

# Incidence of Posttraumatic Stress Disorder and Mild Traumatic Brain Injury in Burned Service Members: Preliminary Report

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**Background:** Although sustaining physical injury in theater increases service members' risk for posttraumatic stress disorder (PTSD), exposure to explosive munitions may increase the risk of mild traumatic brain injury (mTBI). We hypothesized a higher incidence of PTSD and mTBI in service members who sustained both burn and explosion injuries than in nonexplosion exposed service members.

**Methods:** A retrospective review of PTSD and mTBI assessments was completed on burned service members between September 2005 and August 2006. Subjects were divided into cohort groups:

(1) PTSD and mTBI, (2) PTSD and no mTBI, (3) mTBI and no PTSD, (4) no mTBI and no PTSD. Specific criteria used for group classification were based on subjects' total score on Posttraumatic Stress Disorder Checklist, Military version (PCL-M), clinical interview, and record review to meet American Congress of Rehabilitation Medicine criteria for mTBI. Descriptive analyses were used.

**Results:** Seventy-six service members met the inclusion criteria. The incidence rate of PTSD was 32% and mTBI was 41%. Eighteen percent screened positive for PTSD and mTBI; 13% screened positive for PTSD, but not mTBI; 23%

screened positive for mTBI but not PTSD; 46% did not screen positive for either PTSD or mTBI.

**Conclusion:** Given the high incidence of these disorders in burned service members, further screening of PTSD and TBI appears warranted. Because symptom presentation in PTSD and mTBI is clinically similar in acute and subacute stages, and treatments can vary widely, further research investigating symptom profiles of PTSD and mTBI is warranted.

**Key Words:** Burn injury, Blast injury, PTSD, Mild TBI.

J Trauma. 2008;64:S200–S206.

Advances in acute trauma care have increased survival among service members with burn and explosion injuries. Because of improvements in battle site and acute trauma care, more individuals are surviving beyond the “acute phase of injury, making the long-term effects of multiple injuries more apparent”.<sup>1</sup> Seriously injured service members often experience residual physical, cognitive, and emotional impairments and functional disabilities that require rehabilitative treatment to return to the highest possible level of independence in the home, and the opportunity to return to

duty. Service members with mild injuries may have similar experiences that are often undetected. Posttraumatic stress disorder (PTSD) and mild traumatic brain injury (mTBI) are two conditions that have separately received significant attention because of their documented long-term negative impact on health outcomes. Unfortunately, little attention is paid to their interaction. If undetected and untreated, PTSD and mTBI are costly to the individual, the family, the community, and to overall Force health.<sup>2–4</sup>

Psychologic problems are frequently observed in response to burn injury. One-year prevalence rates of PTSD in civilian burn treatment facilities varied between 19% and 45%, taking into account methodologic differences between studies.<sup>5,6</sup> A study of burn support received by 38 burned service members from Operation Iraqi Freedom (OIF) identified that 44.7% of patients had core symptoms of anxiety and 26.3% had core symptoms of depression.<sup>1</sup> Some patients were assessed 1 year after discharge and were found to have symptoms of PTSD; however, the actual incidence of PTSD in this military population is unknown.

Explosive devices such as bombs, grenades, high-velocity missiles, mortar and artillery shells, antitank weapons, and land mines are responsible for 43% to 50% of all injuries in modern-day military conflicts.<sup>7–9</sup> In OIF and Operation Enduring Freedom (OEF), exposure to explosive munitions is one of the leading causes of war zone evacuations in injured service members, particularly in those with burns.<sup>10</sup> “Blast

Submitted for publication October 30, 2007.

Accepted for publication October 31, 2007.

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DOI: 10.1097/TA.0b013e318160ba42

# Report Documentation Page

Form Approved  
OMB No. 0704-0188

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1. REPORT DATE <b>OCT 2007</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-2007 to 00-00-2007</b>	
4. TITLE AND SUBTITLE <b>Incidence of Posttraumatic Stress Disorder and Mild Traumatic Brain Injury in Burned Service Members: Preliminary Report</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>U.S. Army Institute of Surgical Research (USAISR), 3400 Rawley E. Chambers Avenue, Fort Sam Houston, TX, 78234-6315</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

injury” is a generic term frequently used in the current conflict to describe any injury secondary to explosive munitions, such as an improvised explosive device (IED), rocket-propelled grenades (RPG), explosively-formed projectiles (EFP), mortar rounds, vehicle-borne improvised explosive devices (VBIED), and conventional grenades. However, the term “blast injury” is inexact and ignores the four types of blast injury described in the DODI (DoDD 6025.21E, July 5, 2006 Enclosure 2 Taxonomy of injuries from explosive devices.) The high number of explosive injuries and the fact that alterations in brain functionality could modify posttraumatic course, as well as therapeutic and rehabilitative success, emphasize the importance of clarifying whether or not exposure to an explosion causes structural and biochemical changes in the brain and cognitive impairments.<sup>11</sup> Although there is a low probability that open space explosions (based on the primary blast overpressure wave) cause large numbers of mTBI, this assumption is beyond the scope of this work, but must be considered. Potential causes for concussive injuries after explosions include direct exposure to over pressurization waves, injuries from the impact of blast-energized debris (penetrating and nonpenetrating), and displacement of the individual into stationary structures, such as buildings or vehicles.<sup>12</sup> Nonpenetrating brain injuries may go undiagnosed and untreated as attention is focused on the more visible injuries, particularly in cases of multiple injuries.

One of the primary difficulties in determining the specific incidence of TBI and PTSD in service members returning from deployment to Iraq and Afghanistan is that each condition shares a constellation of overlapping symptoms which are relatively nonspecific (Table 1). For example, symptoms found in both PTSD and mTBI include deficits in attention and memory and irritability and sleep disturbance.<sup>13,14</sup> Other symptoms such as headache, dizziness, balance problems, and nausea or vomiting may help to distinguish mTBI from PTSD. Careful consideration must be given to each diagnosis when evaluating service members exposed to explosions. However, the possibility of co-occurrence should not be overlooked.

The lack of understanding of the relationship between PTSD and mTBI was the catalyst for this study, thus, the purpose of this retrospective, descriptive, correlational study, was to examine the incidence of PTSD and mTBI in service members who sustained both a burn and explosion injury during OEF or OIF and were treated at the USAISR. We hypothesized that the incidence of PTSD and mTBI would be higher in service members who sustained both a burn and explosion injury, than in nonexplosion exposed service members. This is a preliminary report of the incidence of PTSD and mTBI using assessment data collected from September 2005 through August 2006.

## METHODS

### Subjects

A purposive sample of service members with burn and explosion injuries treated at the USAISR, who were assessed

**Table 1** Symptom Profile of PTSD and mTBI

PTSD	mTBI
Dissociation	Dissociation
Emotional numbing	Emotional numbing
Reduced awareness	Reduced awareness
Amnesia	Amnesia
Depersonalization	
Derealization	
Reexperiencing	Reexperiencing
Recurrent images	
Nightmares	
Distress on reminders	
Avoidance	Avoidance
Social detachment	Social detachment
Diminished interest	Diminished interest
Avoid reminders	
Foreshortened future	
Arousal	Arousal
Insomnia	Insomnia
Irritability	Irritability
Concentration deficits	Concentration deficits
Hypervigilance	
Elevated startle response	
	Neuromedical
	Headache
	Dizziness or vertigo
	Nausea or vomiting

for both PTSD and TBI during the study period (Sep 2005–Aug 2005) was used for this study. “Blast injury” was operationally defined as sustaining a combat injury caused by explosive munitions, such as an IED, RPG, EFP, mortar rounds, VBIED, and conventional grenades. The population at risk was calculated by using the earliest admission date of subjects in the study through the end of the study period (August 2004–2006). Subjects were included in the study if they sustained both a burn and blast injury and were assessed for both PTSD and TBI. Subjects were excluded if they had a moderate or severe TBI.

### Procedure

Subject’s medical records (Essentris) and the Trauma Burn Registry (established and maintained by USAISR) were crosschecked to verify names and admission dates. The assessment data were gathered by the research team and entered into Excel spreadsheets (Microsoft, Redmond, WA) and then transferred to SPSS software for Windows (Version 14; SPSS 10.0, Chicago, IL) for analysis. Approval for the study was given by the Brooke Army Medical Center (BAMC) Institutional Review Board before commencement.

Subjects were divided into four cohort groups: (1) PTSD and mTBI, (2) PTSD and no mTBI, (3) mTBI and no PTSD, (4) no mTBI and no PTSD. Specific criteria used to classify the subjects into the four cohort groups were based on subjects’ total score on the Posttraumatic Stress Disorder Checklist, Military version (PCL-M), and a clinical interview and record review to

analyze whether the patients met American Congress of Rehabilitation Medicine (ACRM) criteria for mTBI.<sup>15</sup>

### Diagnosis of Posttraumatic Stress Disorder

For this study, PTSD was defined as a score of 44 or greater on the PCL-M. The PCL-M was conducted by the USAISR staff Psychiatric Mental Health Clinical Nurse Specialist. The PCL-M is a self-rated interval-level rating scale used to screen for PTSD in military groups.<sup>16</sup> The PCL-M requires the identification of a specific traumatic event or occurrence from which symptoms are thought to be triggered. This is designated the “reference trauma”. The PCL-M consists of 17 items, each designed to capture one of three distinct clusters of symptoms representing the B, C, or D diagnostic criteria described for PTSD in the *Diagnostic and Statistical Manual of Mental Disorders*, third (1980) and fourth (1994) editions. These three clusters are labeled re-experiencing (“B” items, 1–5), avoidance or numbing (“C” items, 6–12), and hyper-arousal (“D” items, 13–17). The frequency of occurrence of each symptom for the past year is marked using a 1 (not at all) to 5 (extremely) scoring. At least 16 of the 17 items must be completed for the test result to be considered useful.<sup>17</sup> Scores are derived by summing the weighted frequencies for all items marked. Scores can range from 17 to 85. A total score of 44 or higher indicates the presence of PTSD. By lowering the cut-off score to 44 (previously recommended as 50), overall diagnostic efficiency is improved to 0.90, yielding a sensitivity of 0.778, a specificity of 0.864, and correctively identifies 17 of 18 participants with PTSD.<sup>18</sup>

### Diagnosis of Traumatic Brain Injury

Mild TBI was defined as loss of consciousness (<30 minutes); loss of memory for events immediately before (retrograde amnesia), or after the injury (posttraumatic amnesia (PTA) <24 hours); any alteration in mental state at the time of the injury (dazed, disoriented, confused); presence of focal neurologic deficits; and a Glasgow Coma Scale score >13.<sup>15</sup> Subjects with moderate or severe TBI (as defined by GCS <12 and duration of PTA >24 hours) were excluded from the current study. Clinical interviews and review of records regarding diagnosis of TBI were conducted by two clinical neuropsychologists at BAMC.

### Statistical Analysis

Descriptive analyses were performed and mean scores and SD were obtained.  $\chi^2$  was used to test significance. Data were analyzed using SPSS for Windows, Version 14.

## RESULTS

The population at risk included 360 service members admitted to the USAISR Burn Center for burn and explosion injuries from August 2004 to August 2006. The risk period was calculated by using the earliest admission date of subjects in the study through the end of the study period. One

hundred forty-six burned service members treated at the USAISR Burn Center were assessed for PTSD during September 2005 through August 2006. Of these, 80 were also assessed for TBI. Two subjects were excluded because they were not injured in OEF or OIF. Two subjects were diagnosed for moderate and severe TBI and were excluded. Seventy-six subjects met inclusion criteria for this study.

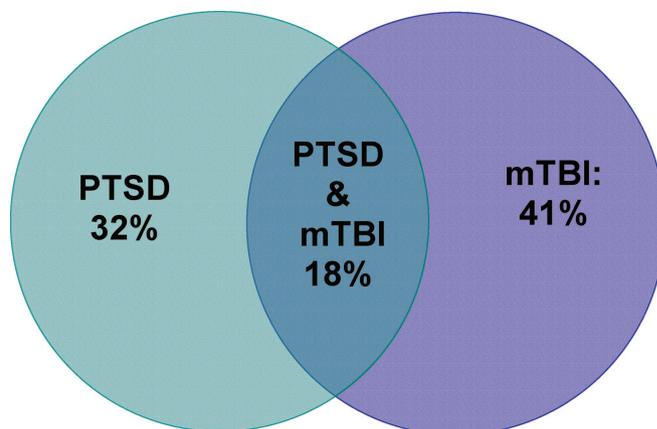
### Incidence Rate

A total of 24 service members (32%) were found to have PTSD and 31 service members (41%) were found to have mTBI (Fig. 1). The incidence of PTSD among burned service members diagnosed with mTBI was significant when compared with those not diagnosed with mTBI ( $p = 0.0345$ ).

Analysis of the four cohort groups identified that 14 service members (18%) had both PTSD and mTBI. Ten service members (13%) had PTSD but did not have mTBI. Seventeen service members (23%) had mTBI but did not have PTSD. Thirty-five service members (46%) did not have either PTSD or mTBI (Table 2).

### Descriptive Data

The average age was  $25.5 \pm 6$  years (range, 18–43) and 96% of subjects were men. The average total body surface area (TBSA) was  $11.8 \pm 12.2$ . The average injury severity



**Fig. 1.** Incidence of PTSD, mTBI and concomitant PTSD and mTBI. This figure shows that of the 76 service members that were assessed for both PTSD and mTBI, 32% (24) screened positive for PTSD, 41% (31) screened positive for mTBI, and 19% (14) had both PTSD and mTBI.

**Table 2** Association Between PTSD and MTBI

	Case Group mTBI	Case Control No mTBI	Total
PTSD	14	10	24
No PTSD	17	35	52
Total	31	45	76

Nineteen percent (14 of 75) of service members had both PTSD and mTBI (case exposure rate). Forty-six percent (35 of 75) of service members had neither PTSD nor mTBI (control exposure rate).

**Table 3 Demographics (Sample)**

	n	%	Avg. $\pm$ SD	Range
Age	76	100	25.5 $\pm$ 5.85	18–43
Gender (male)	73	96.0		
TBSA			11.8 $\pm$ 12.2	0.50–61.5
ISS			11.3 $\pm$ 11.2	1.00–67.00
ICU			4.5 $\pm$ 10.8	0.00–49.00
LOS			15.3 $\pm$ 20.6	1.00–104.00

**Table 4 Demographics (By Group)**

	PTSD		No PTSD	
	mTBI	No mTBI	mTBI	No mTBI
Age				
Avg. $\pm$ SD	25 $\pm$ 5.2	22.5 $\pm$ 4.9	28.9 $\pm$ 7.3	25.1 $\pm$ 5.0
Range	19–36	18–35	19–43	19–39
Gender (male)				
Avg. $\pm$ SD	0.93 $\pm$ 0.26	1.0 $\pm$ 0.0	1.0 $\pm$ 0.0	0.94 $\pm$ 0.2
TBSA				
Avg. $\pm$ SD	10.8 $\pm$ 12.3	9.9 $\pm$ 8.4	17.0 $\pm$ 16.4	10.5 $\pm$ 10.8
Range	0.50–44.0	2.0–24.0	2.0–61.5	0.75–42.5
ISS				
Avg. $\pm$ SD	10.6 $\pm$ 8.4	9.7 $\pm$ 8.5	14.2 $\pm$ 11.0	10.7 $\pm$ 12.9
Range	1.0–29.0	1.0–25.0	1.0–38.0	1.0–67.0
ICU				
Avg. $\pm$ SD	2.0 $\pm$ 6.7	1.6 $\pm$ 3.9	12.1 $\pm$ 12.1	2.8 $\pm$ 8.9
Range	0.00–25.0	0.00–12.0	0.00–42.0	0.00–49.0
LOS				
Avg. $\pm$ SD	13.6 $\pm$ 9.8	16.0 $\pm$ 26.6	19.0 $\pm$ 20.9	14.1 $\pm$ 22.2
Range	2.0–42.0	1.0–9.0	1.0–62.0	1.0–104.0

score (ISS) was 11.3  $\pm$  11.2 (range, 1–67). The average days spent in the intensive care unit (ICU) was 4.5  $\pm$  10.8. The average length of hospital stay (LOS) was 15.3  $\pm$  20.8 (Table 3). Demographic data were calculated across the four cohort groups (Table 4). The range of TBSA was similar across groups, but highest in the group with mTBI and no PTSD, suggesting that burn size is associated with mTBI. ISS and LOS are highest in the group with no PTSD and no mTBI; however, this group is twice the size of the other three groups.

## DISCUSSION

This study was a retrospective review of PTSD and mTBI assessments completed September 2005 through August 2006. Subjects were service members who sustained both a burn and blast injury while serving in combat and were treated at the USAISR. We identified that almost one third of service members in the study met the criteria for PTSD and more than one third met the criteria for mTBI. Of clinical interest is that one fifth of service members with burn and blast injuries met the criteria for both PTSD and mTBI, whereas 46% did not manifest either condition.

The incidence of PTSD found in our study is not surprising. Injured service members returning from combat duty must cope with both the psychological impact of the war

experience, as well as the injury and associated treatments or therapy. Studies identified that PTSD interacts to increased emotional distress and dysfunction after trauma.<sup>19–22</sup> Of concern is that unrecognized or untreated PTSD will impede the recovery from trauma. The incidence of PTSD found in our study is consistent with those found in studies of civilians after trauma (33%–42%), although there is variability in the time of assessment and instruments used for assessment. Studies of service members report the incidence of PTSD as 11% to 17% in noninjured soldiers postdeployment.<sup>23,24</sup> Predeployment rates are lower (5%) and similar to rates of PTSD in the general US population (3%–4%).<sup>23,25</sup> Although conservative, the rate of PTSD in noninjured service members is half the rate of PTSD occurring in trauma patients. Given the number of traumatically injured service members returning from combat duty, understanding the incidence of PTSD is critical.

Because the risk of being in an explosion in the current war is high, there is an increased chance of sustaining a mTBI. mTBI may escape detection at presentation because of the absence of radiographic abnormalities. Additionally, cognitive deficits remain unknown until serious psychosocial dysfunction is present.<sup>26</sup> In this study, we analyzed the incidence of mTBI in service members who sustained burns after exposure to explosive munitions. We found an mTBI incidence rate of 41%, which is generally comparable with the incidence (32%–36%) in other at-risk trauma and critical care populations.<sup>20,21</sup> In terms of co-occurrence of these conditions, the incidence rate of 19% in our study was similar to the range (11%–27%) of incidence of PTSD reported in civilian patients with mild to severe TBI from injuries such as motor vehicle crashes, falls, and assault.<sup>19,22,27–29</sup> Our findings suggest that the brain responds similarly in both populations to a range of physical and emotional injuries that may be specific to military or civilian populations.

One of the major strengths of this study is that there was no selection bias in the referral system, since all service members who sustain a burn injury are treated at the USAISR. However, there are several limitations to the study. The study was a retrospective review of completed PTSD and TBI assessments using a convenience sample, thus, subjects were not randomly selected. Previous to the study inclusion dates, the assessment of PTSD was completed based on clinician judgment. Consistent use of the PCL-M for assessment of PTSD led to the selection of study inclusion dates. We recognize that subjects may have been lost to mortality and discharge. Although self-report studies are not equal to clinician interview-based measures, the PCL-M is a well validated scale. The use of 44 as a cut-off score on the PCL-M increases overall diagnostic efficiency; however, most studies continue to use 50 as criteria for PTSD resulting in a more conservative rate of PTSD.<sup>18,23</sup>

The assessment of TBI was similar to the assessment of PTSD in that although nearly all explosion-injured soldiers were referred for assessment, some attrition occurred as a result of early discharge or transfer to home units. We surmise

that attrition caused a slight decrease in the overall incidence. However, service members discharged rapidly were likely to have reported minimal, if any symptoms which would warrant clinical attention. Assessment of TBI became more frequent with the increased admission of service members with explosion injuries and the availability of staff neuropsychologists. Another limitation of the study is the retrospective assessment of post-traumatic amnesia and self-report of loss of consciousness. However, Glasgow Coma Scale scores are not uniformly available until the patients are received in the ED, and other confounding factors (e.g., intubation, administration of medication) affect the utility of GCS scores in burn patients.<sup>30</sup> Finally, there was variability in timing between the assessment of PTSD and TBI and how long the assessments were completed after injury. The study findings, based on burned service members, cannot be generalized to the uninjured army population at large or similar civilian populations but are likely representative of injured service members at higher risk of psychologic sequelae.

## CONCLUSION

This study identified an incidence rate of 32% for PTSD and 41% mTBI in service members who sustained both a burn and blast injury while serving in combat. In total, 18% of service members with burn and explosion injuries met the criteria for both PTSD and mTBI, whereas 46% did not manifest either condition. Given the high incidence rates in this population, continued concurrent screening of PTSD and mTBI in seriously injured patients is critical. Furthermore, future investigations are needed to enhance early diagnosis of these conditions to provide improved direction for treatment. Prospective studies examining the clinical course of these disorders are warranted to better understand their impact on medical and vocational outcomes.

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## DISCUSSION

**Dr. Carl Andrew Castro** (Walter Reed Army Medical Center, Washington, DC): Posttraumatic stress disorder (PTSD) and mild traumatic brain injury (mTBI), along with amputations, are said to be the three signature wounds of the wars in Iraq and Afghanistan; but surely these combat injuries existed in every war since time immemorial. It is only through scientific advances in psychology and neuroscience that both PTSD and mTBI are now well-recognized combat injuries. Indeed, it is estimated that 10% to 15% of Soldiers and Marines returning from combat duty in Iraq suffer from PTSD, and 10% to 15% of returning service members have mTBI. Although there is overlap, with many service members having both injuries; even a conservative estimate would place the number of Soldiers and Marines returning from combat with either PTSD or mTBI injuries at well over 200,000. These numbers are staggering.

Yet, not all Soldiers and Marines are at equal risk of suffering from PTSD (or mTBI); the level of combat is the main determinant for those most likely to receive these injuries. In a recent assessment conducted in Iraq, just under a third (28%) of all Soldiers and Marines from a brigade or regimental combat team who experienced high levels of combat screened positive for PTSD, twice the estimated rate for all Iraq veterans. In comparison, for Soldiers who reported experiencing medium levels of combat, 14% screened positive for PTSD and for Soldiers who experienced low levels of combat, only 8% screened positive for PTSD. It is important to note that the percent of Soldiers (and Marines) in the low combat group who screened positive for PTSD was no different from the percent of Soldiers who screened positive for PTSD in garrison, and who have never deployed to combat (8% vs. 5%–8%).

The rates of mTBI for Soldiers as function of combat are presently not known. Assuming that the rates of mTBI are similar to those for PTSD, this would mean that over 50% of all Soldiers and Marines experiencing high levels of combat have either PTSD- or mTBI-related combat injuries or both. Let us pause and reflect for a moment on these estimates. If accurate, this would mean that instead of only a minority of Soldiers and Marines suffering from PTSD and mTBI that it is actually a majority of those Soldiers and Marines who are bearing the brunt of the combat duty in Iraq are at risk for PTSD and mTBI. A fact that is not generally appreciated because it is assumed, quite incorrectly, that all Soldiers and Marines are at equal risk for being injured in Iraq or Afghanistan, which is certainly not the case.

What makes both PTSD and mTBI even more insidious, other than its pervasiveness especially among Soldiers and Marines experiencing high levels of combat, is that either injury can result without any accompanying physical injury. Admitting to needing help for a mental health problem in

particular is often met with incredulity, with the Soldier or Marine being accused of being a malingerer, a fake, or weak. For those Soldiers and Marines with long-lasting effects of mTBI in which no brain damage can be detected via a brain scan, they too are likely to be referred to mental health for an evaluation and thus suffer from the stigma associated with mental health. Because of the stigma associated with mental health, I have heard it argued that it is better to receive a diagnosis of mTBI than PTSD (or any mental health disorder for that matter). I am not so sure; what would you rather be told: that you have brain damage or that you have a mental disorder? I think one would be just as unpleasant as the other. Furthermore, the data indicates that you are just as likely to have both injuries. I do not think arguing the merits of one injury over another are terribly helpful.

The important questions are whether or not there exists a set of screening instruments that will allow us to distinguish between PTSD and mTBI and what the treatment regimen should consist of. For PTSD, there are validated screening instruments and well-established treatment regimens. For mTBI, this is less so. No doubt this is caused by the considerable overlap in the symptoms for PTSD and mTBI such as deficits in attention and memory as well as irritability and sleep disturbances. And although much has been made of this overlap of symptoms, there does exist a set of distinct symptoms unique to mTBI, including dizziness, balance problems, nausea, and vomiting. As noted by Gaylord and colleagues, it is important for researchers and clinicians in the fields of PTSD and mTBI to work together to establish validated screening instruments unique (i.e., specific) to each injury. It is also essential that a set of clinical guidelines be developed for those service members who suffer from both PTSD and mTBI.

It is also important that we develop an effective risk communication strategy as to how scientists and clinicians should talk to each other, and how we all will talk to service members, the media, and our senior leaders about PTSD and mTBI. We must be very clear what we mean when we say PTSD and mTBI. The definition for PTSD is very specific (and complex), for mTBI, the definition is less specific, although equally complex. We must agree on the scope of the problem, and communicate accurately efforts that we are currently engaged in to identify Soldiers and Marines early who might be suffering from PTSD and mTBI. Finally, once service members have been diagnosed with PTSD or mTBI or both, we need to be clear about the planned treatment strategy and the expected prognosis, without unduly scaring the service member or their dependents. In short, our message about PTSD and mTBI must be clear, accurate and consistent.

**Kathryn M. Gaylord** (United States Institute for Surgical Research San Antonio, TX): I agree that PTSD and mTBI are now well recognized combat injuries, especially in the popular media. Of concern are the differences and similarities

in the symptom profile of these disorders which impact accurate assessment and treatment. The next step for researchers is to develop sensitive and specific screening instruments that will aid in the understanding of PTSD and mTBI, and increase the communication between researchers and clinicians as you suggest.

The finding that the level of combat is the main determinant for those likely to develop PTSD or mTBI in soldiers and Marines has implications for the severely

injured, since they were likely to have been in high levels of combat. The association between level of combat and risk needs to be further explored in injured populations. Finally, I agree that the stigma associated with mental health, although decreasing, continues to exist and may be most important when considering PTSD and mTBI. The issue may not be that PTSD and mTBI are not differentiated and treated, but that a soldier with either problem seeks adequate assessment or treatment.