



# Assessing for mTBI among Iraq and Afghanistan veterans: Outcomes of injury severity and neurologic factors

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Karen Lau, Ph.D.  
Clinical Neuropsychologist  
Kaiser Permanente, San Rafael

Shira Maguen, Ph.D.  
Associate Professor  
UCSF Medical School  
San Francisco VA Medical Center

# Poll Question

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- What is your primary role at the VA?
  - student, trainee, or fellow
  - clinician
  - researcher
  - administrator, manager, or policy-maker
  - other

# Background

- Incidence of U.S. service members identified with traumatic brain injury continues to rise.

## DoD Numbers for Traumatic Brain Injury Worldwide – Totals

2000 - 2012 Q1

Penetrating	3,877
Severe	2,469
Moderate	40,449
Mild	187,539
Not Classifiable	9,883

**Total - All Severities 244,217**

Source: Defense Medical Surveillance System (DMSS), Theater Medical Data Store (TMDS)

Prepared by MHS Office of Strategic Communications

## DoD Numbers for Traumatic Brain Injury Worldwide – Totals

2000-2014 (Q1 - Q3)

Penetrating	4,577
Severe	3,126
Moderate	25,953
Mild	258,816
Not Classifiable	21,344

**Total - All Severities 313,816**

Source: Defense Medical Surveillance System (DMSS), Theater Medical Data Store (TMDS) provided by the Armed Forces Health Surveillance Center (AFHSC)

Prepared by the Defense and Veterans Brain Injury Center (DVBIC)  
Percentages do not add up to 100% due to rounding.

## DoD Numbers for Traumatic Brain Injury Worldwide – Totals

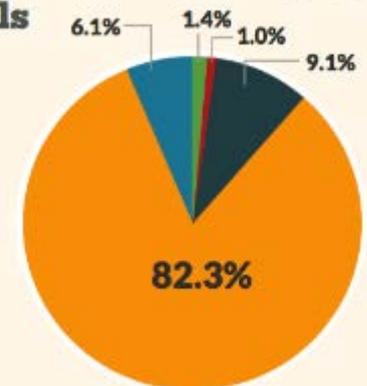
2000-2016 (Q1-Q3)

Penetrating	5,045
Severe	3,733
Moderate	32,434
Mild	294,010
Not Classifiable	21,826

**Total - All Severities 357,048**

Source: Defense Medical Surveillance System (DMSS), Theater Medical Data Store (TMDS) provided by the Armed Forces Health Surveillance Center (AFHSC)

Prepared by the Defense and Veterans Brain Injury Center (DVBIC)  
\*Percentages do not add up to 100% due to rounding



2000-2016 (Q1-Q3), as of Nov 10, 2016

DoD Worldwide TBI Numbers:

<http://dvbic.dcoe.mil/dod-worldwide-numbers-tbi>

# Background

- >80% of TBIs are mild
- Mechanisms of injury:
  - Blasts
  - Blow to head
  - Falls
  - Fragment or bullet
  - Vehicular accident



- Nearly 1/3 of Veterans reported multiple head injury mechanisms (Maguen et al., 2012)

# Diagnosis of mTBI in VA

- Two-tiered screening process:



Second Level  
Comprehensive  
TBI Evaluation

Clinical history

Acute injury severity  
markers

Neurobehavioral  
Symptom Inventory (NSI)

Clinician decision about  
mTBI status

1. Did you have any injury during your deployment from any of the following? (check all that apply: fragment, bullet, explosion, etc.)
2. Did any injury you received while deployed result in any of the following? (check all that apply: being dazed, confused or "seeing stars;" not remembering the injury, losing consciousness, head injury, etc.)
3. Did any of these begin or get worse afterward? (check all that apply: dizziness, headache, memory problems, balance problems, ringing in the ears, irritability, sleep problems.)
4. In the past week, have you had any of the above problems? (check all that apply: dizziness, memory problems, etc.)

# Diagnostic challenges...

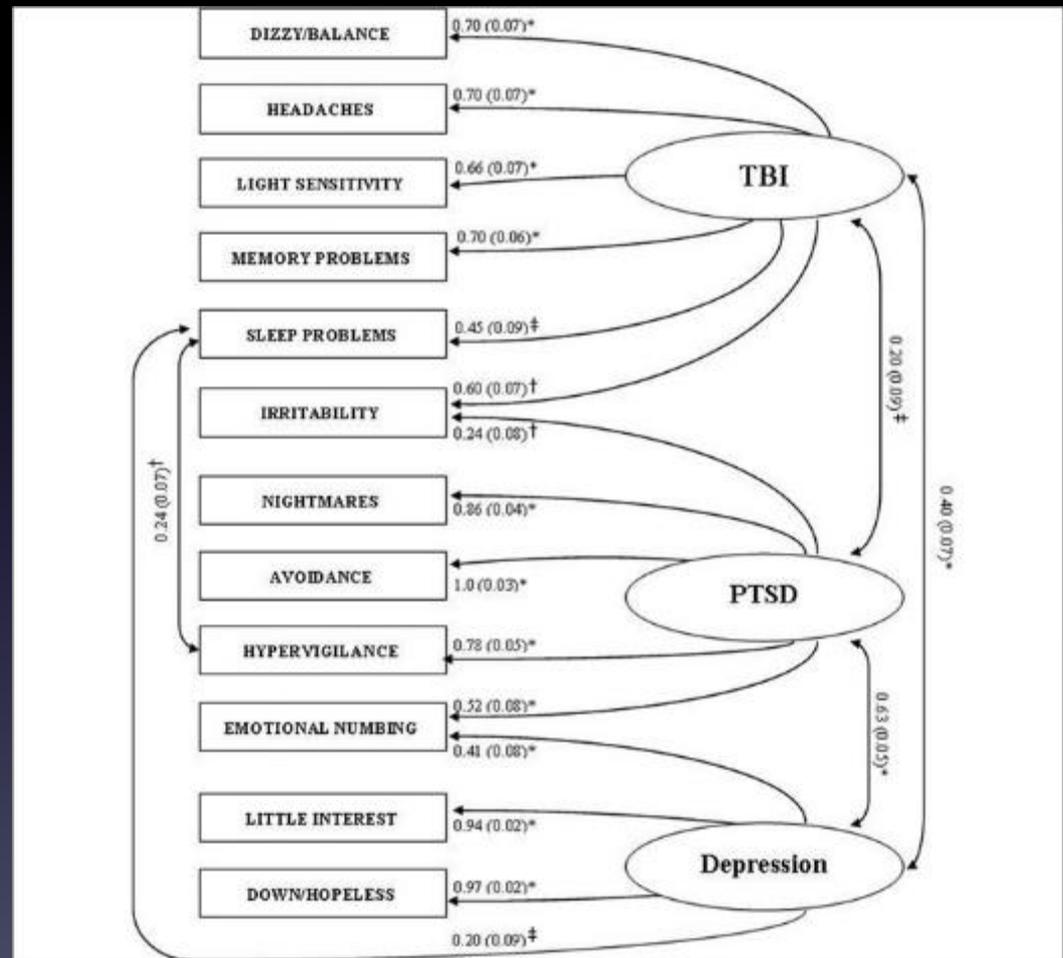
	<b>Civilian mTBI</b>	<b>Military mTBI</b>
Typical time since injury at diagnosis	Hours to days	Months to years
Goals of diagnosis <sup>a</sup>	Documentation of injury, prospective monitoring of course, direct acute care to limit progression and speed recovery	Documentation of injury, identify potential PCS, identify those at risk for progressive neurodegeneration
Involvement of trauma	Common, typically limited to event, may affect reporting	Common, often extends beyond mTBI event (e.g., securing self, others, and equipment following explosion), may confound with experience and reporting of mTBI symptoms (e.g., difficult to differentiate altered consciousness from confusion of threatening situation)

<sup>a</sup>At typical time of diagnosis (i.e., hours to days for civilian mTBI, months to years for military mTBI).

(Davenport, 2016)

# Diagnostic challenges...

Identification of mTBI is complicated by the traumatic nature of the injuries...



(Maguen et al., 2012)

# Diagnostic challenges...

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- Lack of consensus on the clinical utility of the Second Level Comprehensive TBI Evaluation
  - What factors do clinicians consider when confirming a mTBI?

# Aim

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- To investigate self-reported clinical factors that contribute to a clinician-confirmed diagnosis of mTBI *in a sub-set of OEF/OIF/OND Veterans who screened positive on the initial VA TBI screen*

# Methods

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- Retrospective analysis of VA administrative data within 1 VA and associated CBOCs
  - 350 OEF/OIF/OND veterans
    - Screened positive on VA TBI Screen (4/2007 – 6/2010)
    - Received follow-up Comprehensive TBI Evaluation

# Measures

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- Second Level Comprehensive TBI Evaluation evaluates:
  - Retrospective injury severity markers
  - Current neurobehavioral symptoms (also, “postconcussive symptoms”)

# Retrospective injury severity markers

Injury Severity Markers	"Yes, No, or Uncertain"
Loss of consciousness	"Did you lose consciousness immediately after these experiences?"
Posttraumatic amnesia	"Did you experience a period of memory loss immediately before or after the incidence?"
Disorientation/confusion	"Did you have a period of disorientation or confusion following the incident?"

# Current neurobehavioral symptoms (NSI)

Cicerone K, Kalmar K. Persistent postconcussion syndrome: the structure of subjective complaints after mild traumatic brain injury. *Journal of Head Trauma Rehabilitation* 1995;10:1-17. 525.

Please rate the following symptoms with regard to how much they have disturbed you in the **LAST 2 WEEKS**.

Feeling dizzy  
Loss of balance  
Poor coordination, clumsy  
Headaches  
Nausea

Vision problems, blurring, trouble seeing  
Sensitivity to light  
Sensitivity to noise  
Hearing difficulty  
Numbness or tingling on parts of my body  
Change in taste and/or smell  
Loss of appetite or increased appetite

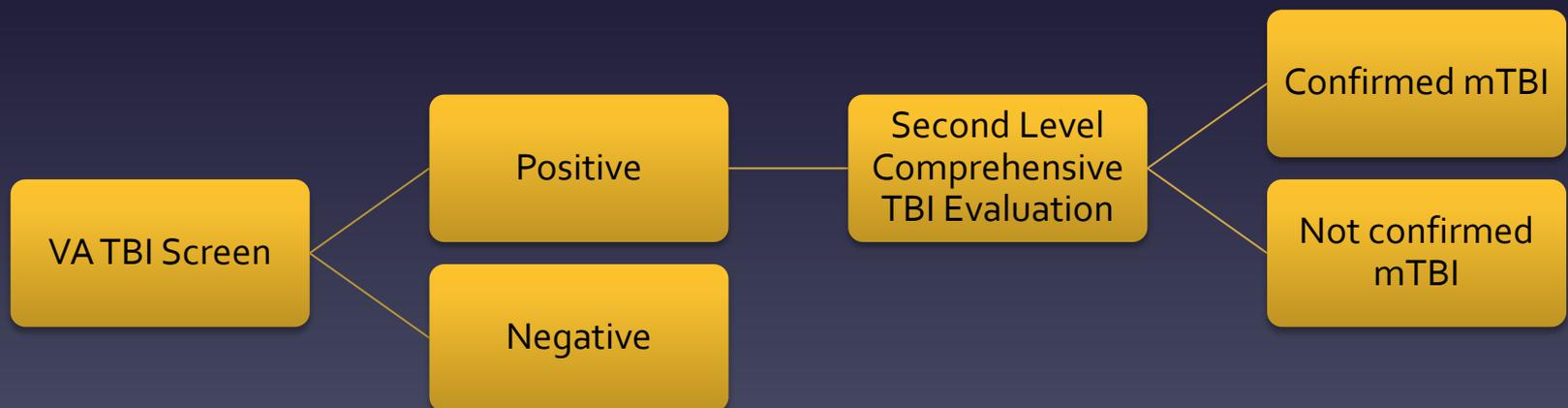
Poor concentration, cannot pay attention  
Forgetfulness, cannot remember things  
Difficulty making decisions  
Slowed thinking, difficulty getting organized, cannot finish things

Fatigue, loss of energy, getting tired easily  
Difficulty falling or staying asleep  
Feeling anxious or tense  
Feeling depressed or sad  
Irritability, easily annoyed  
Poor frustration tolerance, feeling easily overwhelmed by things

- Rated on 5-point Likert scale (0 = none; 4 = very severe)
- Current analyses collapsed Likert scale into 3 categories:
  - No disturbance (0 = none)
  - Mild/moderate (1-2)
  - Severe/very severe (3-4)

# Clinician confirmed TBI diagnosis

- Based on Second Level Comprehensive TBI Evaluation, clinician makes a judgment about whether Veteran's experience and symptoms are consistent or are not consistent with a TBI.



# Sample characteristics

- Age < 30
- Male
- Active duty
- Army

Variable	Value	Full Sample (N=350)
Age Group (quartiles)	<25	106 (30.3%)
	25-27	91 (26.0%)
	28-33	69 (19.7%)
	34+	84 (24.0%)
Sex	Male	338 (96.6%)
	Female	12 (3.4%)
Race	White	137 (39.1%)
	Black	12 (3.4%)
	Hispanic	65 (18.6%)
	Other/Unknown	136 (38.9%)
Marital Status	Married	101 (28.9%)
	Divorced	8 (2.3%)
	Never married	241 (68.9%)
Unit Code	Active Duty	240 (68.6%)
	Reserves	110 (31.4%)
Branch of Service	Army	213 (60.9%)
	Air Force	10 (2.9%)
	Marines	99 (28.3%)
	Navy & Coast Guard	28 (8.0%)
Rank	Enlisted	340 (97.1%)
	Officer	10 (2.9%)
Number of Deployments	One deployment	188 (53.7%)
	Multiple deployments	162 (46.3%)
Clinician-confirmed TBI	No	141 (40.3%)
	Yes	209 (59.7%)

# Analyses of injury severity associations

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- 1. Logistic regression analyses** examined the associations between injury severity markers and clinician-confirmed TBI status

# Injury severity associations

Injury severity markers	Value	Odds Ratio
LOC	No	1
	Uncertain	4.97 <sup>*</sup>
	Yes	10.04 <sup>**</sup>
Confusion	No	1
	Uncertain	1.84
	Yes	7.58 <sup>**</sup>
Posttraumatic amnesia	No	1
	Uncertain	2.90
	Yes	11.12 <sup>**</sup>
At least 1 LOC, PTA, or confusion	No	1
	Uncertain	1.62
	Yes	17.84 <sup>**</sup>

\* $p < .001$ ; \*\* $p < .0001$

# Injury severity associations

- Veterans with at least 1 injury severity marker were almost 18-times more likely to receive a clinician-confirmed TBI.

**Table 1. Classification of TBI Severity [3]**

<b>(If a patient meets criteria in more than one category of severity, the higher severity level is assigned)</b>			
<b>Criteria</b>	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
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]

# Consistent definitions of mTBI



## Definition of mild traumatic brain injury

Developed by the Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine

### About ACRM

The American Congress of Rehabilitation Medicine (ACRM) offers this information product as a service to rehabilitation professionals.

ACRM promotes multidisciplinary leadership and practice innovation; efficacious rehabilitation management of chronic disease and disability; and the life span.

We aim to enhance the lives of persons living with disability through a multidisciplinary approach to rehabilitation, and to promote rehabilitation research and its application in clinical practice.

ACRM welcomes participation by clinicians, physicians, service providers, and researchers.

**Table 1 Mayo TBI Severity Classification System**

**A. Classify as Moderate-Severe (Definite) TBI if one or more of the following criteria apply:**

1. Death due to this TBI
2. Loss of consciousness of 30 minutes or more
3. Post-traumatic anterograde amnesia of 24 hours or more
4. Worst Glasgow Coma Scale full score in first 24 hours; less than 13 (unless invalidated upon review, e.g., attributable to intoxication, sedation, systemic shock)
5. One or more of the following present:

- Intracerebral hematoma
- Subdural hematoma
- Epidural hematoma
- Cerebral contusion
- Hemorrhagic contusion
- Penetrating TBI (dura penetrated)
- Subarachnoid hemorrhage
- Brain stem injury

**B. If none of Criteria A apply, Mild (Probable) TBI if one or more of the following criteria apply:**

1. Loss of consciousness of more than 30 minutes
2. Post-traumatic anterograde amnesia momentary to less than 24 hours
3. Depressed, basilar or linear skull fracture (dura intact)

**C. If none of Criteria A or B apply, Classify as Symptomatic (Possible) TBI if the following symptoms are present:**

- Blurred vision
- Confusion (mental state)
- Dazed
- Dizziness
- Focal neurologic symptoms
- Headache
- Nausea

## Mild TBI POCKET GUIDE

Guideline for Adult Patients

A part of CDC's "Heads Up" Series

### Inclusion Criteria

- Non-penetrating trauma to the head.
- Presenting to ED within 24 hours of injury.
- GCS score 14-15 on initial ED evaluation.
- Age ≥ 16.

### Exclusion Criteria

- Penetrating or multisystem trauma.
- GCS score < 14 on initial ED evaluation.
- Age < 16.

GCS = Glasgow Coma Scale

### Four Critical Questions

**1. Which patients with mild TBI should have a noncontrast head CT scan in the ED?**

*Level A: Loss of consciousness or posttraumatic amnesia and one or more of the following:*

- Headache
- Vomiting
- Age > 60 years old
- Drug or alcohol intoxication
- Deficits in short-term memory
- Physical evidence of trauma above the clavicle
- Posttraumatic seizure
- GCS score < 15
- Focal neurologic deficit
- Coagulopathy

*Level B: Head trauma patients with no loss of consciousness or posttraumatic amnesia and one or more of the following:*

- Focal neurologic deficit
- Vomiting
- Severe headache
- Age ≥ 65 years old
- Physical signs of a basilar skull fracture
- GCS score < 15
- Coagulopathy
- Dangerous mechanism of injury.\*

*\*Dangerous mechanism of injury includes ejection from a motor vehicle, a pedestrian struck, and a fall from a height of ≥ 1 foot or 1 step.*

*Level C: None specified*



# Injury severity associations

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- Veterans who endorsed LOC and PTA were 10-11 times more likely to receive a clinician-confirmed TBI.
- Disorientation and confusion is also associated, but to a lesser degree



# Injury severity associations

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- WHY MIGHT THIS BE?
  - LOC and PTA more clearly reflects possible neurologic injury
    - Greater agreement in mTBI diagnosis among clinicians when there is injury-associated LOC and PTA (Powell et al., 2008; Walker et al., 2015)
  - Disorientation/confusion may be confounded by the traumatic nature of event

# Utility of neurobehavioral symptoms

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- 1. Likelihood ratio** of each neurologic symptom for predicting clinician-confirmed TBI status

# NSI physical symptoms

Physical Symptoms	Rating	Odds Ratio
1. Feeling dizzy (ref = None)	Mild/Moderate	1.90 <sup>**</sup>
	Severe/Very Severe	3.09 <sup>**</sup>
2. Loss of balance	Mild/Moderate	.12
	Severe/Very Severe	.173
3. Poor coordination, clumsy	Mild/Moderate	1.35
	Severe/Very Severe	3.09 <sup>**</sup>
4. Headaches	Mild/Moderate	1.66
	Severe/Very Severe	2.83 <sup>***</sup>
5. Nausea	Mild/Moderate	1.57
	Severe/Very Severe	2.76 <sup>*</sup>
6. Vision problems, blurring, trouble seeing	Mild/Moderate	1.23
	Severe/Very Severe	2.43 <sup>**</sup>
7. Sensitivity to light	Mild/Moderate	1.35
	Severe/Very Severe	2.01 <sup>*</sup>
8. Hearing difficulty	Mild/Moderate	1.86 <sup>*</sup>
	Severe/Very Severe	1.87 <sup>*</sup>

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .0001$

# NSI physical symptoms



SUMMARY: Veterans with severe/very severe levels of dizziness, poor coordination, headaches, nausea, and vision problems were 2-2.5 greater odds of receiving a clinician-confirmed mTBI diagnosis.

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .0001$

# NSI cognitive symptoms

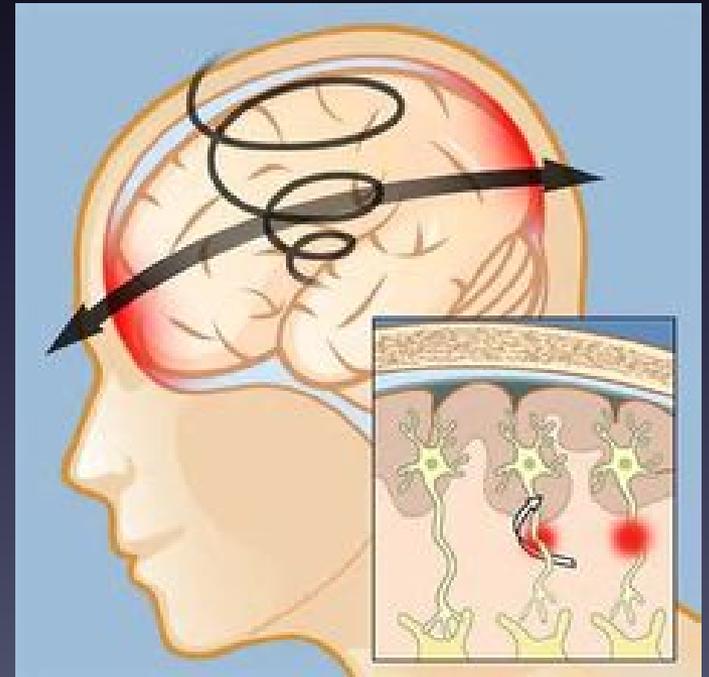
Cognitive symptoms	Rating	Odds Ratio
13. Poor concentration, cannot pay attention	Mild/Moderate	1.10
	Severe/Very Severe	2.00
14. Forgetfulness, cannot remember things	Mild/Moderate	1.24
	Severe/Very Severe	2.00
15. Difficulty making decisions	Mild/Moderate	1.14
	Severe/Very Severe	1.21
16. Slowed thinking, difficulty getting organized, cannot finish things	Mild/Moderate	1.10
	Severe/Very Severe	1.97*

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .0001$

# NSI cognitive symptoms

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- Slowed thinking, difficulty getting organized, cannot finish things:
  - Common cognitive deficits in mTBI
  - Diffuse axonal shearing





# NSI cognitive symptoms

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- Other cognitive symptoms are unrelated:
  - Poor relationship between subjective cognitive complaints and objective neuropsychological findings
  - Subjective cognitive complaints on NSI were significantly correlated with Posttraumatic Stress Disorder Checklist (PCL-C) and Personality Assessment Inventory (PAI)

SOURCE: French, LM, Lange, RT, & Brickell, TA (2014). Subjective cognitive complaints and neuropsychological test performance following military-related traumatic brain injury. *Journal of Rehabilitation & Research Development*, 51(6), 933-950

# NSI emotional symptoms

Emotional symptoms	Rating	Odds Ratio
17. Fatigue, loss of energy, getting tired easily	Mild/Moderate	.78
	Severe/Very Severe	1.37
18. Difficulty falling or staying asleep	Mild/Moderate	1.04
	Severe/Very Severe	1.41
19. Feeling anxious or tense	Mild/Moderate	.75
	Severe/Very Severe	1.39
20. Feeling depressed or sad	Mild/Moderate	1.23
	Severe/Very Severe	1.68
21. Irritability, easily annoyed	Mild/Moderate	2.19
	Severe/Very Severe	2.45*
22. Poor frustration tolerance, feeling easily overwhelmed by things	Mild/Moderate	.45
	Severe/Very Severe	.25

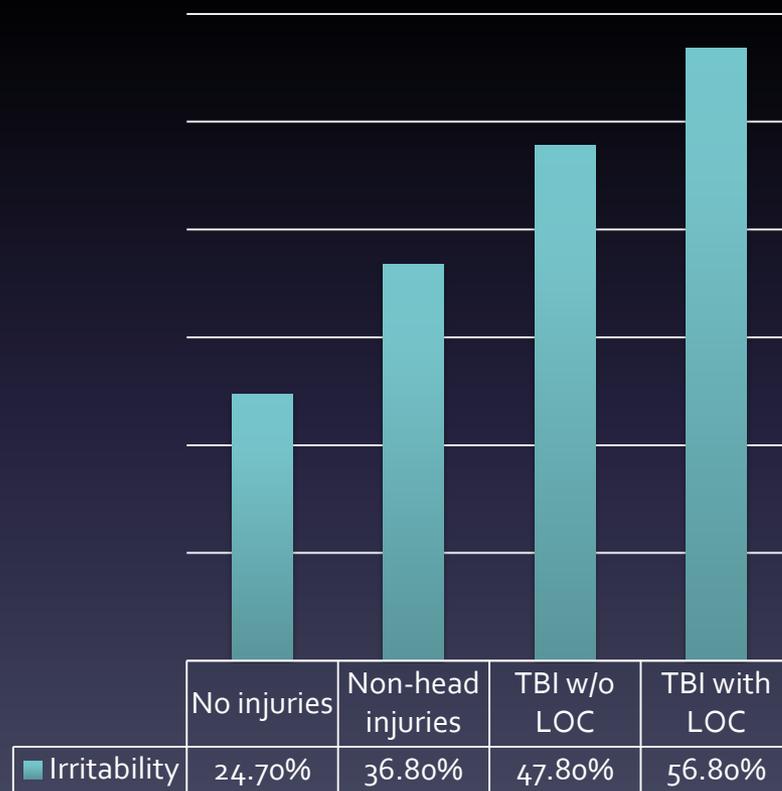
\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .0001$

# NSI emotional symptoms

## Irritability:

- Common characteristic (Yang et al., 2012)
- About 30% with mTBI complain of irritability 1 year post-injury (Deb et al., 1998)
- May reflect disruption in inhibitory control in prefrontal and limbic structures, areas in the brain sensitive to brain injury (Hovland & Mateer, 2000)

## Military and Veterans



Hoge et al., 2008

Additional resource:

[http://dvbic.dcoe.mil/files/DVBIC\\_Research\\_Research-Review\\_TBI-Irritability-Agression\\_Feb2016\\_v1.0\\_2016-04-05.pdf](http://dvbic.dcoe.mil/files/DVBIC_Research_Research-Review_TBI-Irritability-Agression_Feb2016_v1.0_2016-04-05.pdf)

# Overview of findings

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- Retrospective injury-related factors have greatest utility
- $< 1/3$  (10/22) of current NSI symptoms distinguished between Veterans with and without clinician-confirmed mTBI
  - Clinicians place weight on neurologic/physical symptoms (e.g. nausea)
  - Limited association in cognitive and emotional symptoms

# Clinical Implications

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- Goal of Second Level TBI Evaluation
  - Diagnosis (for documentation)
  - Identify Veterans at risk for continued and worsening of postconcussive symptoms
  - Plan multidisciplinary treatment

# Clinical Implications

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- Diagnosis of mTBI within VA:
  - Injury severity markers are key in identifying significance of injury event
  - Consistency with other widely used criteria
  - Limited utility of current neurologic (or postconcussive) symptoms on NSI

# Clinical Implications

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- Psychoeducation for Veterans:
  - mTBI describes a past event
  - Expectations for recovery from mTBI
  - Stress importance of multidisciplinary treatment

# Clinical Implications

## Multidisciplinary treatment (VA Consensus Conference)

- Address physical symptoms
- Further assessment and treatment of mental health conditions
- Further neuropsychological assessment of objective cognitive concerns
- Coordinate integrated treatment plan



# Future Direction

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- Examine consistency between clinicians' ratings of TBI
- Replication using larger national data

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# Questions/Comments?

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- Contact Information:
  - Karen Lau, PhD ([karen.lau@kp.org](mailto:karen.lau@kp.org))
  - Shira Maguen, PhD ([shira.maguen@ucsf.edu](mailto:shira.maguen@ucsf.edu))

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