VA | U.S. Department of Veterans Affairs

Characterization of Lifetime TBI's in a Cohort of Recently Deployed Soldiers

Lisa A. Brenner, Ph.D.

Rocky Mountain Mental Illness, Research, Education and Clinical Center (MIRECC)
University of Colorado, Anschutz Medical Campus

University of Colorado
Anschutz Medical Campus

ROCKY MOUNTAIN MIRECC

Disclaimer

This presentation is based on work supported, in part, by the Department of Veterans Affairs, but does not necessarily represent the views of the Department of Veterans Affairs or the United States Government.

Dog People versus Cat People

Categories Are Necessary for Social Life

1. Help people function in daily life
2. Gather considerable information into idea clusters
3. Enable us to identify people and things
4. Allow for the attachment of emotions
5. Can be irrational

Allport 1954a

Traumatic Brain Injury - Severity

Table 1. Classification of TBI Severity [3]

(If a patient meets criteria in more than one category of severity, the higher severity level is assigned)			
Criteria	**Mild**	**Moderate**	**Severe**
Structural imaging	Normal	Normal or abnormal	Normal or abnormal
Loss of Consciousness (LOC)	0-30 min	>30 min and <24 hours	>24 hours
Alteration of consciousness/ mental state (AOC)*	up to 24 hours	>24 hours; severity based on other criteria	
Posttraumatic amnesia (PTA)	0-1 day	>1 and <7 days	>7 days
Glasgow Coma Scale (GCS) (best available score in first 24 hours)**	13-15	9-12	<9

*Alteration of mental status must be immediately related to the trauma to the head. Typical symptoms would be looking and feeling dazed and uncertain of what is happening, confusion, and difficulty thinking clearly or responding appropriately to mental status questions, and being unable to describe events immediately before or after the trauma event.

**In April 2015, the DoD released a memorandum recommending against the use of GCS scores to diagnose TBI. See the memorandum for additional information.[3]

Department of Veterans Affairs 2016

Common Mild TBI Symptoms

NOT to be confused with the injury itself

TBI is a historical event

Common Mild TBI/Postconcussive Symptoms

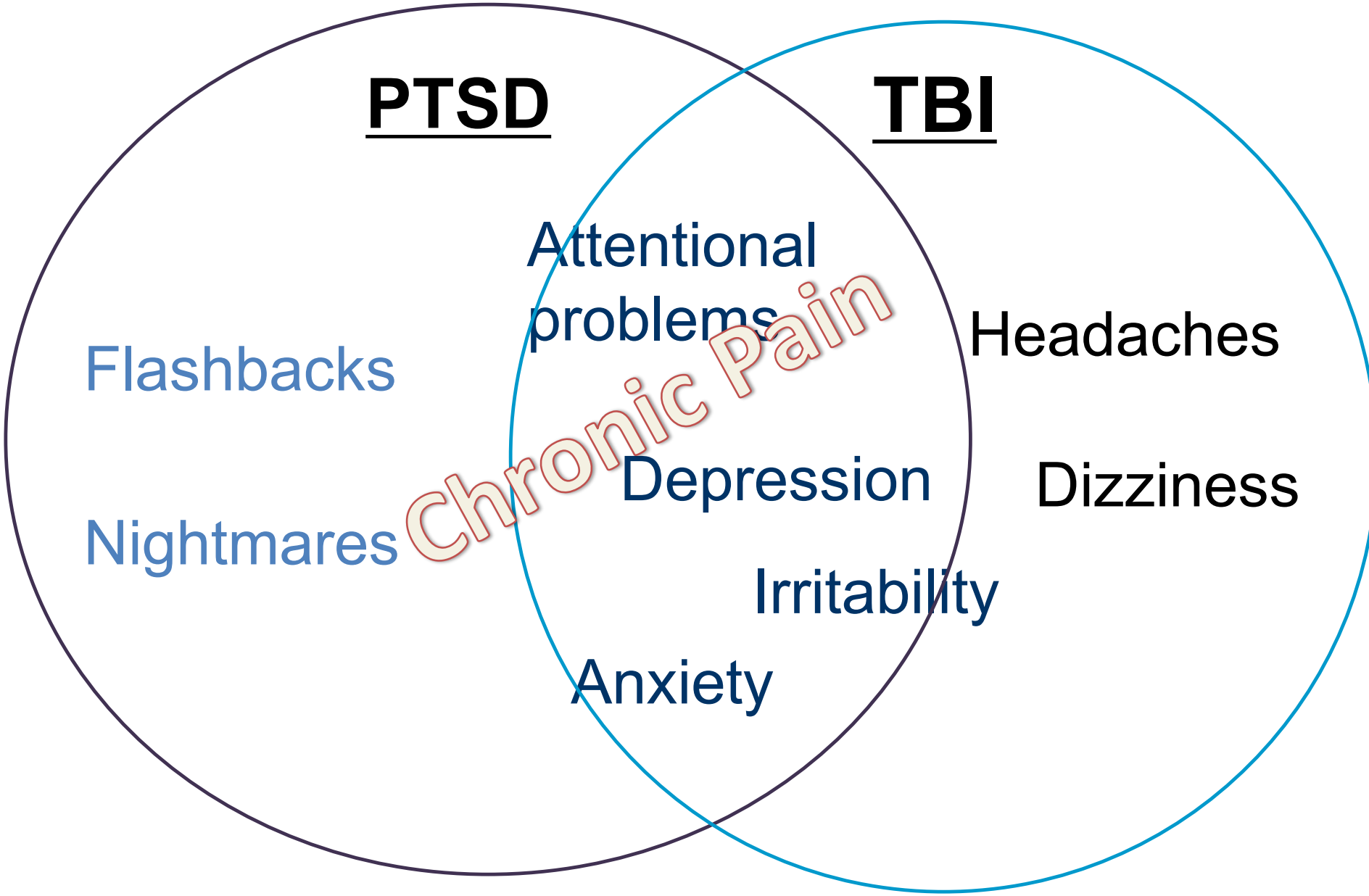
Thinking/Remembering	Difficulty thinking clearly	Feeling slowed down	Difficulty concentrating	Difficulty remembering new information
Physical	Headache Fuzzy or blurry vision	Nausea or vomiting (early on) Dizziness	Sensitivity to noise or light Balance problems	Feeling tired, having no energy
Emotional/Mood	Irritability	Sadness	More emotional	Nervousness or anxiety
Sleep	Sleeping more than usual	Sleep less than usual	Trouble falling asleep	

Immediately post-injury 80% to 100% describe one or more symptoms

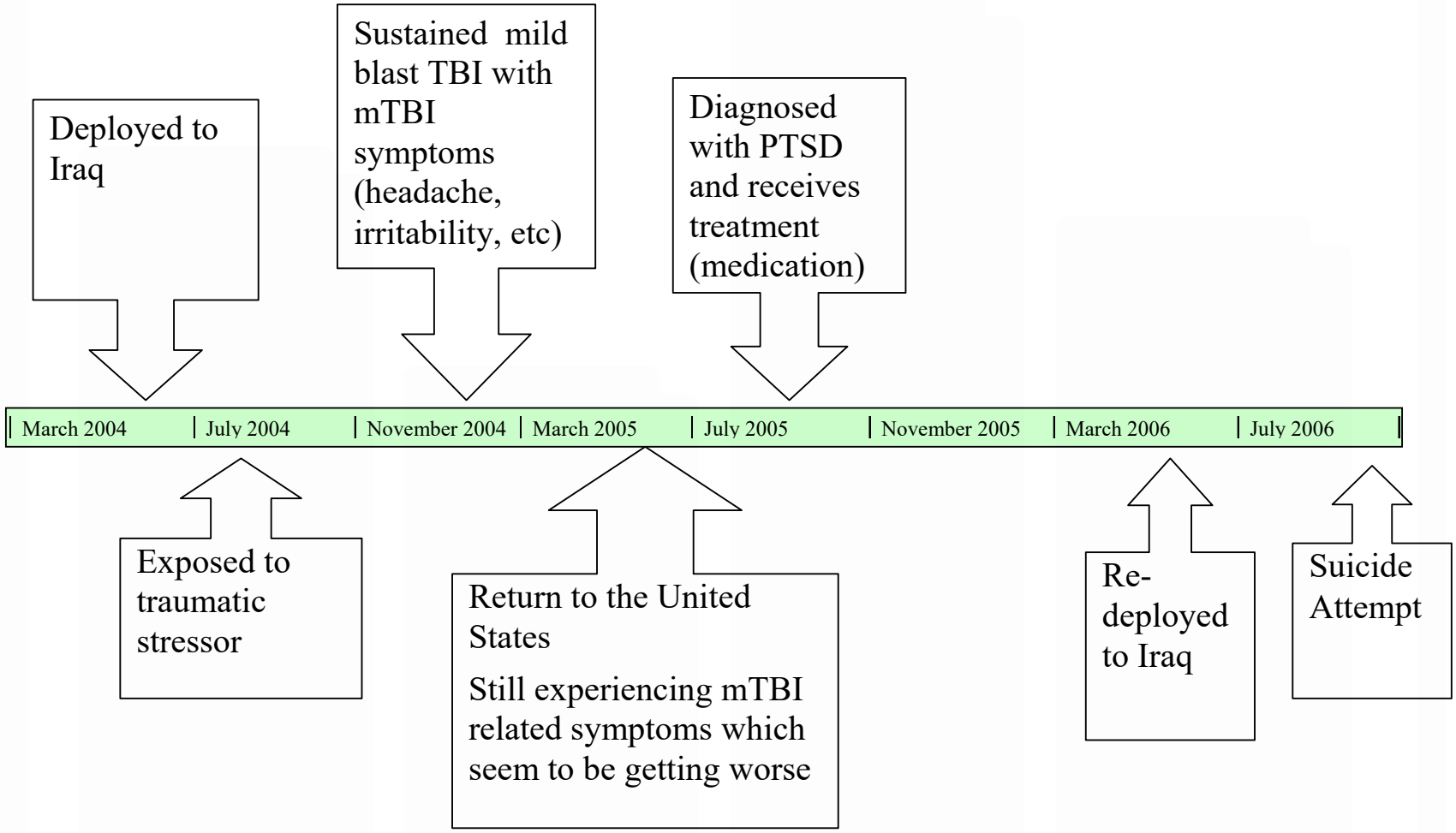
Most individuals return to baseline functioning within a year

http://www.cdc.gov/traumaticbraininjury/pdf/fact_sheet_concusstbi-a.pdf; Carroll et al. 2004; Levin et al. 1987

Potential Clinical Presentation



Case Example: mTBI and PTSD



Increased Rates of PTSD in those with Mild TBI

Article

The Psychiatric Sequelae of Traumatic Injury

Richard A. Bryant, Ph.D.
Meaghan L. O'Donnell, Ph.D.
Mark Creamer, Ph.D.
Alexander C. McFarlane, M.D.
C. Richard Clark, Ph.D.
Derrick Silove, M.D.

Objective: Traumatic injury affects millions of people each year. There is little understanding of the extent of psychiatric illness that develops after traumatic injury or of the impact of mild traumatic brain injury (TBI) on psychiatric illness. The authors sought to determine the range of new psychiatric disorders occurring after traumatic injury and the influence of mild TBI on psychiatric status.

Method: In this prospective cohort study, patients were drawn from recent admissions to four major trauma hospitals across Australia. A total of 1,084 traumatically injured patients were initially assessed during hospital admission and followed up 3 months (N=932, 86%) and 12 months (N=817, 75%) after injury. Lifetime psychiatric diagnoses were assessed in hospital. The prevalence of psychiatric disorders, levels of quality of life, and mental health service use were assessed at the follow-ups. The main outcome measures were 3- and 12-month prevalence of axis I psychiatric disorders, levels of quality of life, and mental health service use and lifetime axis I psychiatric disorders.

Results: Twelve months after injury, 31% of patients reported a psychiatric disorder, and 22% developed a psychiatric disorder that they had never experienced before. The most common new psychiatric disorders were depression (9%), generalized anxiety disorder (9%), posttraumatic stress disorder (6%), and agoraphobia (6%). Patients were more likely to develop posttraumatic stress disorder (odds ratio=1.92, 95% CI=1.08–3.40), panic disorder (odds ratio=2.01, 95% CI=1.03–4.14), social phobia (odds ratio=2.07, 95% CI=1.03–4.16), and agoraphobia (odds ratio=1.94, 95% CI=1.11–3.39) if they had sustained a mild TBI. Functional impairment, rather than mild TBI, was associated with psychiatric illness.

Conclusions: A significant range of psychiatric disorders occur after traumatic injury. The identification and treatment of a range of psychiatric disorders are important for optimal adaptation after traumatic injury.

(Am J Psychiatry 2010; 167:312–320)

Traumatic injury is a common occurrence, with over 2 million people hospitalized in the United States each year following nonfatal injuries (1). Traumatic injury has been shown to be the leading cause of trauma-related psychiatric disorders and hence represents a major public health issue (2, 3). Most attention has focused on the incidence of posttraumatic stress disorder (PTSD) and depression after traumatic injury. Studies indicate that 10%–20% of traumatic injury survivors develop PTSD (4, 5) and 9%–19% develop major depressive disorder (4, 6). Our understanding of the psychiatric impact of traumatic injury has been limited by several factors, however. The focus on PTSD and depression has resulted in a relative neglect of the broad range of psychiatric disorders that can arise after traumatic injury. Some small studies suggest increased rates of anxiety and substance use disorders after traumatic injury (4, 7, 8), but most studies indicate that psychiatric disorders after trauma are typically comorbid with PTSD (9). There remains an outstanding need to evaluate the full range of psychiatric sequelae to traumatic injury.

Another critical issue in the study of traumatic injury has to do with the potential role of mild traumatic brain injury (TBI), which involves transient diminished consciousness following an insult to the brain. Mild TBI represents a major public health issue: the incidence of hospitalized adult patients with mild TBI ranges from 100 to 300/100,000 per year (10). The role of TBI in posttraumatic psychiatric illness has been controversial. Although there is some evidence of comparable rates of PTSD in mild TBI and non-TBI samples (11), some commentators have suggested that impaired consciousness after TBI limits awareness of the traumatic nature of the injury and thus is protective against subsequent PTSD (12). Consistent with this proposal, there is evidence that poorer memory of the traumatic injury after mild TBI is protective against PTSD (13, 14). Several large-scale studies of psychiatric illness associated with TBI have been reported (15–17). For example, based on a large-scale study of 939 health plan members, Fann and colleagues (15) reported that patients with mild TBI were 2.8 times more likely to develop a psychiatric disorder than patients with no TBI. These studies

This article is featured in this month's AJP Audio and is the subject of a CME course (p. 359).

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Mild Traumatic Brain Injury in U.S. Soldiers Returning from Iraq

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.

ABSTRACT

BACKGROUND

An important medical concern of the Iraq war is the potential long-term effect of mild traumatic brain injury, or concussion, particularly from blast explosions. However, the epidemiology of combat-related mild traumatic brain injury is poorly understood.

METHODS

We surveyed 2525 U.S. Army infantry soldiers 3 to 4 months after their return from a year-long deployment to Iraq. Validated clinical instruments were used to compare soldiers reporting mild traumatic brain injury, defined as an injury with loss of consciousness or altered mental status (e.g., dazed or confused), with soldiers who reported other injuries.

RESULTS

Of 2525 soldiers, 124 (4.9%) reported injuries with loss of consciousness, 260 (10.3%) reported injuries with altered mental status, and 435 (17.2%) reported other injuries during deployment. Of those reporting loss of consciousness, 43.9% met criteria for post-traumatic stress disorder (PTSD), as compared with 27.3% of those reporting altered mental status, 16.2% with other injuries, and 9.1% with no injury. Soldiers with mild traumatic brain injury, primarily those who had loss of consciousness, were significantly more likely to report poor general health, missed workdays, medical visits, and a high number of somatic and postconcussive symptoms than were soldiers with other injuries. However, after adjustment for PTSD and depression, mild traumatic brain injury was no longer significantly associated with these physical health outcomes or symptoms, except for headache.

CONCLUSIONS

Mild traumatic brain injury (i.e., concussion) occurring among soldiers deployed in Iraq is strongly associated with PTSD and physical health problems 3 to 4 months after the soldiers return home. PTSD and depression are important mediators of the relationship between mild traumatic brain injury and physical health problems.

From the Division of Psychiatry and Neuroscience, Walter Reed Army Institute of Research, U.S. Army Medical Research and Material Command, Silver Spring, MD (C.W.H., D.M., J.L.T., A.L.C., C.A.C.); and the Deployment Health Clinical Center and Uniformed Services University of Health Sciences, Washington, DC (C.C.E.). Address reprint requests to Dr. Hoge at the Division of Psychiatry and Neuroscience, Walter Reed Army Institute of Research, 503 Robert Grant Ave., Silver Spring, MD 20910, or at charles.hoge@us.army.mil.

N Engl J Med 2008;358:453-63.

"Patients with mild TBI were twice as likely to develop PTSD [or other anxiety disorders]…"

"Mild traumatic brain injury (i.e., concussion) occurring among soldiers deployed in Iraq is strongly associated with PTSD…"

J Head Trauma Rehabil
Vol. 24, No. 1, pp. 14-23

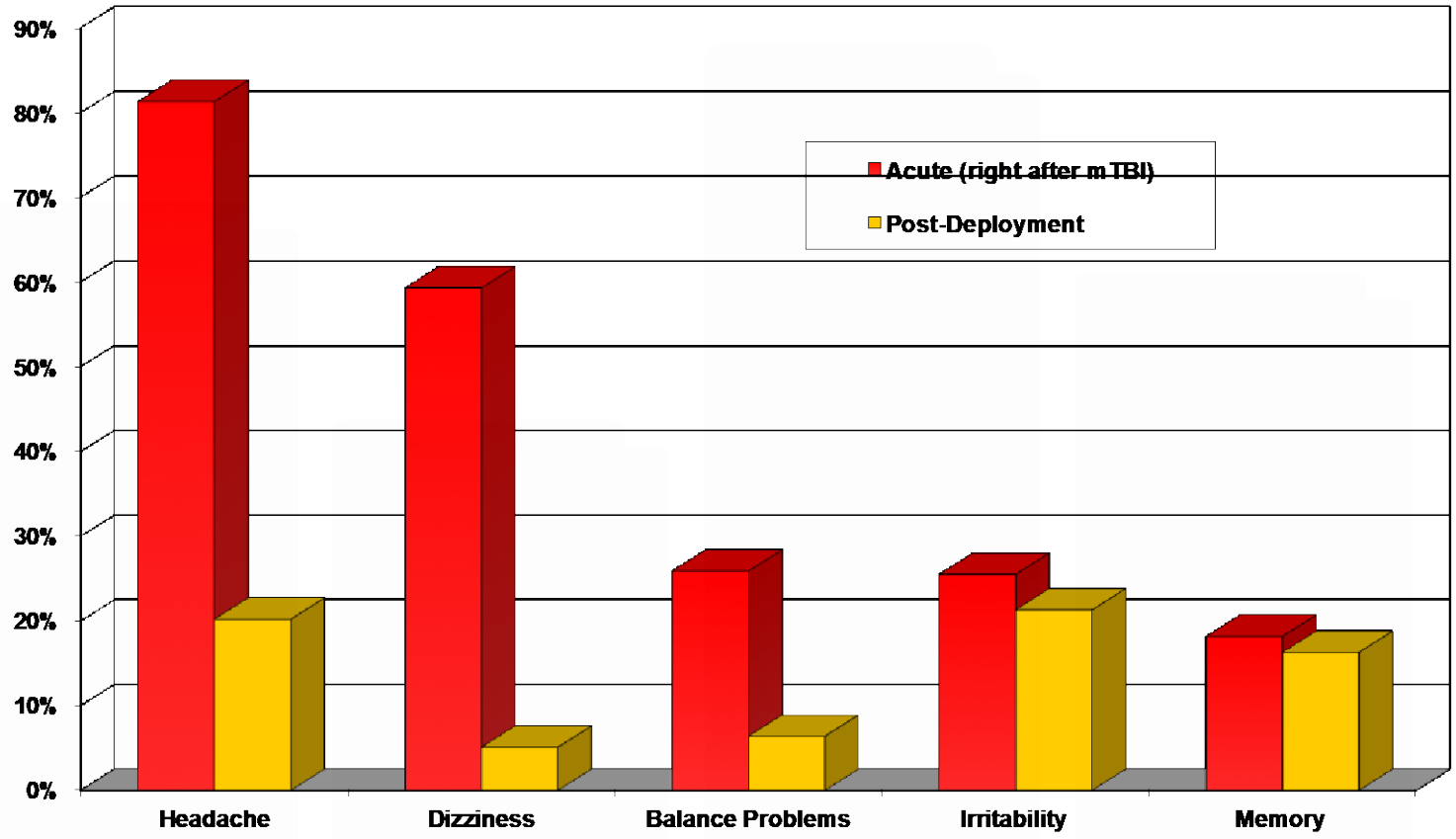
Traumatic Brain Injury Screening: Preliminary Findings in a US Army Brigade Combat Team

Heidi Terrio, MD, MPH; Lisa A. Brenner, PhD; Brian J. Ivins, MS; John M. Cho, MD; Katherine Helmick, MS, CRNP; Karen Schwab, PhD; Katherine Scally, MS, ANP-C; Rick Bretthauer, PA-C; Deborah Warden, MD

Objectives: The objective of this article is to report the proportion of soldiers in a Brigade Combat Team (BCT) with at least 1 clinician-confirmed deployment-acquired traumatic brain injury (TBI) and to describe the nature of sequelae associated with such injuries. **Participants:** Members of an Army unit ($n = 3973$) that served in Iraq were screened for history of TBI. Those reporting an injury ($n = 1292$) were further evaluated regarding sequelae. Of the injuries suffered, 907 were TBIs and 385 were other types of injury. The majority of TBIs sustained were mild. **Methods:** Postdeployment, responses to the Warrior Administered Retrospective Casualty Assessment Tool (WARCAT) facilitated clinical interviews regarding injury history and associated somatic (ie, headache, dizziness, balance) and neuropsychiatric symptoms (ie, irritability, memory). Traumatic brain injury diagnosis was based on the American Congress of Rehabilitation Medicine mild TBI criteria, which requires an injury event followed by an alteration in consciousness. **Results:** A total of 22.8% of soldiers in a BCT returning from Iraq had clinician-confirmed TBI. Those with TBI were significantly more likely to recall somatic and/or neuropsychiatric symptoms immediately postinjury and endorse symptoms at follow-up than were soldiers without a history of deployment-related TBI. A total of 33.4% of soldiers with TBI reported 3 or more symptoms immediately postinjury compared with 7.5% at postdeployment. For soldiers injured without TBI, rates of 3 or more symptoms postinjury and postdeployment were 2.9% and 2.3%, respectively. In those with TBI, headache and dizziness were most frequently reported postinjury, with irritability and memory problems persisting and presenting over time. **Conclusion:** Following deployment to Iraq, a clinician-confirmed TBI history was identified in 22.8% of soldiers from a BCT. Those with TBI were significantly more likely to report postinjury and postdeployment somatic and/or neuropsychiatric symptoms than those without this injury history. Overall, symptom endorsement decreased over time. **Keywords:** *assessment, blast, combat, deployment, Iraq, sequelae, symptoms, traumatic brain injury*

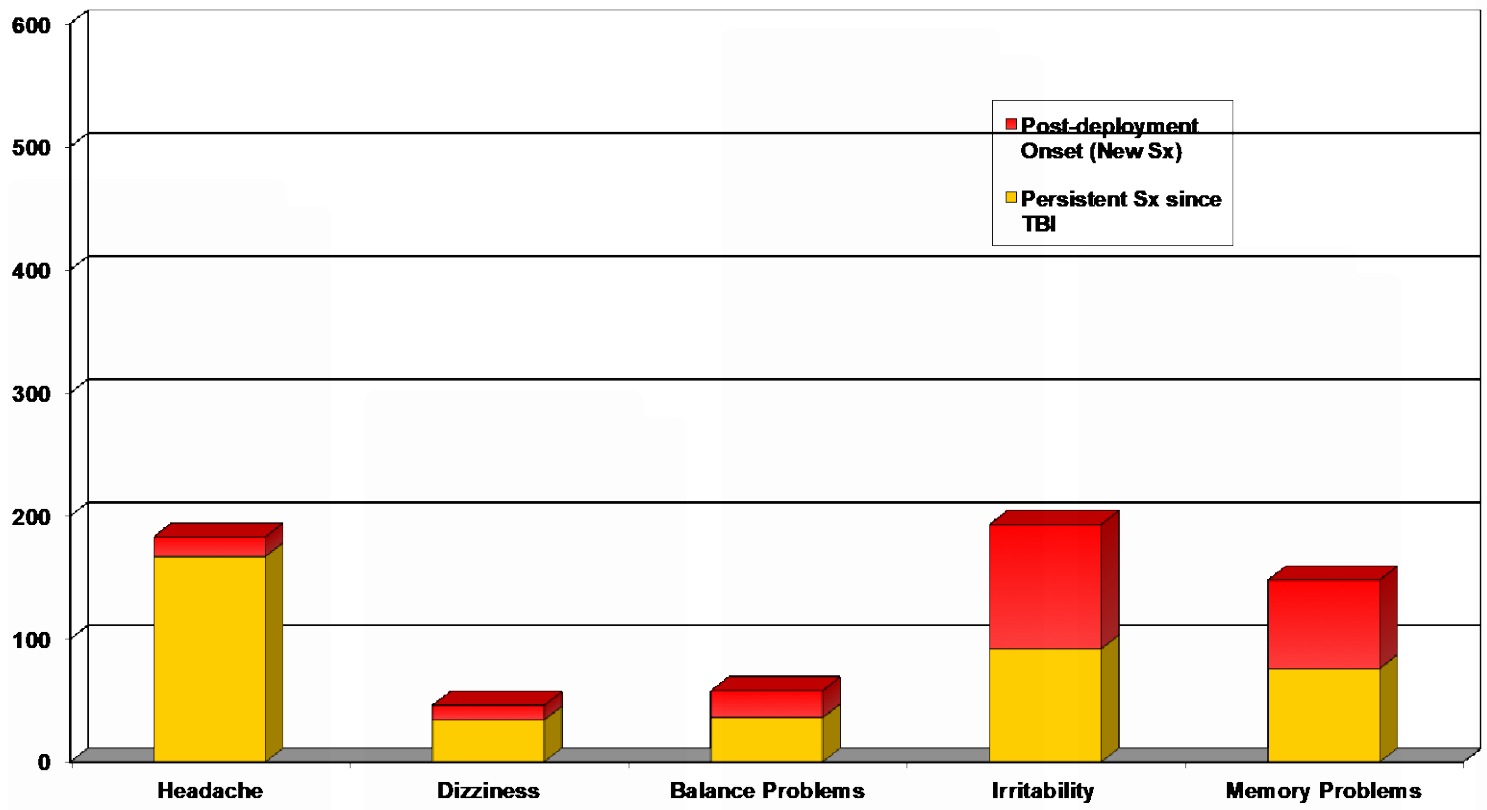
Following deployment to Iraq, a clinician-confirmed TBI history was identified in 22.8% of soldiers from a BCT. Those with TBI were significantly more likely to report postinjury and post deployment somatic and/or neuropsychiatric symptoms than those without this injury history. Overall, symptom endorsement decreased over time.

Ft. Carson: Post-Deployment Data (n = 907)



Terrio H, Brenner LA, Ivins B, Cho JM, Helmick K, Schwab K, et al. Traumatic brain injury screening: Preliminary findings regarding prevalence and sequelae in a US Army Brigade Combat Team. Journal of Head Trauma Rehabilitation. 2009; 24(1):14-23.

Currently Symptomatic: Onset of Symptoms (n = 844)



Terrio H, Brenner LA, Ivins B, Cho JM, Helmick K, Schwab K, et al. Traumatic brain injury screening: Preliminary findings regarding prevalence and sequelae in a US Army Brigade Combat Team. Journal of Head Trauma Rehabilitation. 2009; 24(1):14-23.

J Head Trauma Rehabil
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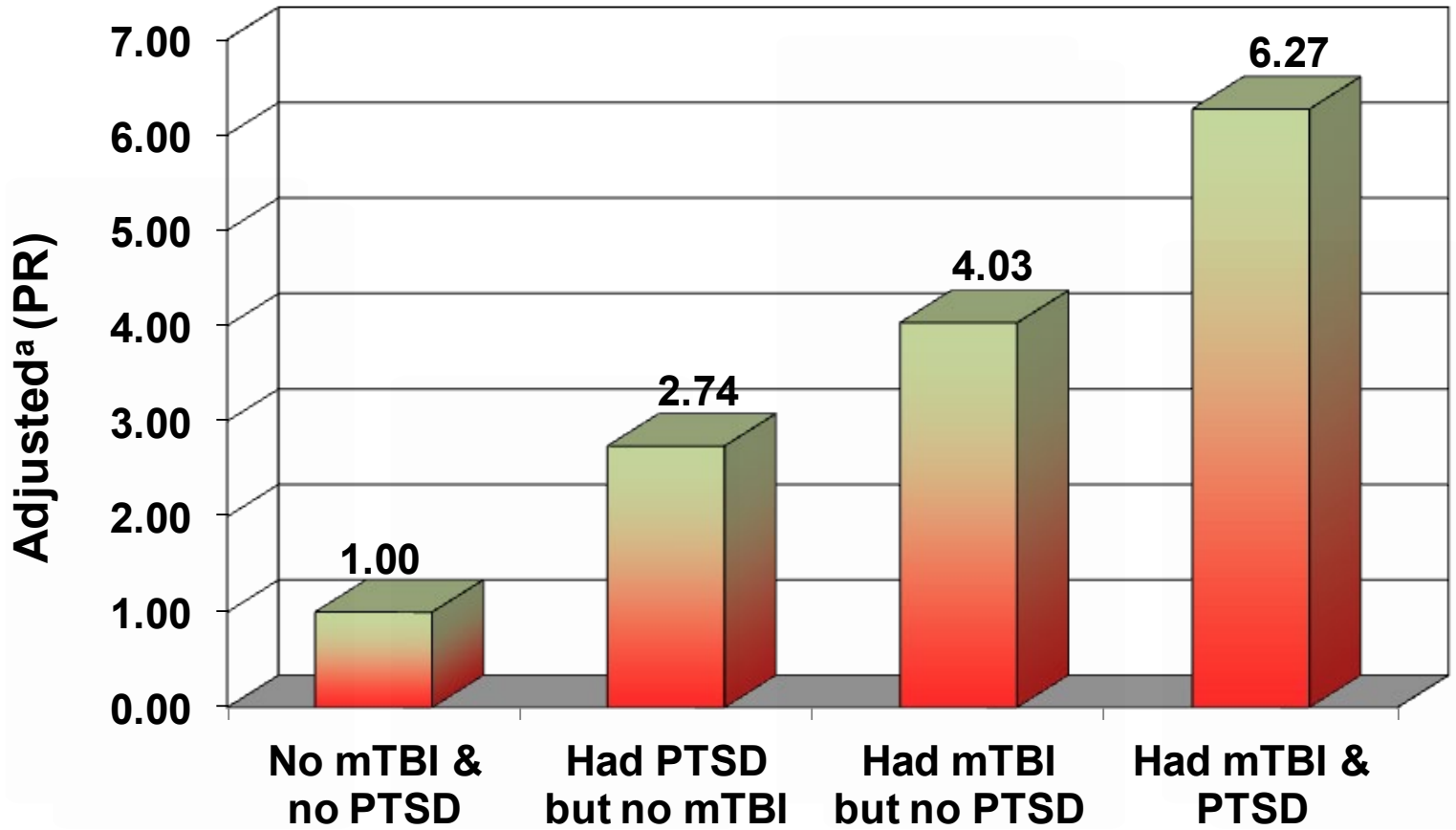
Traumatic Brain Injury, Posttraumatic Stress Disorder, and Postconcussive Symptom Reporting Among Troops Returning From Iraq

Lisa A. Brenner, PhD; Brian J. Ivins, MS; Karen Schwab, PhD; Deborah Warden, MD; Lonnie A. Nelson, PhD; Michael Jaffee, MD; Heidi Terrio, MD, MPH

Objectives: Analyze the contribution of mild traumatic brain injury (mTBI) and/or posttraumatic stress disorder (PTSD) to the endorsement of postconcussive (PC) symptoms during Post Deployment Health Assessment. Determine whether a combination of mTBI and PTSD was more strongly associated with symptoms than either condition alone. **Methods:** Cross-sectional study design where both the exposure, mTBI and/or PTSD, and the outcomes of interest, PC symptoms, were ascertained after return from deployment. Subjects were injured soldiers ($n = 1247$) from one Fort Carson Brigade Combat Team ($n = 3973$). **Main Outcome Measures:** Positive history of PC symptoms. **Results:** PTSD and mTBI together were more strongly associated with having PC symptoms (adjusted prevalence ratio 6.27; 95% CI: 4.13–9.43) than either mTBI alone (adjusted prevalence ratio = 4.03; 95% CI: 2.67–6.07) or PTSD alone (adjusted prevalence ratio = 2.74; 95% CI: 1.58–4.74) after adjusting for age, gender, education, rank, and Military Occupational Specialty. **Conclusions:** In soldiers with histories of physical injury, mTBI and PTSD were independently associated with PC symptom reporting. Those with both conditions were at greater risk for PC symptoms than those with either PTSD, mTBI, or neither. Findings support the importance of continued screening for both conditions with the aim of early identification and intervention. **Keywords:** *Iraq, postconcussive symptoms, PTSD, soldiers, TBI, traumatic brain injury*

In soldiers with histories of physical injury, mTBI and PTSD were independently associated with PC symptom reporting. Those with both conditions were at greater risk for PC
symptoms than those with either PTSD, mTBI, or neither. Findings support the importance of continued screening for both conditions with the aim of early identification and intervention.

Symptom-Exposure: Any Symptoms (n = 389)

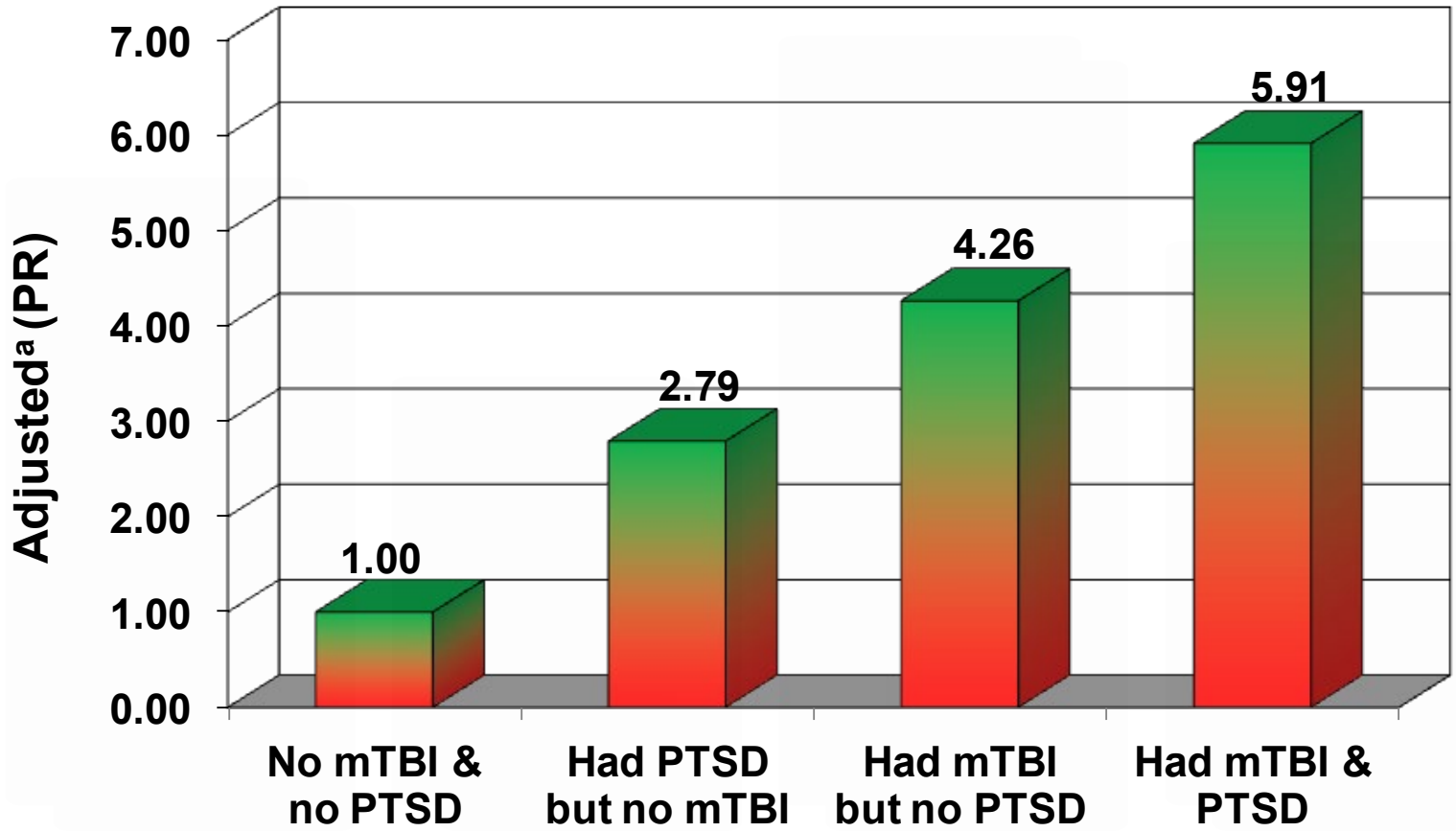


[a]Adjusted for age, gender, education, rank, and MOS

Brenner et al., 2009

Total number of Soldiers (N = 1247)

Symptom-Exposure: Headache (n = 204)

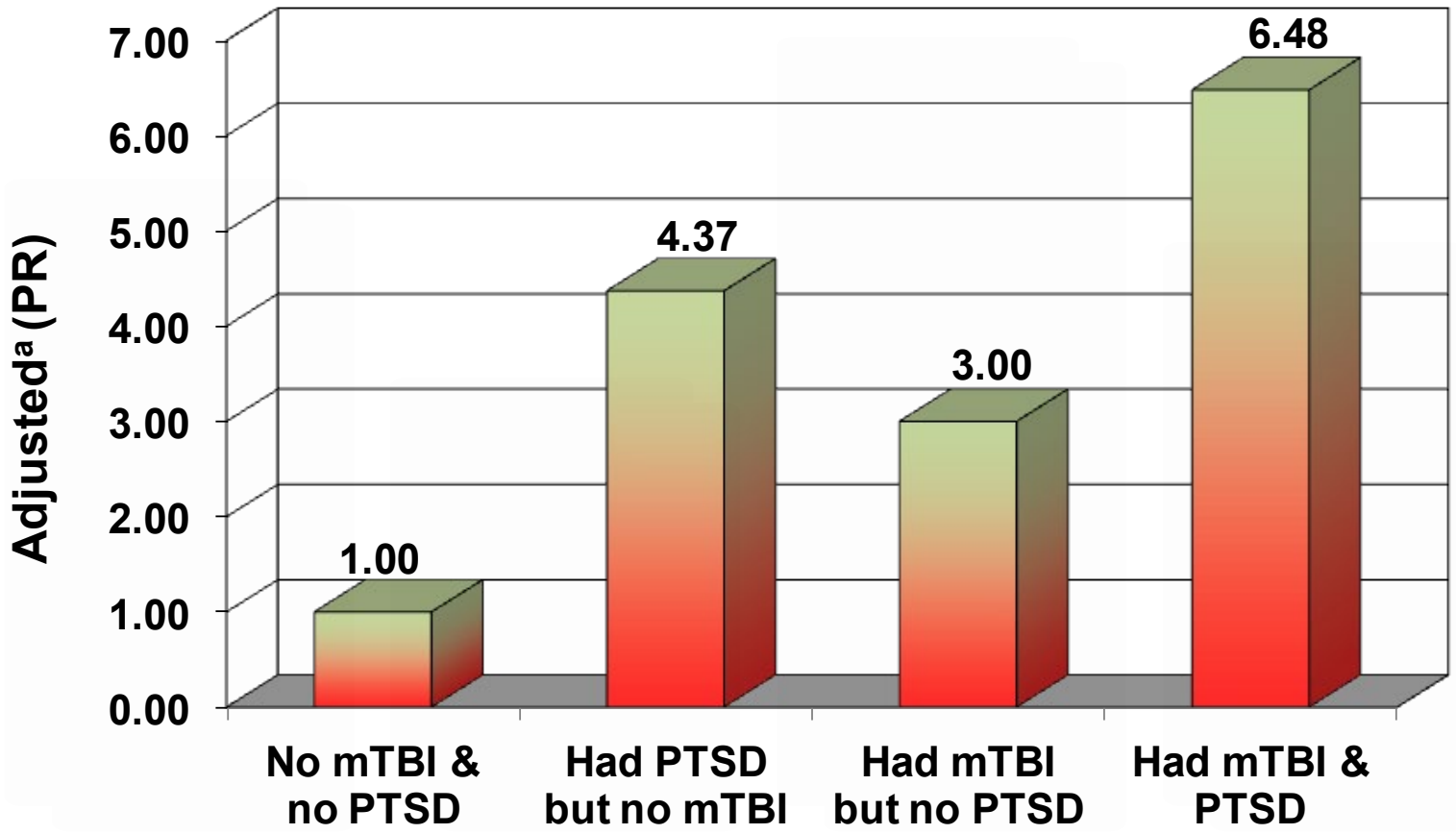


[a]Adjusted for age, gender, education, rank, and MOS

Brenner et al., 2009

Total number of soldiers (n = 1247)

Symptom-Exposure: Dizziness (n = 51)

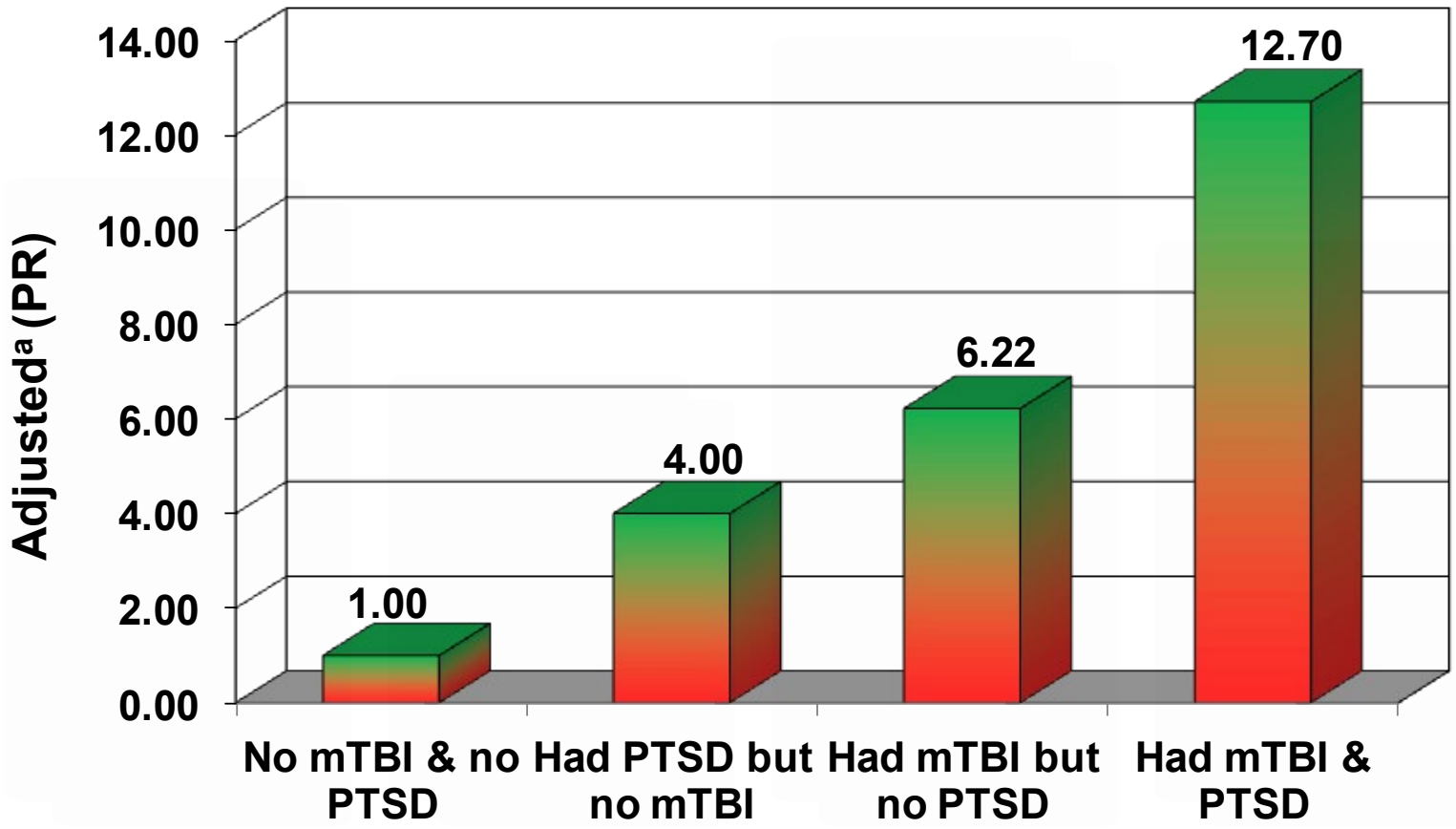


[a]Adjusted for age, gender, education, rank, and MOS

Brenner et al., 2009

Total number of Soldiers (N = 1247)

Symptom-Exposure: Memory Problems (n = 154)

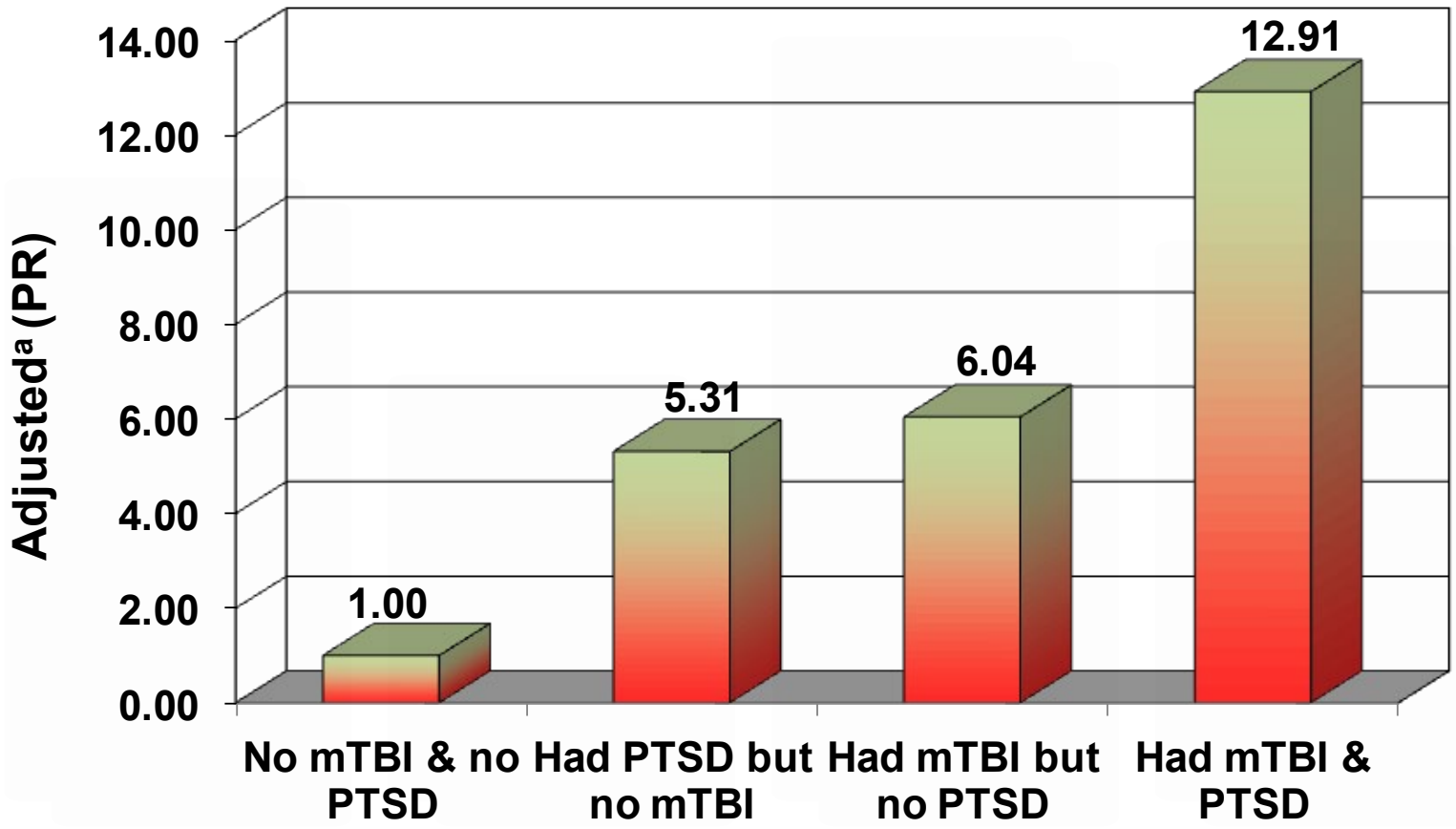


[a]Adjusted for age, gender, education, rank, and MOS

Brenner et al., 2009

Total Number of Soldiers (N = 1247)

Symptom-Exposure: Balance Problems (n = 62)

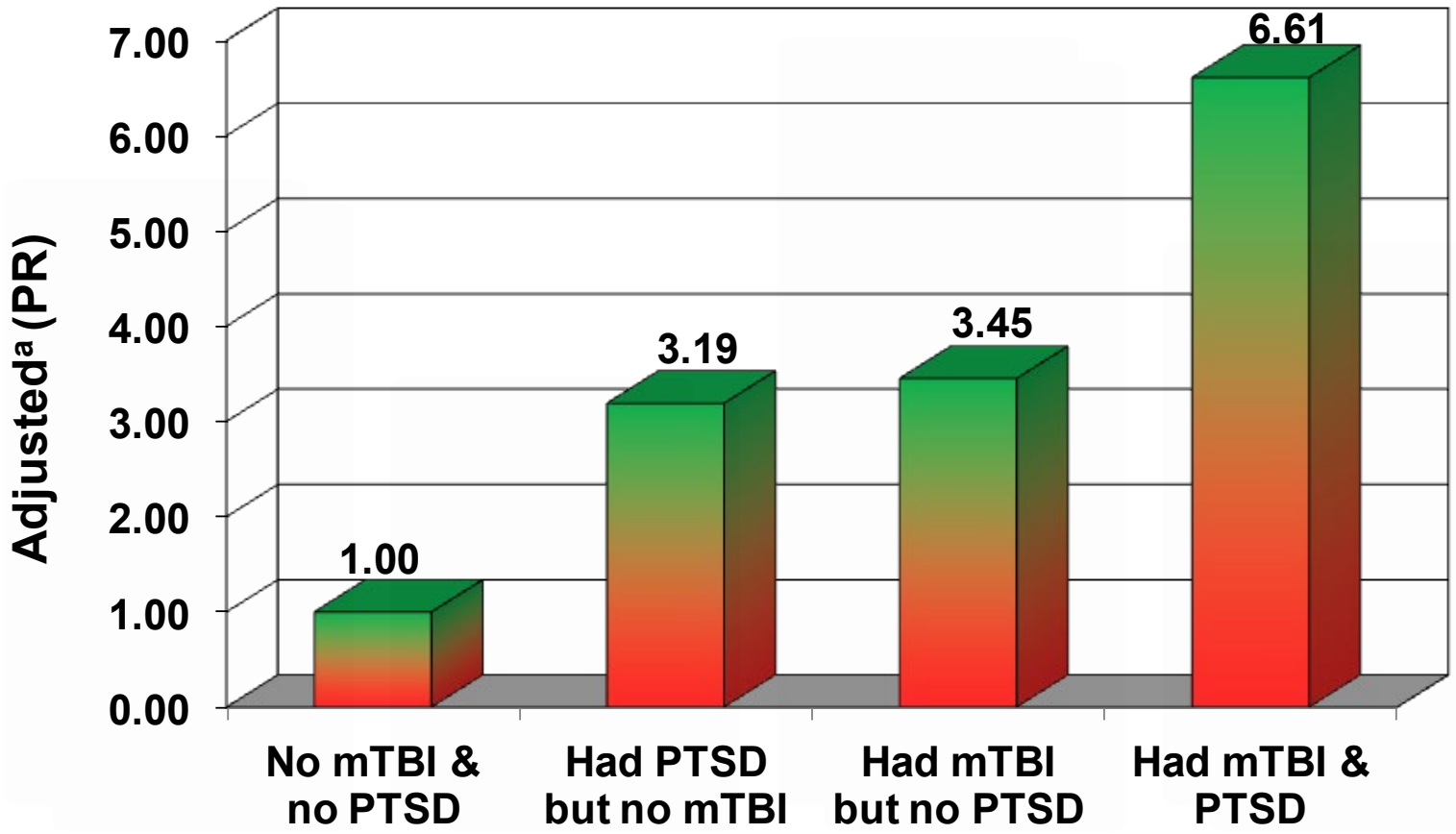


[a]Adjusted for age, gender, education, rank, and MOS

Total no. of soldiers (N = 1247)

Brenner et al., 2009

Symptom-Exposure: Irritability (n = 215)



[a]Adjusted for age, gender, education, rank, and MOS

Total no. of oldiers (N = 1247)

Brenner et al., 2009

Rehabilitation Psychology

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Soldiers Returning From Deployment: A Qualitative Study Regarding Exposure, Coping, and Reintegration

Lisa A. Brenner
Veterans Integrated Service Network 19 Mental Illness Research, Education, and Clinical Center, Denver, Colorado, and University of Colorado Denver, Anschutz Medical Campus

Lisa M. Betthauser
Veterans Integrated Service Network 19 Mental Illness Research, Education, and Clinical Center, Denver, Colorado, and University of Colorado Denver

Nazanin Bahraini
Veterans Integrated Service Network 19 Mental Illness Research, Education, and Clinical Center, Denver, Colorado, and University of Colorado Denver, Anschutz Medical Campus

Jaimie L. Lusk
Veterans Integrated Service Network 19 Mental Illness Research, Education, and Clinical Center, Denver, Colorado, and University of Denver

Heidi Terrio
Defense and Veterans Brain Injury Center, Fort Carson, Colorado, and Evans Army Community Hospital, Colorado Springs, Colorado

Ann I. Scher
Uniformed Services University of the Health Sciences Bethesda, Maryland

Karen A. Schwab
Defense and Veterans Brain Injury Center Silver Spring, Maryland, and Uniformed Services University of the Health Sciences Bethesda, Maryland

Purpose/Objective: The purpose of this study was to qualitatively explore exposure to deployment-related physical and/or emotional trauma and associated symptoms among Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) soldiers. Interviews also focused on in-theater- and reintegration-related experiences. ***Research Method/Design:*** OEF/OIF soldiers (N = 103) participated in semistructured interviews, and a qualitative descriptive methodology was used to analyze the data. ***Results:*** Themes were identified regarding (a) common experiences related to emotional and physical trauma and associated symptoms and strategies for coping and making meaning of experiences and (b) how combat and reintegration experiences affected soldiers' senses of self, relationships with others, and

Previous research suggests that being injured and witnessing emotionally distressing events are common occurrences (Hoge et al., 2004); however, a thorough understanding regarding the short and long-term impact of such exposures is limited. Consistent with previously collected quantitative data, soldiers noted a history of being injured and feeling emotionally distressed during deployment.

Common experiences of injury and emotionally distressing events and associated symptoms

Despite these descriptions, Soldiers seemed hesitant to endorse a history of TBI.

For example, in response to the question, *"Do you believe you sustained a TBI while you were deployed?" "…One Solider stated, "I would say—probably say maybe a mild…I would say a mild one. I wouldn't say it was a severe brain injury, but it was a mild one…and I would say coupled with the depression, and uh psychological problems I once had and relationship stress and threat of being killed and all of that added together was enough to uh damage my brain."* ***2***

Conclusions

For the Soldiers interviewed, boundaries between events which resulted in (physical/emotional) injury, and subsequent symptoms were often fluid, with symptoms more traditionally associated with mTBI or PTSD being attributed to either or both conditions.

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Epidemiology and prognosis of mild traumatic brain injury in returning soldiers

A cohort study

Karen Schwab, PhD
Heidi P. Terrio, MD
Lisa A. Brenner, PhD
Renee M. Pugluis, MD
Henry P. McMillan, PT
Margaret MacDonald, MD
Sidney R. Hinds II, MD
Ann I. Scher, PhD

Correspondence to Dr. Schwab: Karen.Schwab@va.gov

ABSTRACT

Objective: Mild traumatic brain injury (mTBI; concussion) is common in returning service members yet limited definitive evidence exists on its prognosis.

Methods: Almost 25,000 non-medically evacuated soldiers returning from Afghanistan or Iraq to 2 military bases between 2009 and 2014 were screened for mTBI. We invited a random sample to participate in the present study, oversampling those screening positive, resulting in 557 mTBI cases and 1,010 controls, of whom 366 cases and 599 controls completed 3-month follow-up evaluations. The criterion measure of screened mTBI was the Ohio State University Traumatic Brain Injury Identification Method. Postconcussive symptoms (PCS) were measured at follow-up with the Neurobehavioral Symptom Inventory. Symptoms reported at a severe or very severe level were considered clinically relevant.

Results: About half (47%) of soldiers who had sustained an mTBI during this latest deployment reported PCS at 3-month follow-up vs 25% of controls: adjusted odds ratio 2.4 (1.8–3.2). The most commonly reported symptoms (cases vs controls) were sleep problems (30% vs 14%), forgetfulness (21% vs 9%), irritability (17% vs 8%), and headaches (15% vs 5%). mTBI cases were about twice as likely as controls to report receiving rehabilitative services and fair or poor health. Other predictors of PCS included posttraumatic stress, combat exposure, and noncephalic pain. A majority of both cases and controls reported traumatic brain injuries predating this latest deployment.

Conclusions: In this nonclinical population of recently deployed soldiers, a substantial proportion of those who had sustained an mTBI were symptomatic 3 months postdeployment. Future studies need to include longer follow-up to measure symptom resolution.

Clinicaltrials.gov identifier: NCT01847040. *Neurology®* 2017;88:1–9

GLOSSARY

DoD/DVA = Department of Defense/Department of Veterans Affairs; **DSM-IV** = *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition; **LOC** = loss of consciousness; **MOS** = military occupational specialties; **mTBI** = mild traumatic brain injury; **NSI** = Neurobehavioral Symptom Inventory; **OSU TBI-ID** = Ohio State University Traumatic Brain Injury Identification Method; **PCL-C** = Post-Traumatic Stress Disorder Checklist–Civilian Version; **PCS** = postconcussive symptoms; **PTS** = posttraumatic stress; **TBI** = traumatic brain injury.

Over 2 million US service members have returned from the wars in Afghanistan (Operation Enduring Freedom) and Iraq (Operation Iraqi Freedom and New Dawn), many of whom have sustained brain injuries during deployments.[1] Most of these are mild traumatic brain injuries (mTBI; concussion).[2] There is limited understanding of the epidemiology and prognosis of symptoms associated with this common deployment-related injury.[3,4] Civilian guidelines for management of mTBI do not always apply.[5] Aspects of military deployment, including the co-occurrence of traumatic stress, the likelihood of painful injuries, and the risk of multiple concussions, may exacerbate symptoms, complicate diagnosis, and prolong symptom recovery.[6–9]

Editorial, page XXX

Supplemental data at Neurology.org

From The Defense and Veterans Brain Injury Center (K.S., H.P.T., R.M.P., M.M., S.R.H.), Silver Spring; Department of Preventive Medicine and Biostatistics (K.S., A.I.S.), Uniformed Services University, Bethesda, MD; Brooke Army Community Hospital (H.P.T., R.M.P., M.M.), Fort Carson; Rocky Mountain Mental Illness Research Education and Clinical Center (L.A.B.), Denver; Anschutz Medical Campus (L.A.B.), University of Colorado, Aurora; and Intrepid Spirit (H.P.M.), Defense and Veterans Brain Injury Center, Fort Bragg, NC. Current affiliations: Bureau of Prisons Federal Medical Center (H.P.M.), Butner, NC; United States Army Medical Research and Materiel Command (S.R.H.).

Go to Neurology.org for full disclosures. Funding information and disclosures deemed relevant by the authors, if any, are provided at the end of the article.

Table 2 Prevalence of neurobehavioral symptoms at 3 months by traumatic brain injury (TBI) status at screening interview

	TBI status at screening interview	
Severe/very severe symptom at 3 months	TBI-positive cases (n = 358), %	TBI-negative controls (n = 596), %
Sleep	30	14
Forgetful	21	9
Irritation	17	8
Headaches	15	5
Fatigue	12	4
Concentration	12	6
Hearing	11	4
Anxiety	11	3
Frustration	10	4
Thinking	8	3
Light	7	2
Noise	7	2
Decisions	6	2
Appetite	5	2
Depression	4	2
Nausea	3	1
Numbness	3	2
Coordination	2	1
Vision	2	1
Dizzy	1	<1
Balance	1	<1
Taste	1	<1
% with 1 + severe/very severe symptom	47	25

Symptoms from neurobehavioral symptom inventory are scaled from 0 to 4, with severe and very severe symptoms rated as 3 or higher, defined as follows: 3: "Severe—Frequently present and disrupts activities; I can only do things that are fairly simple or take little effort; I feel like I need help"; 4: "Very Severe—Almost always present and I have been unable to perform at work, school, or home due to this problem; I probably cannot function without help." Limited to participants who completed both the baseline and 3-month interviews, excluding 11 participants with possible symptom exaggeration (see Methods). Participant classification based on postdeployment screening (see Methods): no TBI (controls); TBI screen positive (cases).

Table 3 Three-month outcomes by traumatic brain injury (TBI) status at screening interview

	TBI status at baseline screening interview							
			TBI-positive cases (stratified by baseline PTS screening status)					
	A: TBI-negative controls (n = 599)		B: TBI + PTS (n = 54)		C: TBI − PTS (n = 289)		D: All TBI cases (n = 366)	
	%	AOR[a]	%	AOR[a]	%	AOR[a]	%	AOR[a]
% with 1 + severe/very severe symptom	25	1.0 (ref)	71	6.3 (3.3–12.1)	41	1.8 (1.3–2.5)[b]	47	2.4 (1.8–3.2)
Received rehabilitation services	10	1.0 (ref)	27	3.6 (1.7–7.3)	18	2.0 (1.3–3.1)	20	2.3 (1.5–3.4)
Self-reported fair/poor health	15	1.0 (ref)	38	3.4 (1.8–6.4)	27	2.1 (1.4–3.0)	30	2.4 (1.7–3.4)
Work problems (worse off)	14	1.0 (ref)	28	2.0 (1.01–3.8)	18	1.1 (0.8–1.7)[c]	21	1.4 (0.96–2.0)

[a] Adjusted odds ratio (AOR), adjusted for age (age, age^2), sex, military occupational specialties (MOS) (combat, noncombat), race (white, black, Hispanic, other/multiple), rank (E1–E4, E5–E6, E7–E9, chief warrant/officer), educational level, study site (Fort Carson, Fort Bragg).

[b] AORs different in TBI cases with and without posttraumatic stress (PTS) ($p = 0.003$).

[c] Significant interaction by study site although odds ratio not significant for either site.

Symptoms from neurobehavioral symptom inventory are scaled from 0 to 4, with severe and very severe symptoms rated as 3 or higher; limited to participants who completed both the baseline and 3-month interviews (n = 23 missing/refused PTS screen among TBI cases; number of missing cases for each variable of interest: total symptoms, 37; rehabilitation, 40; health, 16; work problems, 14; received rehabilitation services since last deployment ["Since your last deployment, have you received any rehabilitation (rehab) for health or medical problems resulting from your service in the military?"; "In general, would you say your health is ... excellent/very good/good/fair/poor"; outcome is "fair or poor"; "Are you better off, about the same, or worse off now than before your first deployment to theater (work including employment/school/home management)"; outcome is "worse off"]).

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The Impact of Multiple Concussions on Emotional Distress, Post-Concussive Symptoms, and Neurocognitive Functioning in Active Duty United States Marines Independent of Combat Exposure or Emotional Distress

James L. Spira,[1] Corinna E. Lathan,[2] Joseph Bleiberg,[3] and Jack W. Tsao[4]

Abstract

Controversy exists as to whether the lingering effects of concussion on emotional, physical, and cognitive symptoms is because of the effects of brain trauma or purely to emotional factors such as post-traumatic stress disorder or depression. This study examines the independent effects of concussion on persistent symptoms. The Defense Automated Neurobehavioral Assessment, a clinical decision support tool, was used to assess neurobehavioral functioning in 646 United States Marines, all of whom were fit for duty. Marines were assessed for concussion history, post-concussive symptoms, emotional distress, neurocognitive functioning, and deployment history. Results showed that a recent concussion or ever having experienced a concussion was associated with an increase in emotional distress, but not with persistent post-concussive symptoms (PPCS) or neurocognitive functioning. Having had multiple lifetime concussions, however, was associated with greater emotional distress, PPCS, and reduced neurocognitive functioning that needs attention and rapid discrimination, but not for memory-based tasks. These results are independent of deployment history, combat exposure, and symptoms of post-traumatic stress disorder and depression. Results supported earlier findings that a previous concussion is not generally associated with post-concussive symptoms independent of covariates. In contrast with other studies that failed to find a unique contribution for concussion to PPCS, however, evidence of recent and multiple concussion was seen across a range of emotional distress, post-concussive symptoms, and neurocognitive functioning in this study population. Results are discussed in terms of implications for assessing concussion on return from combat.

Key words: adult brain injury; behavioral assessments; cognitive function; head trauma; military injury

Of the entire sample, 25% reported having been previously concussed at some point in their lifetime at least once, 7% reported two previous concussions, and 9% reported three or more times.

“Having had multiple lifetime concussions, however, was associated with greater emotional distress, PPCS, and reduced neurocognitive functioning that needs attention and rapid discrimination, but not for memory-based tasks. These results are independent of deployment history, combat exposure, and symptoms of post-traumatic stress disorder and depression.”

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Characterization of Lifetime TBIs in a Cohort of Recently Deployed Soldiers: The Warrior Strong Study

Lisa M. Betthauser
VA Rocky Mountain Mental Illness Research Education and Clinical Center, Aurora, Colorado, and University of Colorado, Anschutz Medical Campus

Rachel Sayko Adams
Brandeis University and VA Rocky Mountain Mental Illness Research Education and Clinical Center, Aurora, Colorado

Trisha A. Hostetter
VA Rocky Mountain Mental Illness Research Education and Clinical Center, Aurora, Colorado

Ann I. Scher
Uniformed Services University

Karen Schwab
The Defense and Veterans Brain Injury Center, Silver Spring, Maryland, and Uniformed Services University

Lisa A. Brenner
VA Rocky Mountain Mental Illness Research Education and Clinical Center, Aurora, Colorado, and University of Colorado, Anschutz Medical Campus

Objective: To describe and characterize the lifetime history of traumatic brain injury (TBI) among active duty soldiers returning from deployment to Afghanistan or Iraq. ***Method:*** Data were extracted from a larger parent study that was conducted at two large United States Army bases between 2009 and 2014 during Post-Deployment Health Assessment. The sample included 1,060 soldiers who sustained at least one TBI during their lifetime. ***Results:*** The Ohio State University TBI-Identification Method interview was administered to characterize individuals' total lifetime history of TBI. Soldiers reported sustaining a median of 2 lifetime TBIs. Slightly more than half of the sample without a most recent deployment-related TBI still reported a history of a lifetime TBI (some of which occurred during previous deployments). Most lifetime injuries reported were of mild severity; however, 6% of individuals reported a history of moderate/severe TBI. Blast was the most frequent mechanism associated with recent deployment-related mild TBIs. ***Conclusion:*** Findings suggest that soldiers who screened positive, as well as those who screened negative, for a history of TBI during their recent deployment still endorsed a lifetime history of TBI. Future research is needed to explore the functional impact of multiple TBIs over one's lifetime to help inform screening, assessment, and treatment among military personnel.

Impact and Implications

Although soldiers in this sample mostly reported mild traumatic brain injuries (TBIs), 6% of individuals reported lifetime moderate to severe TBIs. Moreover, a number of soldiers reported a history of nondeployment TBIs. A history of such injuries may contribute to persistent post-TBI symptoms, as well as postmilitary functional challenges. Additional research to investigate the timing, severity, and history of multiple TBIs on short- and long-term outcomes is indicated.

Keywords: traumatic brain injury, lifetime history, deployment, soldiers, OEF/OIF

Table 2
Summary of Lifetime TBIs

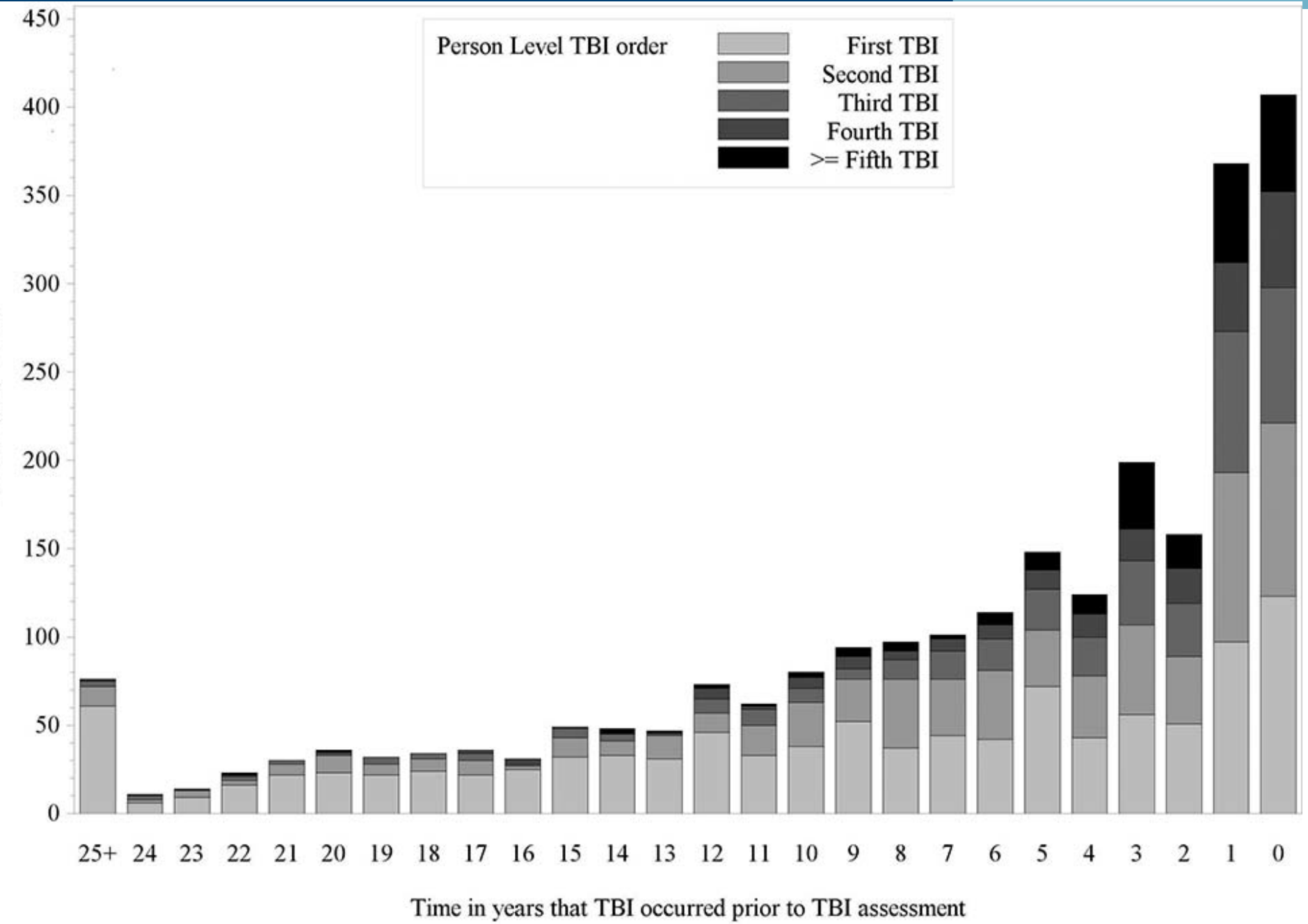
Characteristic	Median (range) or *n* (%)		
	Total sample (person *n* = 1,060)	Positive postdeployment TBI screen (recent deployment; person *n* = 505)	Negative postdeployment TBI screen (recent deployment; person *n* = 555)
Number of reported lifetime TBIs			
1	432 (41%)	161 (32%)	271 (49%)
2	252 (24%)	112 (22%)	140 (25%)
3	169 (16%)	100 (20%)	69 (12%)
4	100 (9%)	58 (11%)	42 (8%)
5	51 (5%)	35 (7%)	16 (3%)
6+	56 (5%)	39 (8%)	17 (3%)
Age at first TBI	17 (1–45)	19 (1–45)	16 (3–43)
Years since first TBI	8 (0–43)	6 (0–42)	9 (0–43)
Age at last TBI	23 (3–51)	24 (8–51)	21 (3–45)
Years since last TBI	1 (0–43)	0 (0–40)	4 (0–43)
Had a deployment related TBI	624 (59%)	448 (89%)	176 (32%)
Most severe injury was moderate or severe	59 (6%)	26 (5%)	33 (6%)
Average age at time of moderate TBI	16 (3–42)	17.5 (6–42)	14 (3–25)

Note. TBI = traumatic brain injury.

Table 5
Mechanism of Injury by Severity of TBI

Characteristics	Count (%)	
	Mild TBIs (injury n = 2,376)	Moderate/severe TBIs (injury n = 62)
Mechanism of injury		
Total sample (injury n = 2,438)		
Blast	690 (29)	2 (3)
Fall	386 (16)	9 (15)
Assault	177 (7)	5 (8)
Sports	577 (24)	12 (19)
Transportation	284 (12)	30 (48)
Self	2 (0)	0 (0)
Other	257 (11)	4 (6)
Missing	3 (0)	0 (0)
Positive postdeployment TBI screen (recent deployment; injury n = 1,340)		
Blast	496 (38)	2 (7)
Fall	179 (14)	3 (11)
Assault	91 (7)	1 (4)
Sports	244 (19)	6 (22)
Transportation	137 (10)	14 (52)
Self	2 (0)	0 (0)
Other	163 (12)	1 (4)
Missing	1 (0)	0 (0)
Negative postdeployment TBI screen (recent deployment; injury n = 1,098)		
Blast	194 (18)	0 (0)
Fall	207 (19)	6 (17)
Assault	86 (8)	4 (11)
Sports	333 (31)	6 (17)
Transportation	147 (14)	16 (46)
Other	94 (9)	3 (9)
Missing	2 (0)	0 (0)

Note. TBI = traumatic brain injury.


Person Level TBI order
First TBI
Second TBI
Third TBI
Fourth TBI
>= Fifth TBI
450
400
350
300
250
200
150
100
50
0
25+ 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Time in years that TBI occurred prior to TBI assessment

Developmental Trajectories of PTSD - Andersen et al. (2014)

Goal

ID trajectories of PTSD symptoms from 5-6 weeks pre-deployment to 2.5 years after deployment

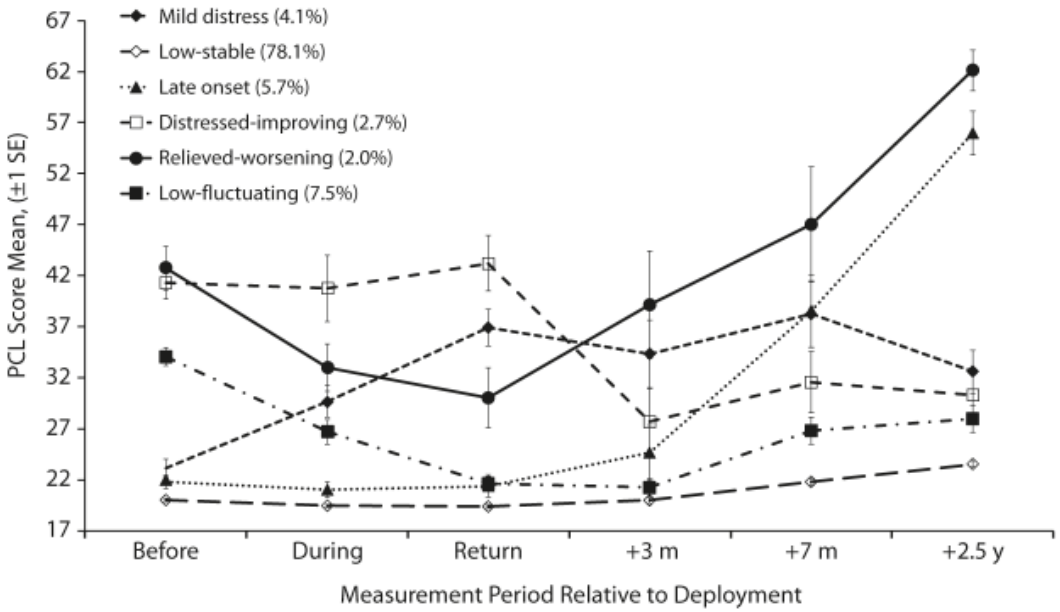
Method

561 Danish soldiers deployed to Afghanistan in 2009

PCL, pre-deployment vulnerabilities, deployment/post-deployment stressors

Latent growth mixture modeling (Hierarchical multivariable logistic regression)

Figure 2. Developmental Trajectories of Posttraumatic Stress Disorder (PTSD) Symptoms at 6 Time Points Before, During, and After Deployment (N = 561)



Abbreviations: PCL = PTSD Checklist, SE = standard error.

Are there factors that impact trajectories?

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A retrospective cohort study of comorbidity trajectories associated with traumatic brain injury in veterans of the Iraq and Afghanistan wars

Mary Jo Pugh[1,2], Erin P. Finley[1,3], Chen-Pin Wang[2], Laurel A. Copeland[4,5], Carlos A. Jaramillo[1], Alicia A. Swan[1,3], Christine A. Elnitsky[6], Luci K. Leykum[1,4], Eric M. Mortensen[7,8], Blessen A. Eapen[1], Polly H. Noel[1,9], Jacqueline A. Pugh[1,3], & The TRACC Research Team[1,2,6]

[1]South Texas Veterans Health Care System, San Antonio, TX, USA, [2]Department of Epidemiology and Biostatistics, [3]Division of Hospital Medicine, Department of Medicine, University of Texas Health Science Center San Antonio, San Antonio, TX, USA, [4]Center for Applied Health Research, Central Texas Veterans Health with Baylor Scott & White, Temple, TX, USA [5]Texas A&M Health Science Center, Department of Medicine, Bryan, TX, USA, [6]University of North Carolina, School of Nursing, College of Health and Human Services, Charlotte, NC, USA, [7]Division of General Internal Medicine, VA North Texas Health Care System, Dallas, TX, USA, [8]Division of General Internal Medicine, University of Texas Southwestern Medical Center, Dallas, TX, USA, and [9]Department of Family and Community Medicine, University of Texas Health Science Center San Antonio, San Antonio, TX, USA

Abstract

Objectives: To identify and validate trajectories of comorbidity associated with traumatic brain injury in male and female Iraq and Afghanistan war Veterans (IAV).
Methods: Derivation and validation cohorts were compiled of IAV who entered the Department of Veterans Affairs (VA) care and received 3 years of VA care between 2002–2011. Chronic disease and comorbidities associated with deployment including TBI were identified using diagnosis codes. A latent class analysis (LCA) of longitudinal comorbidity data was used to identify trajectories of comorbidity.
Results: LCA revealed five trajectories that were similar for women and men: (1) Healthy, (2) Chronic Disease, (3) Mental Health, (4) Pain and (5) Polytrauma Clinical Triad (PCT: pain, mental health and TBI). Two additional classes found in men were 6) Minor Chronic and 7) PCT with chronic disease. Among these gender-stratified trajectories, it was found that women were more likely to experience headache (Pain trajectory) and depression (Mental Health trajectory), while men were more likely to experience lower back pain (Pain trajectory) and substance use disorder (Mental Health trajectory). The probability of TBI was highest in the PCT-related trajectories, with significantly lower probabilities in other trajectories.
Conclusions: It was found that TBI was most common in PCT-related trajectories, indicating that TBI is commonly comorbid with pain and mental health conditions for both men and women. The relatively young age of this cohort raises important questions regarding how disease burden, including the possibility of neurodegenerative sequelae, will accrue alongside normal age-related decline in individuals with TBI. Additional 'big data' methods and a longer observation period may allow the development of predictive models to identify individuals with TBI that are at-risk for adverse outcomes.

Keywords

Comorbidity, Trajectories, Iraq and Afghanistan wars, veteran, healthcare, brain injury

History

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LCA revealed five trajectories that were similar for women and men: (1) Healthy, (2) Chronic Disease, (3) Mental Health, (4) Pain and (5) Polytrauma Clinical Triad (PCT: pain, mental health and TBI). Two additional classes found in men were 6) Minor Chronic and 7) PCT with chronic disease. Among these gender-stratified trajectories, it was found that women were more likely to experience headache (Pain trajectory) and depression (Mental Health trajectory), while men were more likely to experience lower back pain (Pain trajectory) and substance use disorder (Mental Health trajectory). The probability of TBI was highest in the PCT-related trajectories, with significantly lower probabilities in other trajectories.

Treating the Symptoms Regardless of Etiology

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Assessment and Diagnosis of Mild Traumatic Brain Injury, Posttraumatic Stress Disorder, and Other Polytrauma Conditions: Burden of Adversity Hypothesis

Lisa A. Brenner
VA VISN 19 Mental Illness Research, Education, and Clinical Center (MIRECC); University of Colorado Denver, School of Medicine

Rodney D. Vanderploeg
James A. Haley VA Medical Center; University of South Florida; Defense and Veterans Brain Injury Center

Heidi Terrio
Evans Army Community Hospital; Defense and Veterans Brain Injury Center

Objective/Method: Military personnel returning from Iraq and Afghanistan have been exposed to physical and emotional trauma. Challenges related to assessment and intervention for those with posttraumatic stress disorder (PTSD) and/or history of mild traumatic brain injury (TBI) with sequelae are discussed, with an emphasis on complicating factors if conditions are co-occurring. Existing literature regarding cumulative disadvantage is offered as a means of increasing understanding regarding the complex symptom patterns reported by those with a history of mild TBI with enduring symptoms and PTSD. ***Implications:*** The importance of early screening for both conditions is highlighted. In addition, the authors suggest that current best practices include treating symptoms regardless of etiology to decrease military personnel and veteran burden of adversity.

Keywords: Operation Enduring Freedom, Operation Iraqi Freedom, traumatic brain injury, posttraumatic stress disorder, war, polytrauma

Since October 2001, approximately 1.64 million U.S. troops have been deployed to Operation Enduring Freedom and Operation Iraqi Freedom (OEF/OIF) in Afghanistan and Iraq. A significant number have had multiple deployments. Service members in these environments experience not only traditional combat firefights with insurgents, but also the chronic threat of roadside bombs and improvised explosive devices (IEDs). In OEF/OIF, research suggests that 75% of combat injuries result from such explosive munitions (Owens et al., 2008). As a result of this increasingly common mechanism of injury, as well as improvements in body armor and surgical stabilization on the front-line of combat, more war-wounded are returning with multiple complex injuries in unpredictable patterns (Gawande, 2004). Common conditions in multiple combinations include open wounds; traumatic brain; spinal cord, eye, ear, and musculoskeletal injuries; traumatic amputations; and mental health problems. The term *polytrauma* has been introduced to describe these more complex blast-related injuries.

The RAND Corporation recently conducted a large representative sample survey ($n = 1{,}965$) of those who had been deployed as part of OEF/OIF. A random sampling methodology was used to assess exposure to various psychological and physical traumas, and injuries, and evaluate current symptoms (Tanielian & Jaycox, 2008). Trauma exposure was common. Fifty percent reported that they had a friend who was seriously wounded or killed, 45% indicated that they saw dead or seriously injured noncombatants, and over 10% reported that they were injured and required hospitalization. Frequency of trauma events was found to be even more common in a *New England Journal of Medicine* study (Hoge et al., 2004), in which over 90% of service members surveyed upon returning from Iraq reported being shot at or seeing dead bodies or human remains, and over 80% reported knowing someone who was seriously injured or killed. The RAND survey found that approximately 19% of returning service members met criteria for either posttraumatic stress disorder (PTSD) or depression (Tanielian & Jaycox, 2008); these numbers are similar to those reported by Hoge and colleagues (Hoge, Auchterlonie, & Milliken, 2006). As might be expected, there was a strong relationship between combat trauma experiences and PTSD. The development of PTSD was also significantly associated with having been wounded or injured (Hoge et al., 2004).

Both the RAND survey (Tanielian & Jaycox, 2008) and Hoge and colleagues (2008) found relatively high rates of probable mild traumatic brain injury (TBI) or concussions, 19.5% and 15.2%, respectively. Concussion and psychological comorbidities were also common in both studies. RAND survey results suggest that

Lisa A. Brenner, VA VISN 19 Mental Illness Research, Education, and Clinical Center (MIRECC); Departments of Psychiatry, Neurology, and Physical Medicine and Rehabilitation, University of Colorado Denver, School of Medicine, Denver, CO; Rodney D. Vanderploeg, James A. Haley VA Medical Center; Departments of Psychology and Psychiatry and Behavioral Medicine, University of South Florida; Defense and Veterans Brain Injury Center, Tampa, FL; Heidi Terrio, Department of Deployment Health and Headquarters, Evans Army Community Hospital; Defense and Veterans Brain Injury Center, Fort Carson, CO.

Correspondence concerning this article should be addressed to Lisa A. Brenner, VA VISN 19 MIRECC, 1055 Clermont Street, MIRECC, Denver, CO 80220. E-mail: lisa.brenner@va.gov

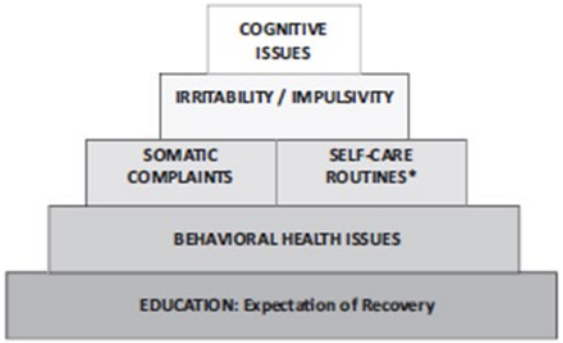

Figure 3. Traumatic brain injury step-care treatment model. *Includes sleep hygiene, diet, exercise, and avoiding further traumatic brain injury.

Why an On-line Toolkit?

Traumatic Brain Injury (TBI) is a significant public health concern. This toolkit provides necessary information to address the needs of individuals with a history of TBI and co-occurring mental health conditions. The toolkit specifically emphasizes TBI in justice-involved and Military/Veteran populations. Community mental health clinicians', justice-involved professionals', and Military/Veteran experts' input was integral in identifying areas of focus. This toolkit is designed to assist professionals in identifying TBI and associated co-occurring problems and to facilitate determining potential need for further evaluation and/or treatment/case planning modification. In addition, relevant information and resources for families/support systems are available.

Download a copy of the TBI Toolkit Overview presentation

https://www.mirecc.va.gov/visn19/tbi_toolkit/index.asp

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