



# Traumatic Brain Injury Essentials - 2014 Update

**Hal S. Wortzel, MD**

Director of Neuropsychiatric Services, VISN 19 MIRECC

Michael K. Cooper Professor of Neurocognitive Disease

Director, Neuropsychiatry Service

Associate Professor of Psychiatry, Neurology, and Physical

Medicine & Rehabilitation

University of Colorado School of Medicine

## Traumatic Brain Injury (TBI) is...

- A life altering injury for survivors and their families, profoundly impacting the patient's neuropsychiatric status

*Or*

- A very common injury that is essentially inconsequential to the individual's neuropsychiatric status following recovery

# TBI

- Either may be true in a given case
- But many providers fail to distinguish between different injuries and their severities
  - Records frequently simply refer to “history of TBI” with no further clarification of severity
- Addressing the neuropsychiatric needs of an individual with history of TBI mandates specific skills/knowledge in TBI assessment in addition to the broad-based skills needed to navigate what is frequently a complex differential diagnosis

# Why?

- Every individual and every injury is unique
- Biomechanical forces to brain rarely occur in isolation
  - Forces also act on other anatomical structures (cervical spine, inner ear, etc.) potentially yielding polytrauma and often complicating neuropsychiatric presentation (headache, pain, dizziness, etc.)
- Biomechanical trauma is frequently accompanied by emotional trauma
  - PTSD, depression

***Neuropsychiatric symptoms of TBI are nonspecific***

# Football's Gigantic Problem-

*Deseret News, August 5, 2012*

“Are you ready for some football? First, however, are you ready for some autopsies?”

Junior Seau dies by suicide at the age of 43 on May 2, 2012. Death fuels speculation and mass media discussion on brain damage from football, and *chronic traumatic encephalopathy* .



# Self-Worth Shattering: A Single Bomb Blast Can Saddle Soldiers with Debilitating Brain Trauma

*Scientific American, May 16, 2012*

“Researchers say they have demonstrated that exposure to a single blast equivalent to that generated by a typical improvised explosive device can result in CTE and long-term brain impairments that accompany the disease.”



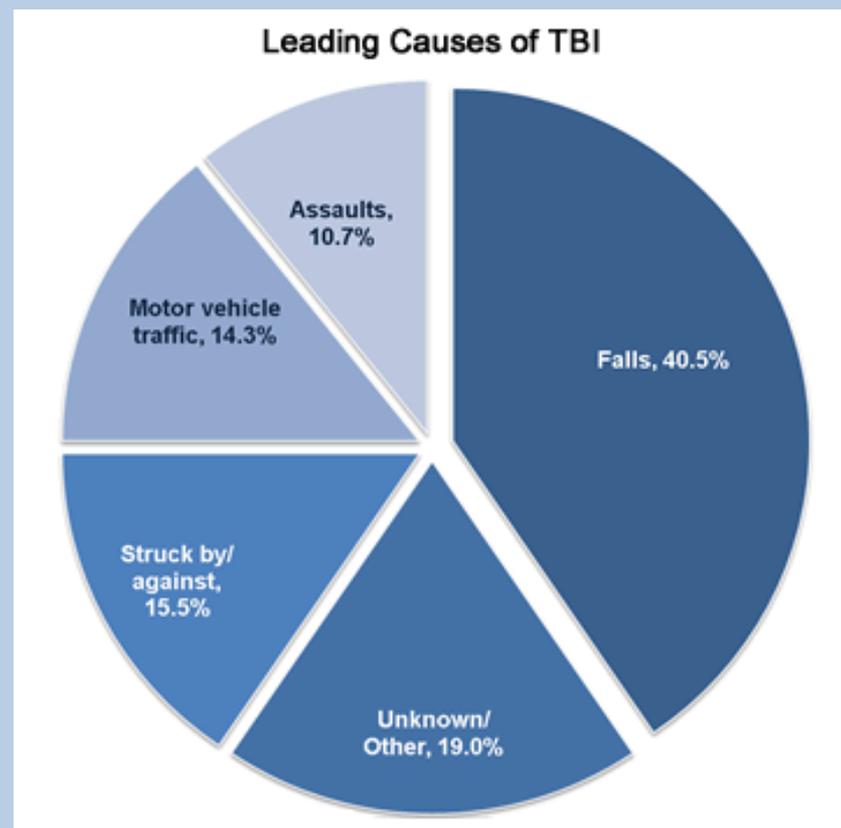
## OEF/OIF and TBI

- TBI is most common physical injury for combatants in Afghanistan and Iraq
- Explosion or blast injury is most common
- 2006 survey of more than 2,500 recently returned army infantry soldiers: 5% reported injuries with LOC during a yearlong deployment, 10% reported injuries with altered mental status
- RAND report with even higher rates: 19% with probable TBI on survey of almost 2,000 previously deployed service personnel.
- Terrio et al. with similarly high rate (23%) of clinician-confirmed TBI in a U.S. Army brigade combat team with at least one deployment

Conservative estimates suggest *hundreds of thousands* possible service-related TBIs

## Scope of the Problem

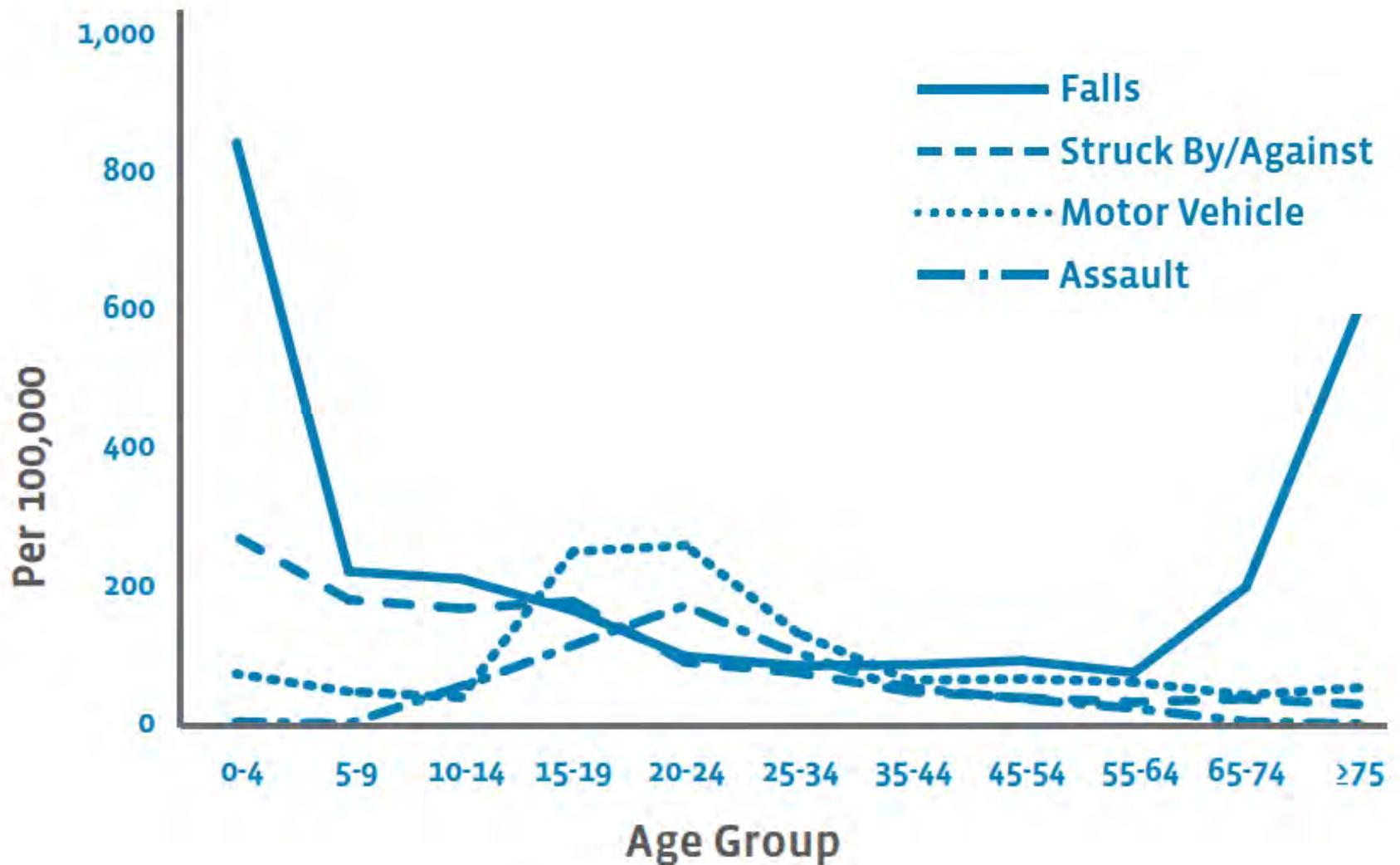
- In 2010, nearly 2.5 million emergency department visits, hospitalizations, or deaths associated with TBI in 2010 in the United States
- Contributed to > 50,000 deaths
- Diagnosed in > 280,000 hospital admissions and 2.2 million ED visits



Center for Disease Control and Prevention  
([http://www.cdc.gov/traumaticbraininjury/get\\_the\\_facts.html](http://www.cdc.gov/traumaticbraininjury/get_the_facts.html))

## Scope of the Problem

- 1.6 – 3.8 million TBIs each year for which no immediate medical attention is sought
- 125,000 develop TBI-related disability annually
- 3.2 million living with chronic TBI-related disability



Estimated Average Annual Rates of Traumatic Brain Injury-Related Emergency Department Visits, Hospitalizations, and Deaths, by External Cause, United States, 2002–2006. Source: Faul M, Xu L, Wald MM, Coronado VG. Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations and Deaths 2002 – 2006. Atlanta (GA): Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2010.

# Psychiatric disorders and TBI

	Not controlling for alcohol abuse		Controlling for alcohol abuse	
	Odds ratio	95% CI	Odds ratio	95% CI
Major depression	2.4	1.7-3.4	2.3	1.6-3.2
Dysthymia	2.0	1.2-3.1	1.7	1.1-2.7
Bipolar disorder	1.4	0.6-3.0	1.1	0.5-2.5
Obsessive-compulsive disorder	2.1	1.3-3.4	2.0	1.2-3.2
Panic disorder	2.8	1.5-5.2	2.5	1.3-4.6
Any phobia	1.7	1.3-2.4	1.6	1.2-2.3
Drug abuse/dependence	1.8	1.2-2.5	1.5	1.0-2.1
Alcohol abuse/dependence	2.2	1.7-2.8		
Schizophrenia	1.8	1.0-3.3	1.7	0.9-3.0
Suicide attempt	5.7	3.7-8.7	4.5	2.8-7.1

The association between psychiatric disorders and TBI after controlling for sociodemographic variables (age, sex, marital status, and SES) and quality of life variables. From the New Haven Epidemiologic Catchment Area Study (n=5034). Adapted from Silver et al. (2001).

# Suicide risk compared to general population...

## Standardized Mortality Ratios and 95% CI

Males with TBI	3.9	3.13-4.59
Females with TBI	4.7	3.06-7.06
Age at injury < 21	3.5	1.92-6.27
21-40	4.7	3.35-6.50
41-60	5.2	3.73-7.17
>60	2.5	1.55-4.01
Concussion	3	2.82-3.25
(Severe) Lesion	4.1	3.33-4.93
<b>Comorbid Substance Abuse</b>	<b>7.4</b>	<b>4.32-12.82</b>

## General Definition of TBI

- Application to the brain of an external physical force or rapid acceleration and/or deceleration forces
  - Not due to congenital, degenerative, vascular, hypoxic-ischemic, neoplastic, toxic-metabolic, infectious, or other causes
- Produces an immediately apparent physiological disruption of brain function manifested by cognitive or neurological impairments
- Results in partial or total functional disability (regardless of the duration of such disability)

# American Congress of Rehabilitation Medicine

## Definition of Mild TBI:

- A traumatically induced physiological disruption of brain function, as manifested by at least *one* of the following:
  - Any period of loss of consciousness (LOC)
  - Any loss of memory for events immediately before or after the accident (posttraumatic amnesia, PTA)
  - Any alteration in mental state at the time of the accident (e.g., feeling dazed, disoriented, or confused)
  - Focal neurologic deficit(s) that may or may not be transient

Kay, T., Harrington, D. E., Adams, R. E., Anderson, T. W., Berrol, S., Cicerone, K., Dahlberg, C., Gerber, D., Goka, R. S., Harley, J. P., Hilt, J., Horn, L. J., Lehmkuhl, D., & Malec, J. (1993). Definition of mild traumatic brain injury: Report from the Mild Traumatic Brain Injury Committee of the Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine. *Journal of Head Trauma Rehabilitation*, 8(3), 86-87.

# American Congress of Rehabilitation Medicine

## Definition of Mild TBI:

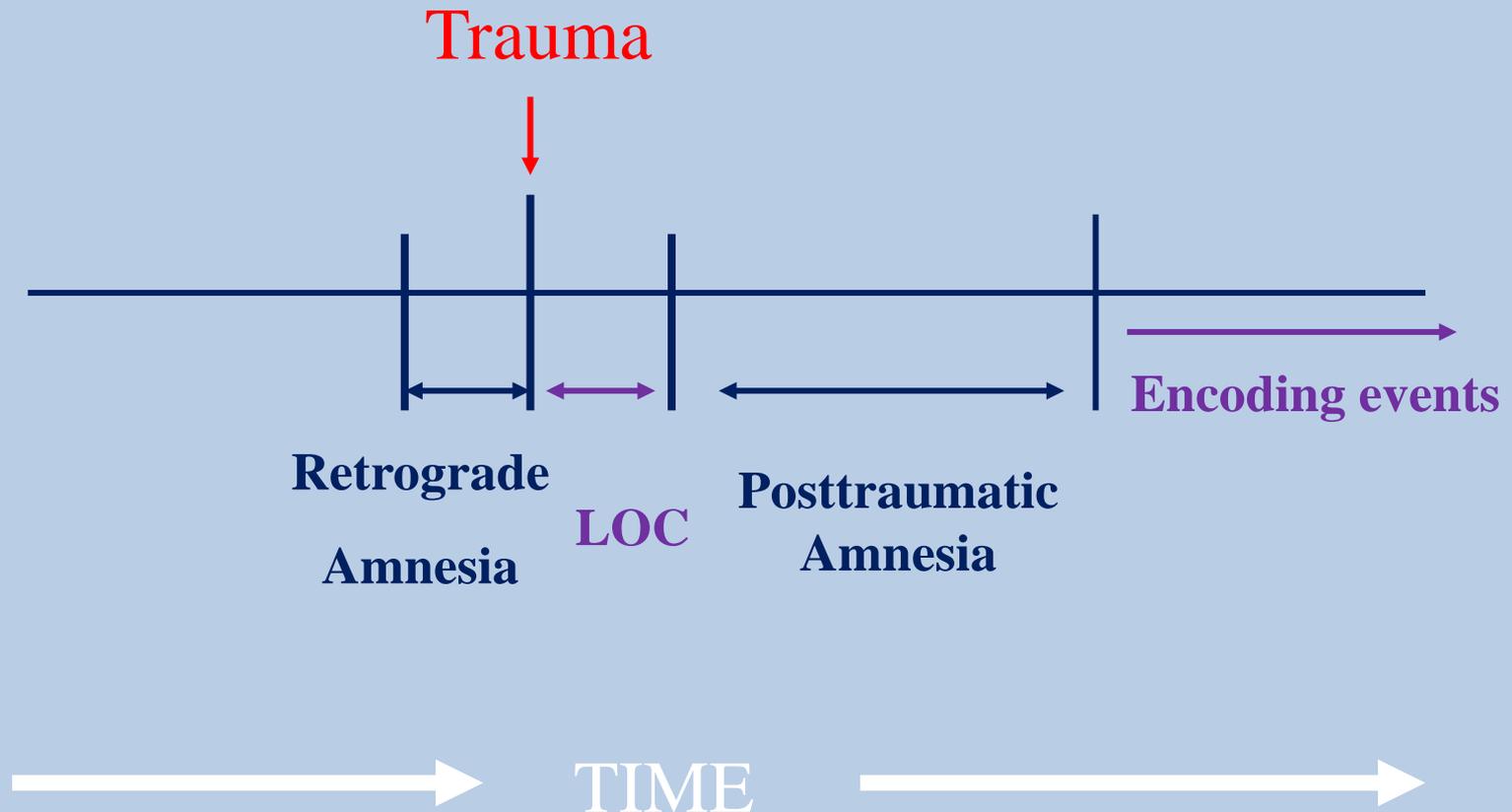
- The severity of the injury does not exceed the following:
  - LOC  $\leq$  30 minutes
  - After 30 minutes, Glasgow Coma Scale = 13-15
  - PTA  $\leq$  24 hours
- TBI producing disturbances that exceed these criteria is classified as moderate or severe

# TBI Phenomenology and Severity Classification

<b>Modified VA/DoD TBI Severity Classification System</b>					
	<b>LOC (hours)</b>	<b>PTA (days)</b>	<b>AOC (days)</b>	<b>GCS score (best in first 24 hours)</b>	<b>CT or MRI</b>
<b>Mild TBI</b>	≤ 0.5	≤ 1	≤ 1	13-15	Normal
<b>Complicated Mild TBI</b>	≤ 0.5	≤ 1	≤ 1	13-15	Abnormal
<b>Moderate TBI</b>	> 0.5 to < 24	> 1 to < 7	> 1	9-12	Normal or abnormal
<b>Severe TBI</b>	≥ 24	≥ 7	> 1	3-8	Normal or abnormal

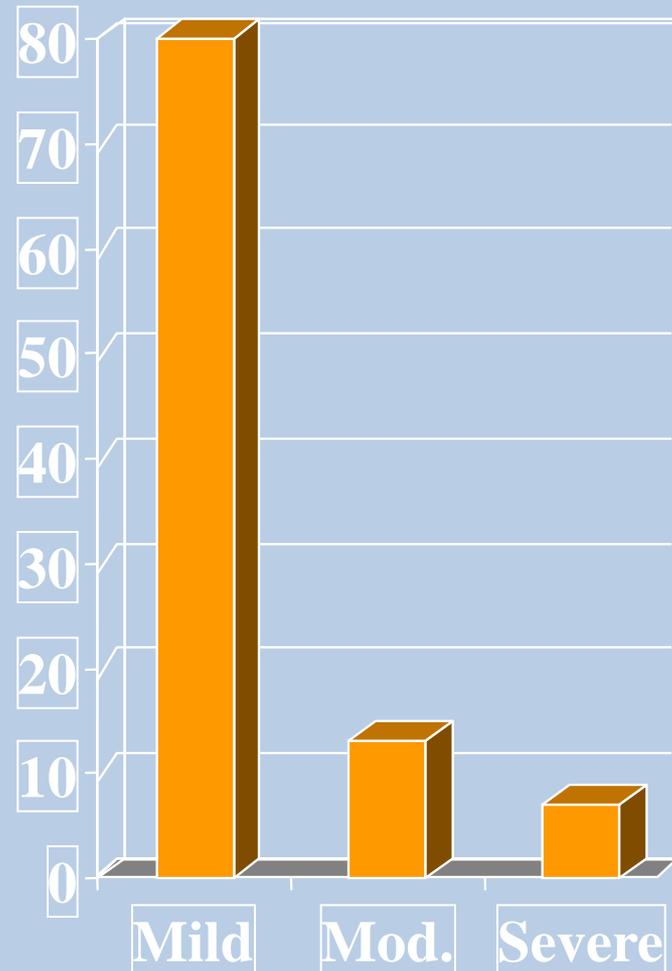
Adapted from Kay et al. 1993; Marr and Coronado 1992; Defense and Veterans Brain Injury Center Working Group on the Acute Management of Traumatic Brain Injury in Military Operational Settings 2006; Clinical Practice Guideline: Management of Concussion/mild Traumatic Brain Injury, VHA 2009; Menon et al. 2010; in Arciniegas 2011 [in press]

# Posttraumatic Amnesia



# Frequency of TBI Types

- Mild injuries = 80%
- Moderate = 10 - 13%
- Severe = 7 - 10%



# Prognosis for mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury

We searched the literature on the epidemiology, diagnosis, prognosis, treatment and costs of mild traumatic brain injury. Of 428 studies related to prognosis after mild traumatic brain injury, 120 (28%) were accepted after critical review. These comprise our best-evidence synthesis on prognosis after mild traumatic brain injury. There was consistent and methodologically sound evidence that children's prognosis after mild traumatic brain injury is good, with quick resolution of symptoms and little evidence of residual cognitive, behavioral or academic deficits. **For adults, cognitive deficits and symptoms are common in the acute stage, and the majority of studies report recovery for most within 3-12 months.** Where symptoms persist, compensation/litigation is a factor, but there is little consistent evidence for other predictors. The literature on this area is of varying quality and causal inferences are often mistakenly drawn from cross-sectional studies.

# Factors moderating neuropsychological outcomes following mild traumatic brain injury: A meta-analysis

There continues to be debate about the long-term neuropsychological impact of mild traumatic brain injury (MTBI). A meta-analysis of the relevant literature was conducted to determine the impact of MTBI across nine cognitive domains. The analysis was based on 39 studies involving 1463 cases of MTBI and 1191 control cases. The overall effect of MTBI on neuropsychological functioning was moderate ( $d = .54$ ). However, findings were moderated by cognitive domain, time since injury, patient characteristics, and sampling methods. Acute effects (less than 3 months postinjury) of MTBI were greatest for delayed memory and fluency ( $d = 1.03$  and  $.89$ , respectively). **In unselected or prospective samples, the overall analysis revealed no residual neuropsychological impairment by 3 months postinjury ( $d = .04$ ).** In contrast, clinic-based samples and samples including participants in litigation were associated with greater cognitive sequelae of MTBI ( $d = .74$  and  $.78$ , respectively at 3 months or greater). Indeed, litigation was associated with stable or worsening of cognitive functioning over time. The implications and limitations of these findings are discussed.

# 2014 Update by the International Collaboration on mTBI Prognosis

- Updates offered across six publications
  - Self-reported prognosis in adults after mTBI (Cassidy et al.)
  - Prognosis after mTBI – cognitive, psychiatric and mortality outcomes (Carroll et al.)
  - Risk of dementia and chronic cognitive impairment (Godbolt et al.)
  - Prognosis and return to play after sports concussion (Cancelliere et al.)
  - Prognosis after mTBI in the military (Boyle et al.)
  - Methodological issues and research recommendations (Kristman et al.)

# Methodological Issues and Research Recommendations

- 299 relevant studies – 101 deemed scientifically admissible (34%)
- WHO task force (2004) accepted 28%
- ***“Despite the proliferation of mTBI research over the past decade, virtually no improvement was seen in study quality. These low acceptance rates indicate a literature plagued with poorly designed studies and, as a result, many unanswered important clinical and research questions.”***

# Systematic review of self-reported prognosis in adults after mild traumatic brain injury: results of the International Collaboration on Mild Traumatic Brain Injury Prognosis

**OBJECTIVE:** To update the mild traumatic brain injury (MTBI) prognosis review published by the World Health Organization Task Force in 2004.

**STUDY SELECTION:** Controlled trials and cohort and case-control studies were selected according to predefined criteria. Studies had to assess subjective, self-reported outcomes. After 77,914 titles and abstracts were screened, 299 articles were eligible and reviewed for scientific quality. This includes 3 original International Collaboration on MTBI Prognosis (ICoMP) research studies.

**DATA EXTRACTION:** Eligible studies were critically appraised using the Scottish Intercollegiate Guidelines Network criteria. Two reviewers independently reviewed each study and tabled data from accepted articles. A third reviewer was consulted for disagreements.

**DATA SYNTHESIS:** Evidence from accepted studies was synthesized qualitatively into key findings, and prognostic information was prioritized according to design as exploratory or confirmatory. Of 299 reviewed studies, 101 (34%) were accepted and form our evidence base of prognostic studies. Of these, 23 addressed self-reported outcomes in adults, including 2 of the 3 original ICoMP research studies. These **studies show that common postconcussion symptoms are not specific to MTBI/concussion and occur after other injuries as well. Poor recovery after MTBI is associated with poorer premorbid mental and physical health status and with more injury-related stress.** Most recover over 1 year, but persistent symptoms are more likely in those with more acute symptoms and more emotional stress.

**CONCLUSIONS:** **Common subjective symptoms after MTBI are not necessarily caused by brain injury per se, but they can be persistent in some patients.** Those with more initial complaints and psychological distress recover slower. We need more high-quality research on these issues.

## A Biopsychosocial Condition...

- Postconcussion symptoms are equally prevalent in those with non-head injuries
- Most symptoms could be viewed as common reactions to stress of injury, or other mental or physical health stressors
- “All this evidence calls into question the validity of the PCS as a specific diagnosis and sequelae of mTBI.”

## A Biopsychosocial Condition...

- Symptoms common in general population, chronic pain, and whiplash
- Patients with mTBI tend to minimize symptoms experienced prior to injury
- ***“Thus, we recommend that the term postconcussion syndrome be replaced with posttraumatic symptoms because they are common to all injuries.”***

# Systematic review of the prognosis after mild traumatic brain injury in adults: cognitive, psychiatric, and mortality outcomes: results of the International Collaboration on Mild Traumatic Brain Injury Prognosis.

**DATA SYNTHESIS:** Evidence was synthesized qualitatively according to modified SIGN criteria, and studies were categorized as exploratory or confirmatory based on the strength of their design and evidence. After 77,914 records were screened, 299 were found to be relevant and critically reviewed, and 101 were deemed scientifically admissible. Of these, 21 studies that were related to the objective outcomes form the basis of this review. **Most evidence indicates the presence of cognitive deficits in the first 2 weeks post-MTBI, and some evidence suggests that complete recovery may take 6 months or a year. A small number of studies indicate that MTBI increases the risk of psychiatric illnesses and suicide.**

**CONCLUSIONS:** **Early cognitive deficits are common, and complete recovery may be prolonged. Conclusions about mortality post-MTBI are limited.** This review has implications for expected recovery after MTBI and MTBI-related health sequelae. Well-designed confirmatory studies are needed to understand the medium- to long-term consequences of MTBI and to further evaluate the effect of prior MTBI and injury severity on recovery.

## Cognitive functioning influenced by expectations?

- Three studies exploring this issue with “consistent findings that having negative expectations about head injuries is associated with poorer cognitive test performance.”
- Keep in mind the state of the literature and the manner in which it gets disseminated to the public
- *Are we seeding for widespread negative expectations?*

Perhaps yes...

**CNN Health:**

First Major League Baseball player diagnosed with CTE

By Stephanie Smith and Dan Moriarty, CNN

Updated 8:51 PM EST, Sun December 15, 2013

<http://www.cnn.com/2013/12/15/health/baseball-ryan-freel-cte-suicide/>



# Systematic review of the risk of dementia and chronic cognitive impairment after mild traumatic brain injury: results of the International Collaboration on Mild Traumatic Brain Injury Prognosis

**DATA SYNTHESIS:** Evidence from accepted studies was synthesized qualitatively according to modified Scottish Intercollegiate Guidelines Network criteria, and prognostic information was prioritized as exploratory or confirmatory according to design. Of 77,914 records screened, 299 articles were eligible and reviewed. Methodological quality was acceptable for 101 (34%) articles, of which 1 article considered dementia and 7 articles considered CCI. **The study examining the risk of dementia after MTBI did not find an association. One randomized controlled trial found that being informed about possible cognitive dysfunction after MTBI was associated with worse cognitive performance on standard tests.** Children with MTBI and intracranial pathology ("complicated" MTBI) performed worse than did children without intracranial pathology. Children showed higher rates of cognitive symptoms a year after MTBI than did a control group.

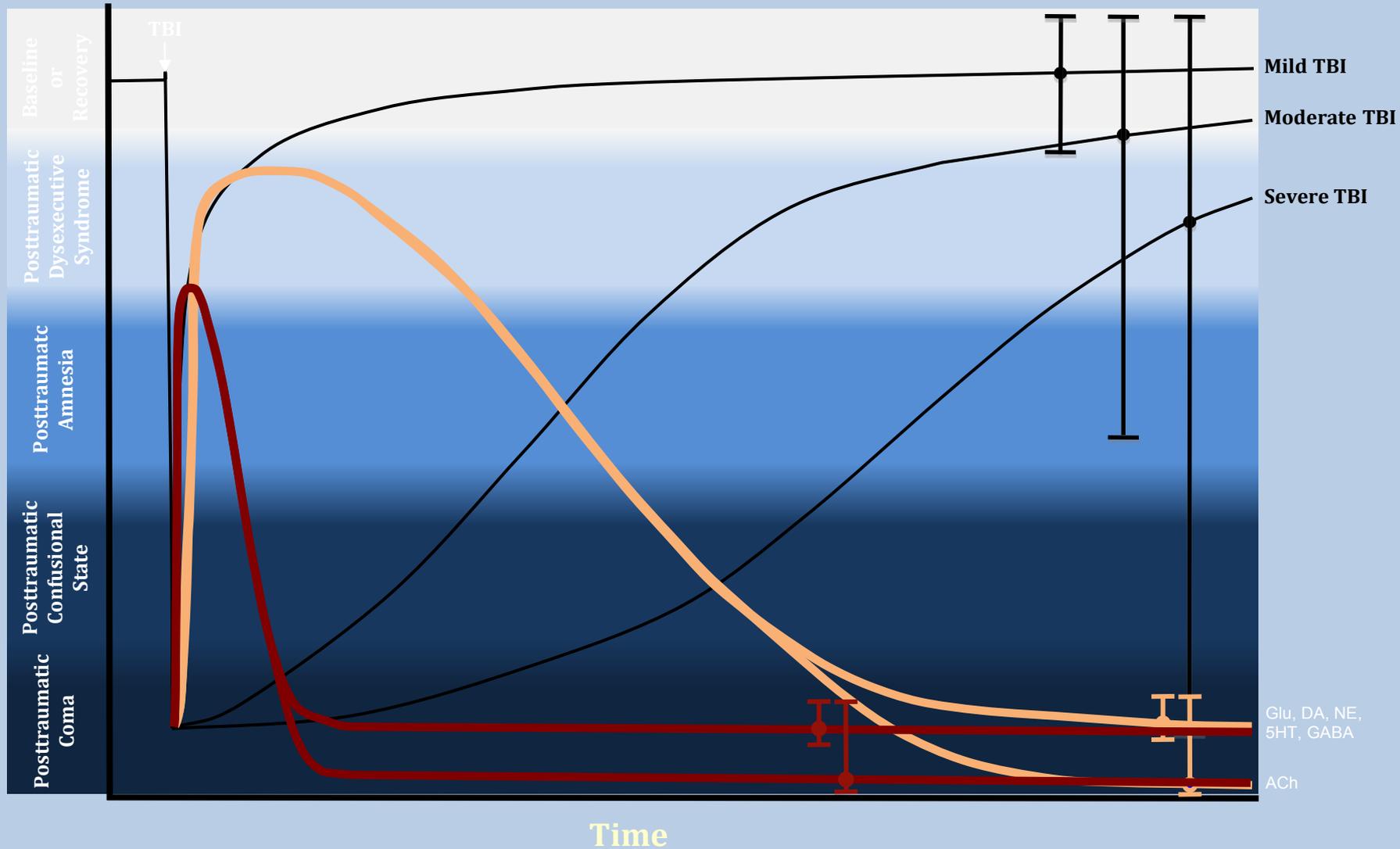
**CONCLUSIONS:** **There is a lack of evidence of an increased risk of dementia after MTBI. In children, objective evidence of CCI exists only for complicated MTBI.** More definitive studies are needed to inform clinical decisions, assessment of prognosis, and public health policy.

## Recovery from Moderate-to-Severe TBI

- About 35-60% of persons with moderate to severe TBI will develop chronic neurobehavioral and/or physical symptoms related to TBI
  - More severe initial injury increases the likelihood of incomplete neurological, neurobehavioral, and functional recovery
- Successful return to work and/or school is inversely related to the severity of persistent neurobehavioral and physical symptoms

# Course of Recovery from TBI

Stage of Posttraumatic Encephalopathy



Adapted from Arciniegas 2011, Arciniegas et al. 2010, and Arciniegas and McAllister 2008

# Posttraumatic Cognitive Impairments

- In the acute and late periods following TBI, the domains of cognition most commonly affected by TBI include:
  - Arousal/disturbances of consciousness
  - Processing speed/reaction time
  - Attention (selective, sustained, alternating, divided)
  - Working memory
  - Memory (new learning, retrieval, or [usually] both)
  - Functional communication (use of language)
  - Executive function

(Reviewed in: Bigler 2007; Arciniegas and Silver 2006; Nuwer 2005;  
Meythaler et al. 2001)

# Common Posttraumatic Emotional and Behavioral Problems

- Depression
- Mania
- Pathological Laughing and Crying
- Anxiety
- Irritability or loss of temper (“rage episodes”)
- Disinhibition
- Agitation/Aggression (“socially inappropriate behavior”)
- Apathy (loss of drive to think, feel, and/or behave)
- Psychosis
- Sleep disturbance

# Common Posttraumatic Symptoms

- Headache
- Sleep Disturbances
- Fatigue
- Dizziness
- Light sensitivity
- Sound sensitivity

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

**Most individuals return to baseline functioning within a year**

Posttraumatic Symptoms –  
NOT to be confused with the injury itself

**TBI is a historical event**

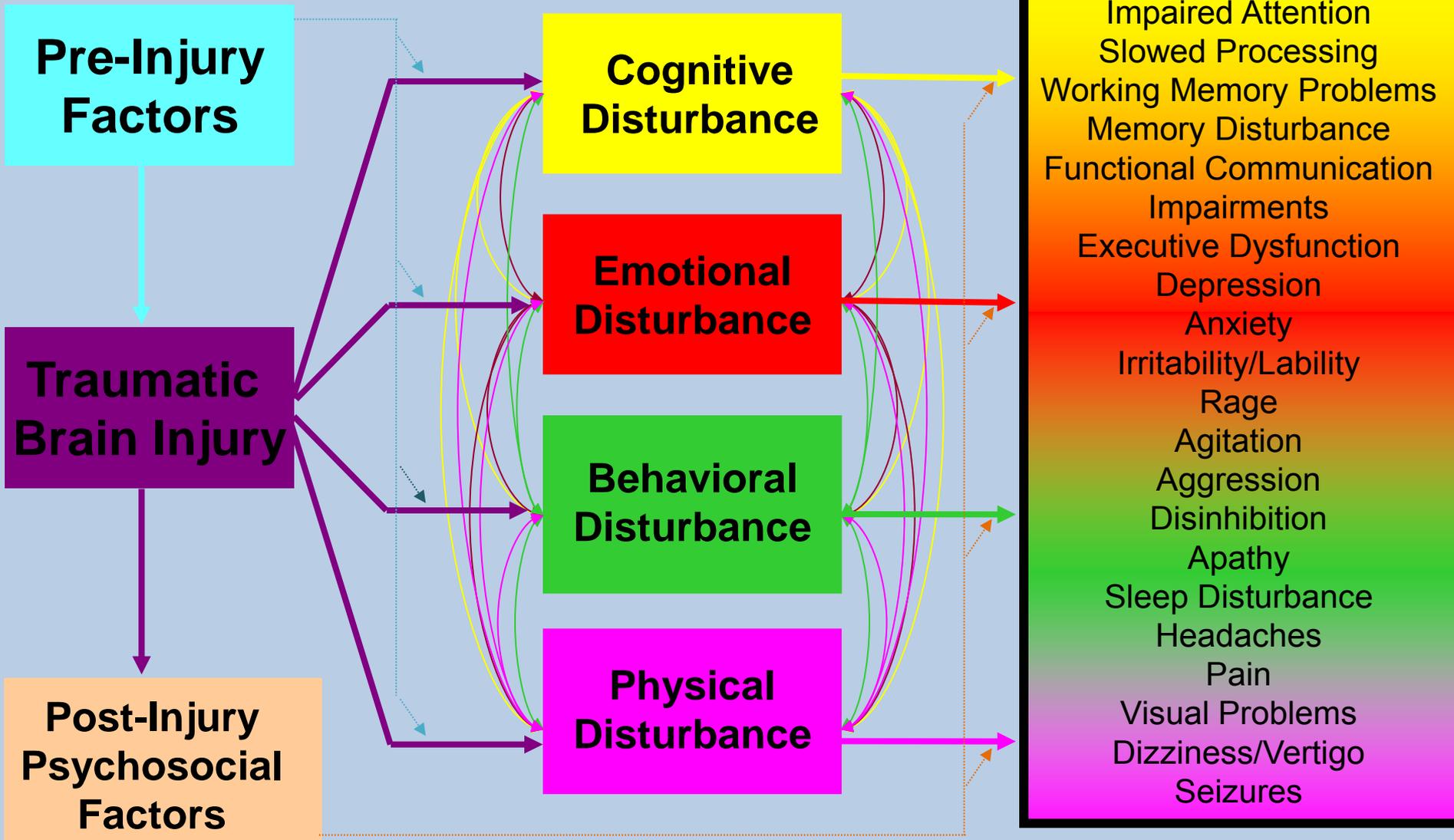
## Self-diagnosis of TBI

- “Gold standard” for diagnosis of TBI remains self-report and requires caution:
  - Under-reporting vs. over-reporting
  - Poor understanding of TBI
  - Misunderstanding symptoms as reflective of TBI when other diagnoses offer better explanations
  - Stigma vs. secondary gains
- **Avoid missed opportunities to target other treatable conditions (PTSD, MDD, etc.)**

## Self-diagnosis of TBI

- Reports of mild TBI without evidence in the medical record require careful evaluation of the history and other available evidence
  - Use ACRM definition of mild TBI as an anchor for the clinical history
  - Interview witnesses, if any, to the purported injury
  - Review medical, neurological, and neuropsychological evaluations (including comparison to pre-injury whenever such data can be obtained)
  - Review (by visual inspection, not just reports) any structural neuroimaging (CT, MRI) for findings consistent with *traumatic* brain injury
- !! Biomechanical trauma frequently co-occurs with psychological trauma

# A Model of Influences on Neurobehavioral Outcome after TBI



(Adapted from Silver and Arciniegas (2006))

## Pre-Injury Factors

- Age and gender
- Baseline intellectual function
- Psychiatric problems & substance abuse
- Sociopathy
- “Risk-taking” and “novelty-seeking” behavior
- Premorbid behavioral problems
- Social circumstances and SES
- Neurogenetic (ie, APOE-4, COMT, ?other)

# Injury Factors

- **Biomechanical Injury**
  - acceleration/deceleration
  - translational/rotational
  - angular acceleration/deceleration
  - cavitation (“microexplosive”)
  - diffuse axonal injury (DAI)
- **Cytotoxic Injury**
  - cytoskeletal & axonal injury
  - disturbance of cell metabolism
  - $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  dysregulation
  - free radical release
  - neurotransmitter excitotoxicity
- **Secondary Injury**
  - traumatic hematomas
  - cerebral edema
  - hydrocephalus
  - increased intracranial pressure (ICP)
  - systemic complications
    - hypoxia/hypercapnia
    - anemia
    - electrolyte disturbance
    - infection

# Injury Factors: Translation, Rotation, & Angular Acceleration Forces

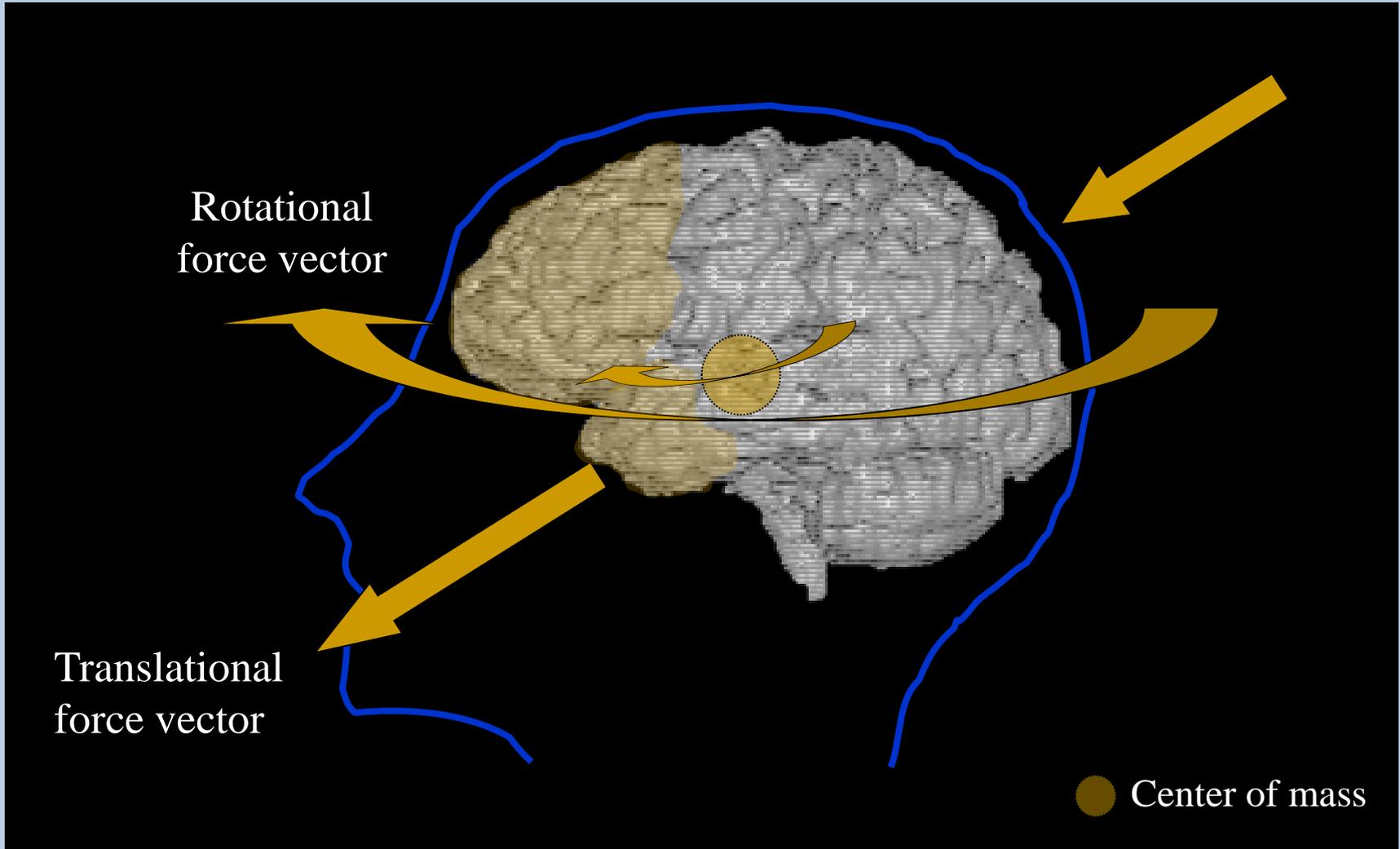
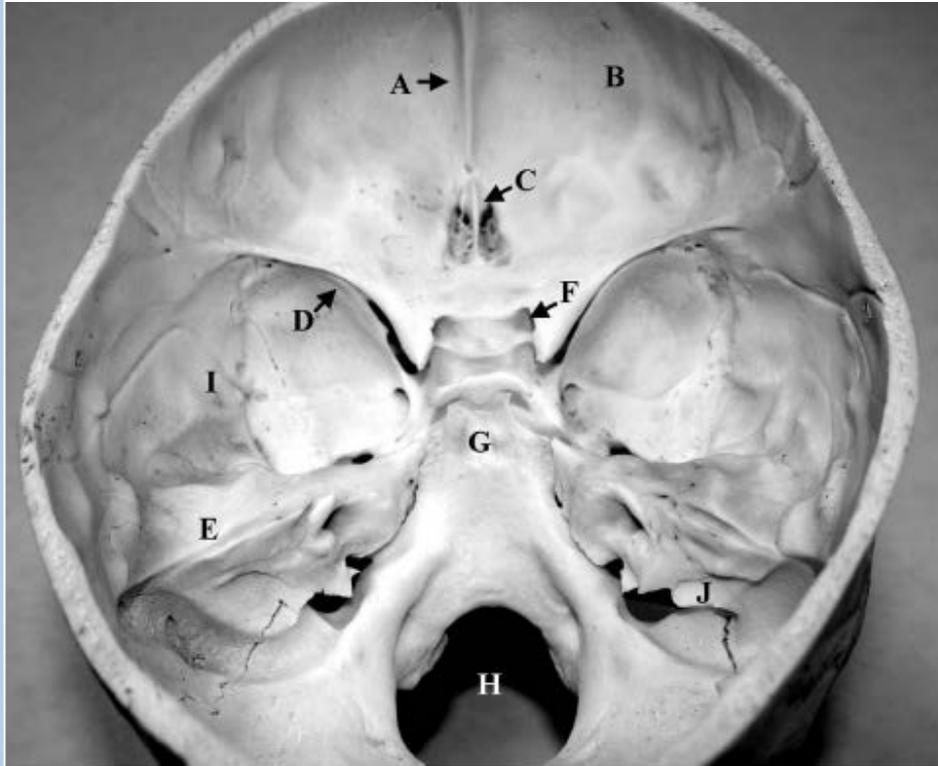
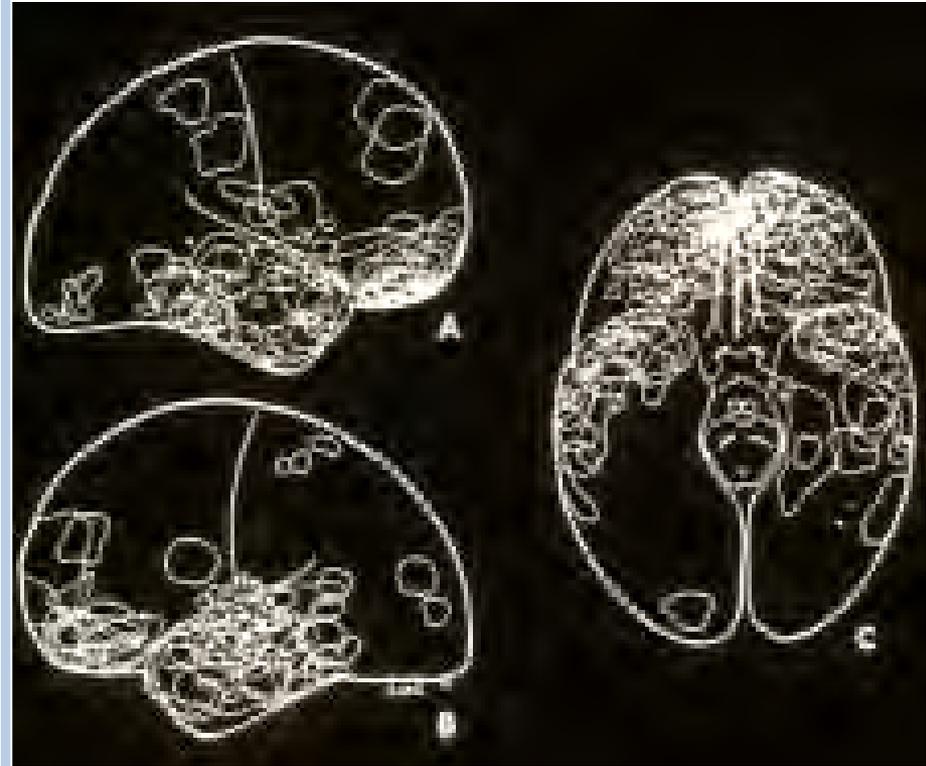


Figure adapted from Arciniegas and Beresford 2001

# Contact Forces

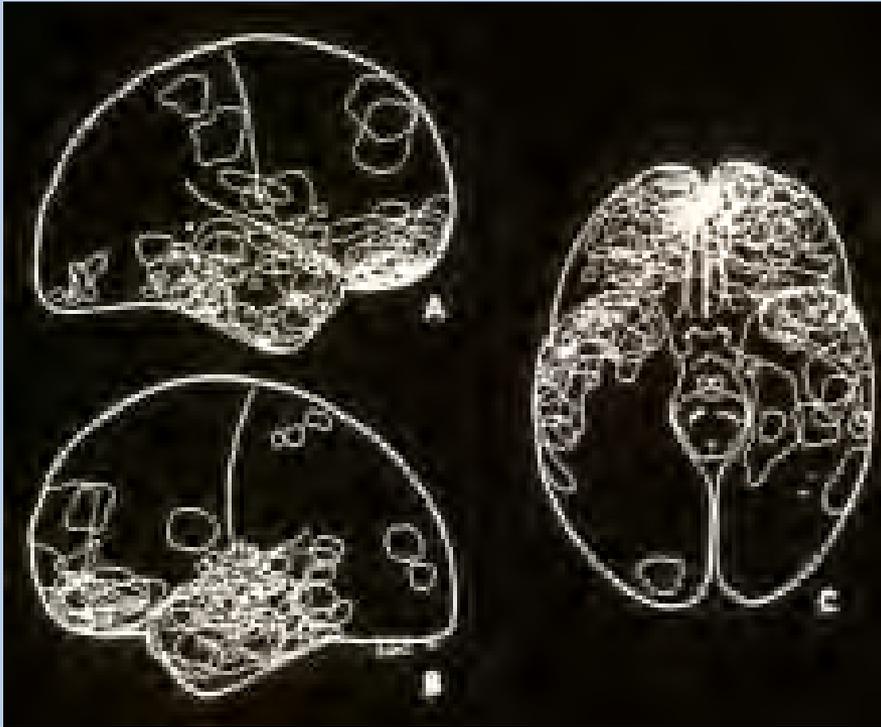


Source: Bigler ED: Anterior and Middle Cranial Fossa in Traumatic Brain Injury: Relevant Neuroanatomy and Neuropathology in the Study of Neuropsychological Outcome Neuropsychology, 21 (5):515–531, 2007

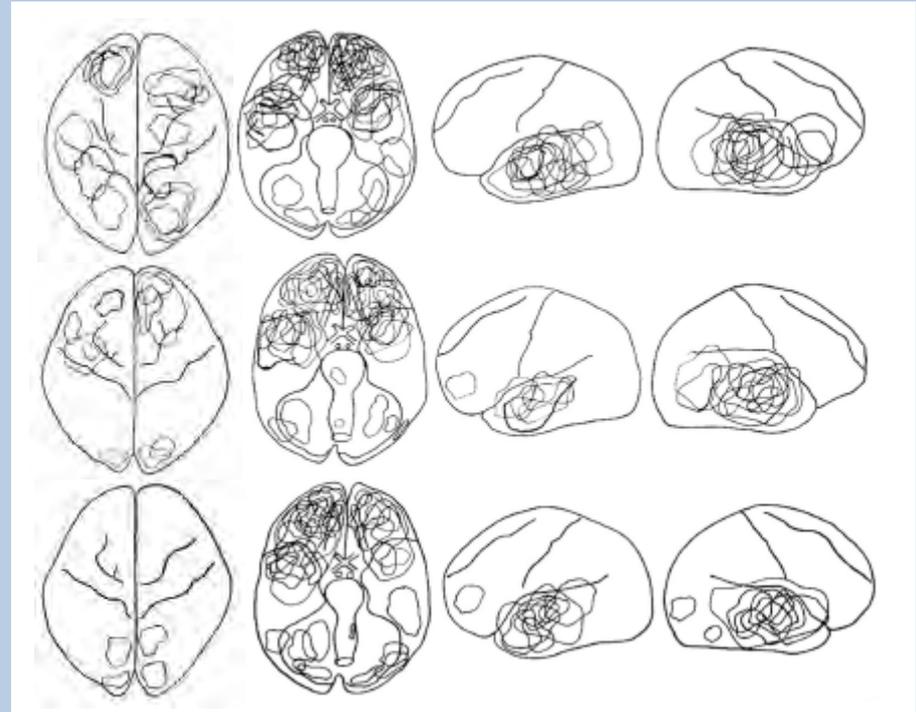


Coureville 1937, Coureville 1950, Gurdjian 1975; A. Right lateral view; B. Left lateral view; C. Ventral view. Image courtesy of Thomas W. McAllister, MD (Dartmouth-Hitchcock Medical Center)

# Typical Locations of Cortical Contusion after Severe TBI



Coureville 1937; image courtesy of Thomas W. McAllister, MD (Dartmouth-Hitchcock Medical Center)

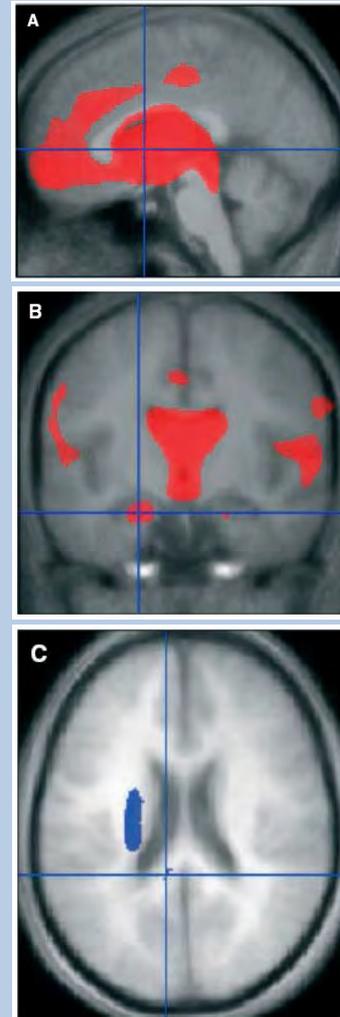


Coureville 1950 and Gurdjian 1975; adapted from Bigler 2007

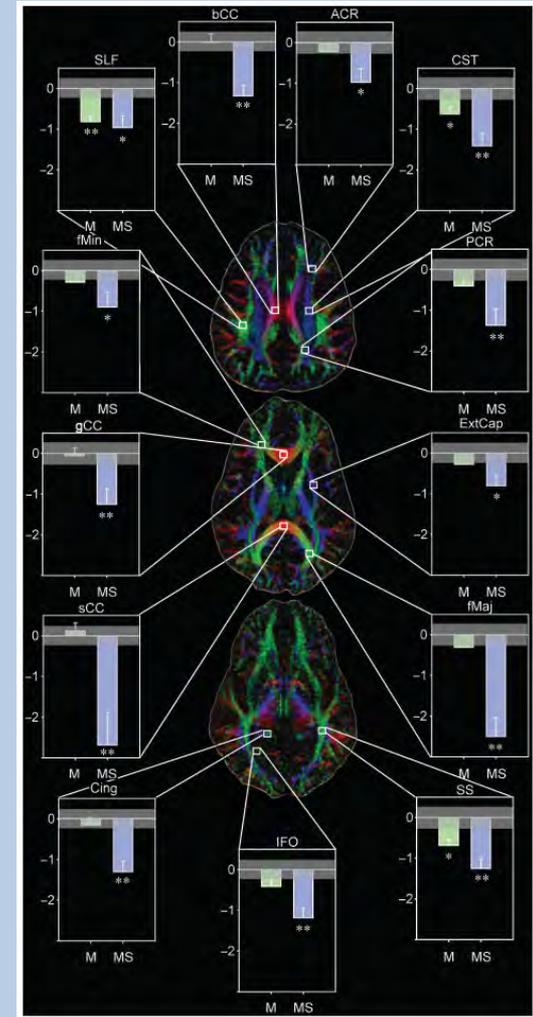
# Regional Vulnerability to TBI



Yeates et al. 2007



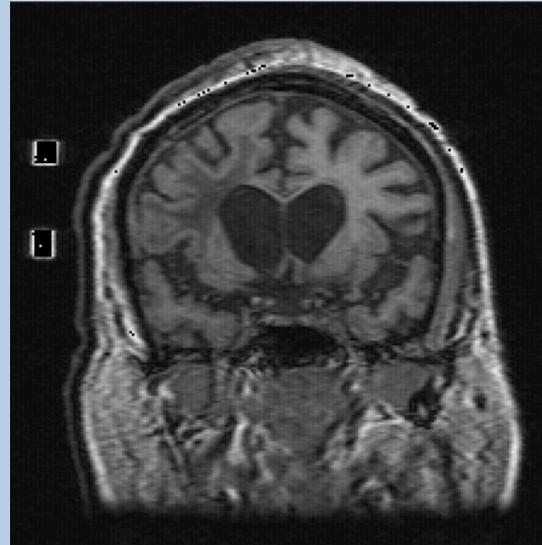
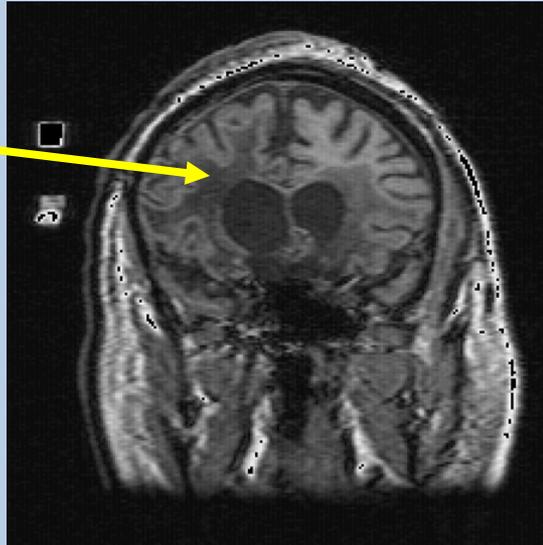
Salmond et al. 2005



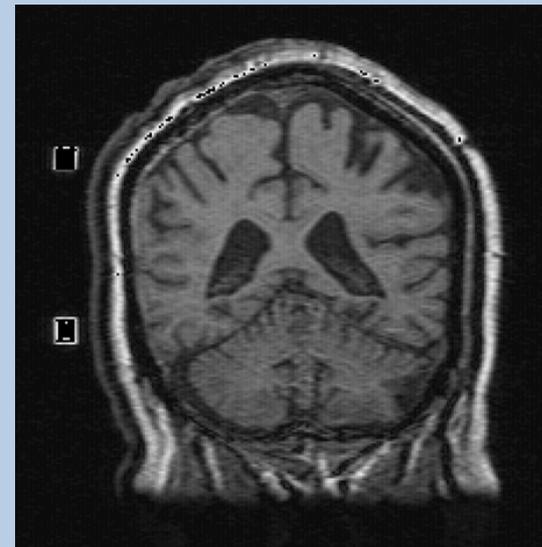
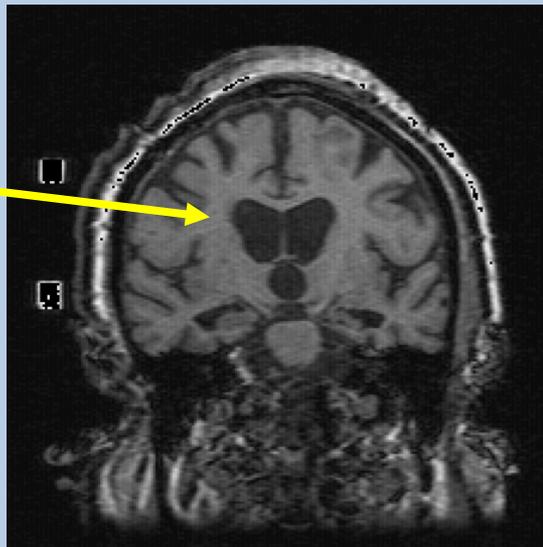
Kraus et al. 2007

# Diffuse (Multifocal) Axonal Injury

Diffusely injured white matter

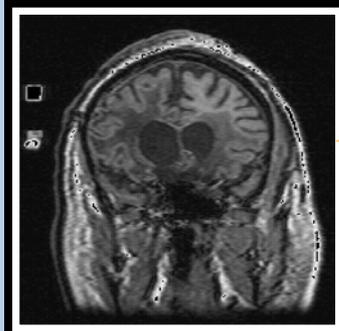


Normal appearing white matter

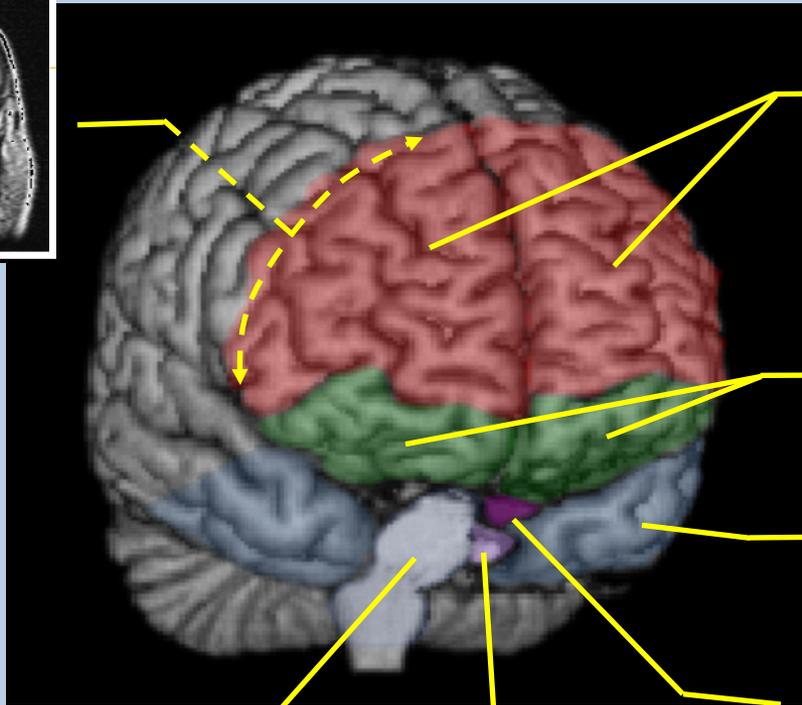


T1-weighted coronal images in a person who suffered a severe TBI after being hit by a bus

# Regional Vulnerability to TBI and Brain-Behavior Relationships



White matter  
(processing speed)



Ventral brainstem  
(arousal, ascending modulatory  
neurotransmitter systems)

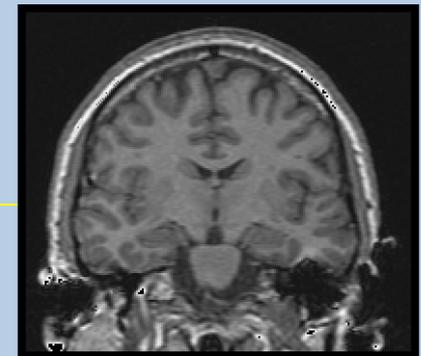
Entorhinal-hippocampal complex  
(declarative memory, sensory gating, attention)

Dorsolateral prefrontal cortex  
(executive function, including sustained and complex  
attention, memory retrieval, abstraction, judgment,  
insight, problem solving)

Orbitofrontal cortex  
(emotional and social responding)

Temporal poles  
(memory retrieval, semantics aspects of  
language, sensory-limbic integration)

Amygdala  
(emotional learning  
and conditioning)

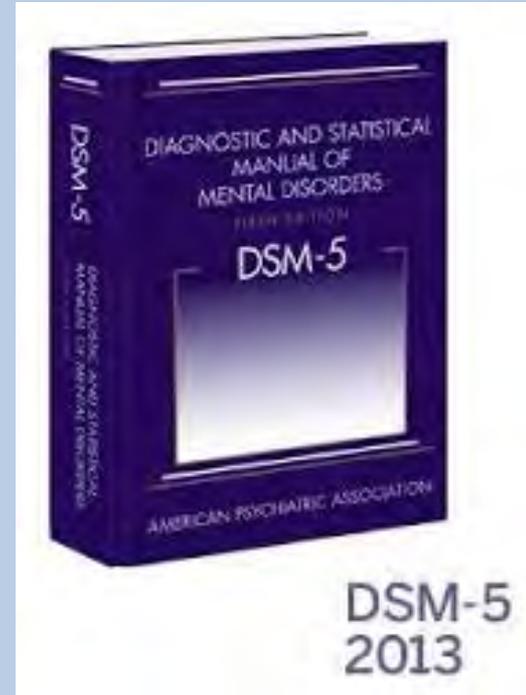


## Post-injury Factors

- Untoward medical complications
- Failure to receive timely medical, neurological, psychiatric, or other needed rehabilitative services
  - Early engagement in neurorehabilitation is associated with improved functional outcomes
- Lack of education regarding the course of recovery and interpretation of symptoms
- Lack of family, friends, or resources to support recovery
- Premature return to work/school with ensuing failure to perform at expected levels
- Poor adjustment to or coping with disability by injured person or family
- Litigation or other legal entanglements

## Enter DSM-5

- Released May 2013
- TBI and its neuropsychiatric sequelae afforded detailed consideration
- Criteria for diagnosing an injury event as TBI, and attributing neurocognitive problems to it, are offered
- DSM-5 approach to TBI represents a major step forward



## TBI in DSM-5

- TBI and its cognitive sequelae principally addressed within framework of Mild or Major Neurocognitive Disorders (NCD)
- Renaming and reframing of DSM-IV's "Delirium, Dementia, Amnestic, and Other Cognitive Disorders" chapter
- Captures conditions involving acquired cognitive impairment with decline from a previously attained level of performance

# Major or Mild Neurocognitive Disorder Due to TBI

## Diagnostic Criteria:

- A. Criteria met for major or mild neurocognitive disorder
- B. There is evidence of a traumatic brain injury – that is, an impact to the head or other mechanisms of rapid movement or displacement of the brain within the skull, with one or more of the following:

# Major or Mild Neurocognitive Disorder Due to TBI

## Diagnostic Criteria:

1. Loss of consciousness (LOC)
2. Posttraumatic amnesia
3. Disorientation and confusion
4. Neurological signs (e.g., neuroimaging demonstrating injury; a new onset of seizures; a marked worsening of a preexisting seizure disorder; visual field cuts; anosmia; hemiparesis)

# Major or Mild Neurocognitive Disorder Due to TBI

## Diagnostic Criteria:

C. The neurocognitive disorder presents immediately after the occurrence of the TBI or immediately after recovery of consciousness and persists past the acute post-injury period

*Criteria mirror those of the American Congress of Rehabilitation Medicine (ACRM) definition of mild TBI*

## Development and Course

- Severity of TBI rating based upon features of the historic injury event
- Severity of TBI does not necessarily correspond to the severity of the resulting NCD
- Course of recovery is variable, depending upon factors such as: specifics of injury event itself; age; prior history of brain injury; substance abuse

## Severity Rating for TBI

Injury Characteristic	Mild TBI	Moderate TBI	Severe TBI
<b>Loss of consciousness</b>	<b>&lt; 30 minutes</b>	<b>30 minutes – 24 hours</b>	<b>&gt; 24 hours</b>
<b>Posttraumatic Amnesia</b>	<b>&lt; 24 hours</b>	<b>24 hours – 7 days</b>	<b>&gt; 7 days</b>
<b>Glasgow Coma Scale Score</b>	<b>13 - 15 (not below 13 at 30 minutes)</b>	<b>9 – 12</b>	<b>3 - 8</b>

## Development and Course

- Neurobehavioral symptoms tend to be most severe in the immediate aftermath
- Except for severe injuries, typical course involves complete or substantial improvement
- Neurocognitive symptoms of mild TBI tend to resolve within days to weeks, with complete resolution typical by 3 months
- Substantial subsequent deterioration should trigger search for other explanations

## Development and Course

- Moderate and severe TBI may feature persisting neurocognitive deficits as well as neurophysiological, emotional, and/or behavioral complications
  - Seizures; photosensitivity; hyperacusis; irritability; aggression; depression; sleep disturbances; fatigue; apathy; inability to resume preinjury occupation and/or social functioning
- Moderate and severe TBI with increased risk for depression, aggression, and possibly neurodegenerative disease

## Progress

- Unlike editions before it, DSM-5:
  - Offers criteria for identifying an injury event equating with TBI
  - Provides criteria for rating the severity of a TBI
  - Describes the natural history associated with TBI, and the anticipated course of recovery for mild TBI
  - Encourages providers to think about alternative explanations when confronted by atypical clinical courses and/or outcomes

## Avoid Logical Fallacies...

- Post hoc ergo propter hoc (after TBI, therefore because of TBI)
- Post hoc ergo cum hoc (with TBI, therefore because of TBI)
- Such errors will result in missed opportunity to target treatable neuropsychiatric comorbidities and optimize function

## Lessons from our Youth



The sky is not falling.



But serious injuries do occur, and we potentially deprive those in legitimate need by crying wolf.

## Take home points...

- Not all TBI is alike
- Distinguish between mild and moderate/severe injuries
- Formulations regarding quantity and quality of neuropsychiatric sequelae from TBI require attention to pre-injury, injury, and post-injury factors
- Cognitive, emotional, behavioral and somatic symptoms frequently follow; these are nonspecific
- **Don't miss opportunities to identify and target other treatable neuropsychiatric conditions!!!**

**And...**

**Never ride without  
a helmet!**

Questions/  
Comments

