT), the diagnosis and treatment of Traumatic Brain Injury (TBI) has gained significant momentum and support. The Defense and Veterans Brain Injury

Center (DVBIC), headquartered at Walter Reed Army Medical Center in Washington DC, defines TBI as “a blow or jolt to the head or penetrating head injury that disrupts the function of the brain.”<sup>1</sup> Since the early 1990’s, governmental programs have existed specifically to address the needs of traumatic brain injured veterans. These programs, along with increases in both research and resources, have stimulated understanding of TBI and launched the support of this injury to never before seen levels. It is also widely recognized that there is much room for improvement in this developing field as well. Much of what is known about TBI is qualified in the cause and effect relationship that exists between injuries and symptoms rather than a developed scientific understanding of impacts on brain function. The research methodology employed in this project focused first on an attempt to understand the definitions associated with the injury, as well as examine the effectiveness of the government programs that support it. Finally, it is this project’s intent to provide recommendations on these findings for better prevention, diagnosis, and treatment.

### *Purpose*

The purpose of this report is to provide the uniformed reader with a baseline understanding of the significance, severity, and forms of Traumatic Brain Injury. While substantial progress has been made to support this injury in the forms of finance, research, and care, improvements can be made in the methods used to diagnose TBI that will help gain a more accurate understanding of the real volume of Service members that have been affected from TBI.

### *Scope*

The focus of this analysis is military TBI. While TBI has applicability in the civilian sector, namely from vehicle accidents or falls, significant enough differences exist to allow for separate interpretations. An example of this gap, seen in Deborah Warden’s article “Military TBI During the Iraq and Afghanistan Wars,” where she points out that “military females have an incidence rate of TBI roughly on par with civilian males.”<sup>2</sup> This idea is taken a step further in its original idea published in 1996 in *The Journal of Trauma: Injury, Infection, and Critical Care*, in adding the caveat that this particular study was taken during peacetime.<sup>3</sup> It is an obvious assertion that the number of female Soldier cases of TBI in wartime is exponential to that of civilian men. The diversity in military TBI cases alone is wide enough to fill the many pages of this analysis and allow for a focused specificity.

## **Slipping Through the Cracks**

### *Baselines*

In order to gain a better overall understanding of TBI it is important to acknowledge a few key terms and concepts. Perhaps because of the relatively recent focus of research surrounding TBI, most of the substance regarding its definition is rooted in two factors: levels of the severity and causal information.

### *Levels of Severity*

Traumatic Brain Injury is diagnosed in three levels, progressing from mild to moderate, then onto severe. As described in the Department of Veterans Affairs Independent Study Course, released in 2004, classifications for each level...

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<sup>1</sup> Defense and Veterans Brain Injury Center, “DVBIC Fact Sheet,” [http://dvbic.org/public\\_html/pdfs/DVBIC-Facts-2007.pdf](http://dvbic.org/public_html/pdfs/DVBIC-Facts-2007.pdf), all further citing referred to as DVBIC.

<sup>2</sup> Deborah Warden, “Military TBI During the Iraq and Afghanistan Wars,” *The Journal of Head Trauma Rehabilitation* 21, no. 5 (September/October 2006): 398.

<sup>3</sup> Ommaya, AK, Ommaya, AK, Dannenberg, AL, Salazar, AM, “Causation, Incidence, and Costs of Traumatic Brain Injury in the U.S. Military Medical System,” *The Journal of Trauma: Injury, Infection and Critical Care* 40, no. 2 (February 1996): 216.

Are defined using one of three indexes: score on the Glasgow Coma Scale (GCS), length of loss of consciousness (LOC), and length of post-traumatic amnesia (PTA). GCS is a 15-point scale measuring eye opening, motor, and verbal responses, LOC is the length of time the patient was non-responsive, and PTA is the time interval from when the person regains consciousness until he or she is able to form memories for ongoing events.<sup>4</sup>

The results of the screening are compiled and the data from these tests are then translated into classifying levels of severity as described in Figure 1.

<b>Severity Grades of TBI</b>		
Mild (Grade 1)	Moderate (Grade 2)	Severe (Grade 3 & 4)
Altered or LOC < 30 min with normal CT &/or MRI	LOC < 6 hours with abnormal CT &/or MRI	LOC > 6 hours with abnormal CT &/or MRI
GCS 13-15	GCS 9-12	GCS < 9
PTA < 24 hours	PTA < 7 days	PTA > 7 days

Figure 1. Severity Grades of TBI. *United States, Traumatic brain injury: independent study course* (Veterans health initiative, 2003).

The table above outlines the criteria required to establish a diagnosis for TBI severity. While this seems to be a rather straightforward and effective model for evaluation, it also raises a significant question that could potentially develop inconsistencies- how accurate is the self diagnosis of LOC? The question a TBI screener is positive to ask, “What is the last thing you remember?” will undoubtedly render an answer that the screener cannot substantiate with any certainty. There seems to be a substantial amount of gray area that can come from this line of reasoning.

#### *Primary Cause*

The variances of causal data relating to TBI range across a wide spectrum. Causes seemingly close to civilian models resulting from falls, fights, or otherwise clumsy acts exist. The other end of the spectrum, which can safely be assumed a product of military conflict and making up to 88 % of all combat cases, is blast injury.<sup>5</sup> The DBVIC contends that blast is the leading cause of TBI injury in war zones.<sup>6</sup> Injury from a blast can occur from one of four circumstances which result in the assigning of an injury category derived from the event. An Injury caused by a change in the atmospheric pressure around the Soldier is considered a primary source injury. A Secondary source injury occurs by penetration of debris, i.e. being hit by something. Tertiary injury occurs when the Soldier becomes the projectile and ends up hitting or running into something. The fourth type of injury, quaternary source, is the result of heat related to the blast.<sup>7</sup> The significance in classification of each case of TBI is important because establishing a “ground zero” for each incident provides a clear starting point for both rehabilitation and study.

<sup>4</sup> United States, *Traumatic brain injury: independent study course*. Veterans health initiative. [Washington, D.C.]: Dept. of Veterans Affairs, 2003.

<sup>5</sup> Warden, 399.

<sup>6</sup> DVVIC, Fact Sheet.

<sup>7</sup> Elisabeth Moy Martin, et al, "Traumatic brain injuries sustained in the Afghanistan and Iraq wars," *Journal of Trauma Nursing* 15, no. 3 (July 2008): 94-99, *CINAHL Plus with Full Text*, EBSCOhost (accessed December 7, 2008), 95

### *Types of Head Injuries*

Finally, head injuries are defined as either penetrating or closed head. Penetrating injuries are caused “by an object that pierces the skull and enters the brain tissue,” while closed head injuries occur “when the head hits an object but the object does not break through the skull, resulting in a rapid acceleration-deceleration of the brain.”<sup>8</sup> The concept of open versus closed head injury is arguably the most important detail in attempts to understand the scope of the problem. It would be very hard to dispute the rationale that for each diagnosed open and closed head case of TBI, another undiagnosed closed case exists. A sleeping giant exists in the unknown percentage of undiagnosed mild TBI cases caused when Soldiers share a blast unequally.

### *What does it mean?*

The significance of outlining the concepts mentioned thus far lead directly to the heart of this report. The 2008, 453 page research study conducted by Rand, *The Invisible Wounds of War: Psychological and Cognitive Injuries, their Consequences, and Services to Assist Recovery*, concluded that “about 80% of patients with known TBI are categorized as mild TBI.”<sup>9</sup> Taking this idea even further, in the *Journal of Head Trauma Rehabilitation*, Warden conveys her idea that 88% of cases deal with closed head TBI.<sup>10</sup> Perhaps the most significant point to realize from these amazing estimates is that they are of Soldiers that have been diagnosed. What of the cases that go undiagnosed? If the overarching percentage of TBI cases are mild; and injury is not visible, the reality of what is very well likely the true numbers of injured Soldiers is nothing short of frightening.

### *Diagnosis*

The author of this report has first hand experience specific to this topic, including the diagnosis processes of TBI. While having been deployed cumulatively for approximately 30 months in support of the GWOT, events directly related to this subject have not been avoided. The process of diagnosis can happen in either the combat or home station setting.

In a combat related blast event TBI is rather easy to diagnose when the Soldier is visibly dazed and looking like their “bell” has been rung. But it is not that simple; two variables may exist that can significantly increase the possibility of missing the symptoms of mild TBI. First, symptoms are not nearly as easy to identify if a dazed state goes unnoticed because of the existence of a greater injury. Naturally, triage of a lost limb is an urgent priority and can very well be the focus throughout exfiltration. Second, is the epicenter of undiagnosed cases, which Warden concedes, “we know virtually nothing about any possible sequelae of exposure to multiple blasts when an individual does not sustain injuries that require medical evacuation from the war zone.”<sup>11</sup> This point is important because it highlights an idea widely known about the Armed Forces, no one does anything alone. A blast event is nearly never an individual experience. The Servicemember that self-assesses himself as having a less than minor injury after a blast and continues to fight is the greatest candidate for a missed diagnosis.

The mechanisms set up over the past few years at home station for TBI screenings and diagnosis have become very mature. An examination of the TBI clinic at the Soldier Readiness Process (SRP) site on Fort Carson<sup>12</sup> will show as the closest example of the level of effort and care that is prevalent. Soldiers recently returning from a combat zone are required to conduct a Post-Deployment Health Assessment

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<sup>8</sup> Terri Taniellan and Lisa H. Jaycox, *Invisible wounds of war psychological and cognitive injuries, their consequences, and services to assist recovery*, Santa Monica, CA: RAND, (2008): 13.

<sup>9</sup> Ibid, 13.

<sup>10</sup> Warden, 400.

<sup>11</sup> Ibid, 399.

<sup>12</sup> TBI Clinic on Fort Carson, “Fort Carson SRC Medical,” <http://evans.amedd.army.mil/srp/>.

(PDHA) within 5 working days and then a follow up Re-Assessment (PDHRA) between the first 3-6 months back. During the initial assessment, a TBI screening is mandatory and is available at any time up to and including the re-assessment. The development of the program, with the influx of new technology and the diligence of the staff are helping Soldiers in post deployment, post blast diagnosis.

### **Conclusion**

In Hoge's comprehensive study of 2525 recently returned Infantrymen in *The New England Journal of Medicine*, he notes slightly over 15 % reported TBI related symptoms, with another nearly 17% reporting other injuries.<sup>13</sup> Logic dictates that if 50% of Soldiers injured have acknowledged symptoms of TBI, a percentage of those otherwise injured (especially if blast related) are high risk for developing symptoms of TBI. This point is reinforced in both Warden and Tanielian's previously mentioned idea; being that the percentage of blast related mild TBI cases is over 80% of those diagnosed, then a percentage of those with "other injuries" also have TBI, knowingly or not. A recently published article by the *Associate Press* by Lauran Neergaard titled "Brain-injured troops face unclear long-term risks," helps in clarifying the idea that "because symptoms may not be immediately apparent, troops may not seek care."<sup>14</sup> Or they may not want it. The one major flaw with post deployment screening and diagnosis is the consideration of the human factor. After spending up to the last 15 months in a combat zone, it is very easy to get tunnel vision. A focus on friends, food, or family is upmost in the mind of the Soldier forced to sit in long lines and then potentially answer questions in a way they fear will delay their renewed freedom any longer. This is a tough pill to swallow for program managers and leaders working very hard to provide proper care to returning Soldiers, but it is a reality. Possibly too little, too late, it is avoidable. Incorporation of the TBI screening process into an already existing re-deployment checklist that commanders must utilize either at a larger Forward Operation Base (FOB), or the funnel all troops are required to pass through anyway, Kuwait.

Perhaps what is most interesting about the emergence of TBI as the "signature injury of the Iraq war,"<sup>15</sup> is that it is essentially a self-inflicted gunshot wound. Technological advances in equipment have significantly increased survivability on the battlefield. Simply put, advances in Personal Protective Equipment (PPE), ranging from body armor to eye-wear allow for Soldiers to live through events that would have killed previous generations of warriors. The Department of Defense, along with many other links updated almost daily, publishes a document titled "DoD Military Casualty Information" which shows a ratio of nearly 10:1 between injuries and deaths.<sup>16</sup> Successful advances focused on keeping Soldiers alive have created a completely new set of challenges.

### **Recommendations**

The real-time progress being made in the fields related to Traumatic Brain Injury cannot be downplayed. While science will continue to challenge researchers as they continue to try to better understand the links between brain function and TBI, screening and diagnosis professionals must also continue to be as proactive. An undoubted way to increase the effectiveness of screening, by removal the above mentioned

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<sup>13</sup> Charles W. Hoge, M.D., Dennis McGurk, Ph.D., Jeffrey L. Thomas, Ph.D., Anthony L Cox, M.S.W., Charles C. Engel, M.D., M.P.H., and Carl A. Castro, Ph.D. 2008, "Mild Traumatic Brain Injury in U.S. Soldiers Returning from Iraq," *The New England Journal of Medicine* 358, no. 5 (January 31), <http://content.nejm.org/cgi/content/short/358/5/453> (accessed November 6 2008), 453.

<sup>14</sup> Laureen Neergaard, "Brain-injured troops face unclear long-term risks," Associated Press, <http://license.icopyright.net/user/viewFreeUse.act?fuid=MjEyNTM2NQ==>.

<sup>15</sup>Ibid, 1.

<sup>16</sup> United States Department of Defense, "DoD Military Casualty Information," [http://search.dma.mil/search?q=casualty+report&spell=1&access=p&output=xml\\_no\\_dtd&ie=UTF-8&client=defenseink&site=defense\\_link&proxystylesheet=defenseink](http://search.dma.mil/search?q=casualty+report&spell=1&access=p&output=xml_no_dtd&ie=UTF-8&client=defenseink&site=defense_link&proxystylesheet=defenseink).

“human factor” would be to move the screening process as close to the vehicle, building, or ambush as realistically possible. The establishment of an in-country mechanism focused not only on real-time post blast data, but also the incorporation of the home station screening model to the massive ports-of-exit for redeploying troops could significantly increase efficiency in early detection of Traumatic Brain Injury.

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