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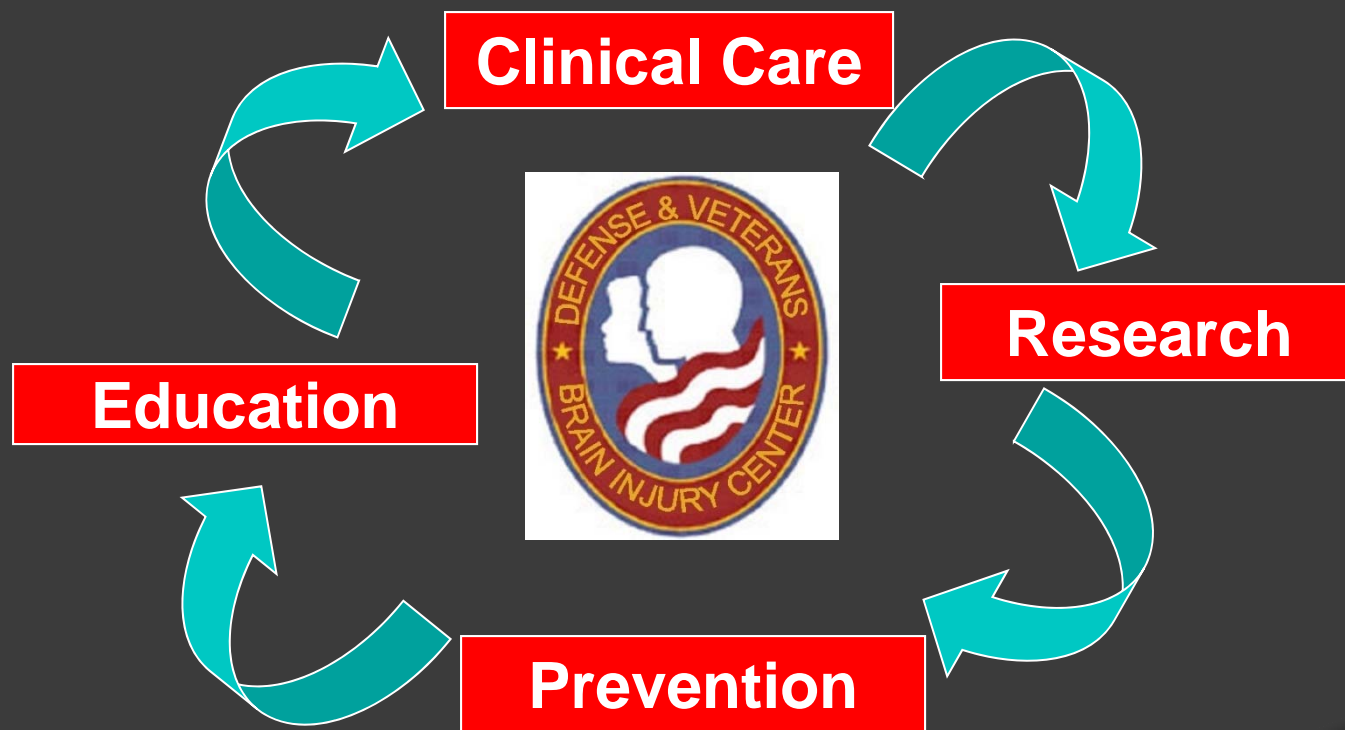
Defense and Veterans Brain Injury Center

THE ASSESSMENT AND MANAGEMENT OF COMBAT RELATED CONDITIONS

Disclaimer

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DVBIC Mission





DVBIC Headquarters (DC)

Military Lead Sites

- *Naval Medical Center San Diego (CA)*
- *Walter Reed Army Medical Center (DC)*
- *Wilford Hall Medical Center / Brooke Army Medical Center (TX)*

Military Associate Sites

- *Camp Pendleton Concussion Clinic (CA)*
- *Ft. Bragg Concussion Clinic (NC)*
- *Ft. Carson Soldier Readiness Center (CO)*
- *Landstuhl Regional Medical Center (Germany)*

MEDCEN Sites

- *Camp Lejeune (NC)*
- *Ft. Hood TBI Clinic (TX)*

VA Sites

- *Minneapolis VAMC (MN)*
- *Palo Alto VAMC (CA)*
- *Richmond VAMC (VA)*
- *Tampa VAMC (FL)*

Civilian Partners

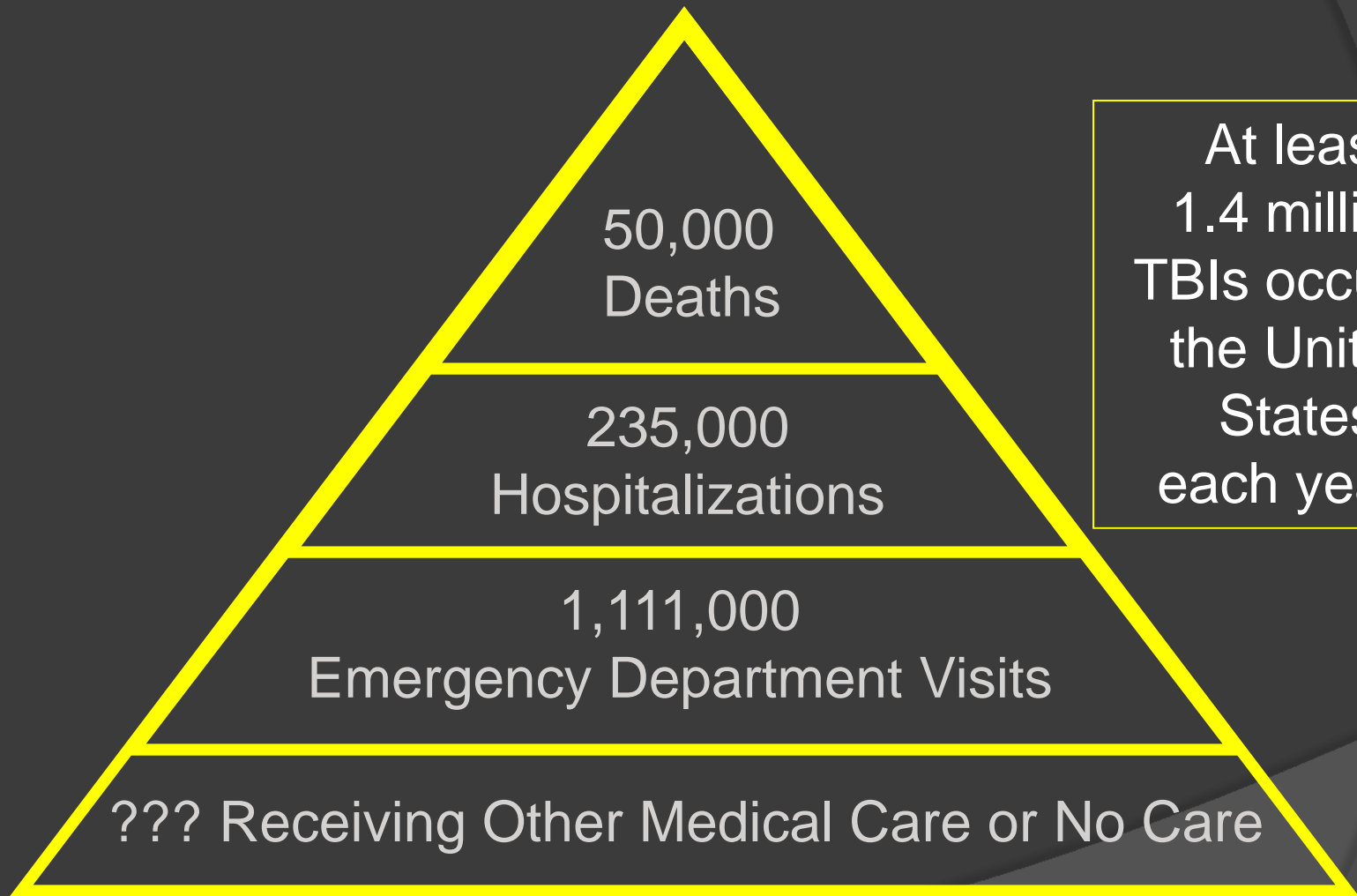
- *Lakeview Virginia Neurocare (VA)*
- *Laurel Highland Rehab Center (NH)*

Traumatic Brain Injury (TBI)

- ⦿ A traumatically induced structural injury and/or physiological disruption of brain function as a result of an external force that is indicated by new onset or worsening of at least one of the following clinical signs, immediately following the event:
 - Any period of or a decreased level of consciousness (LOC)
 - Any loss of memory for events immediately before or after the injury (PTA)
 - Any alteration in mental status at the time of injury (AOC)
 - Neurological deficits that may or may not be transient



TBI in the United States



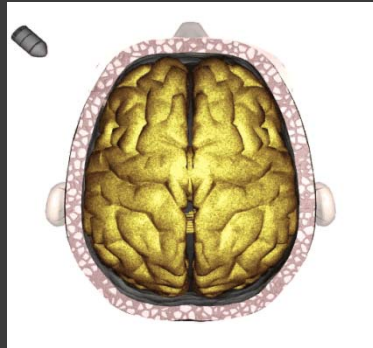
At least
1.4 million
TBIs occur in
the United
States
each year.*

* Source: CDC, Average annual numbers, 1995-2001

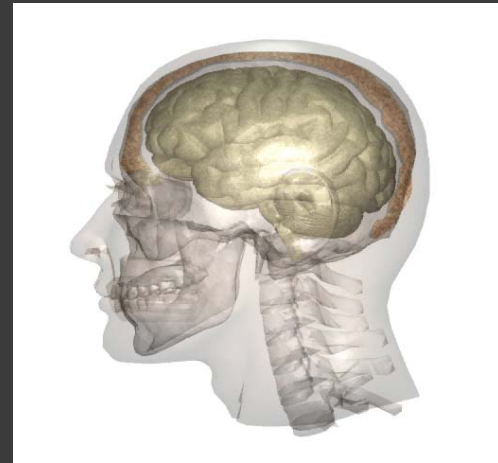
Mechanisms of Brain Injury



Contrecoup



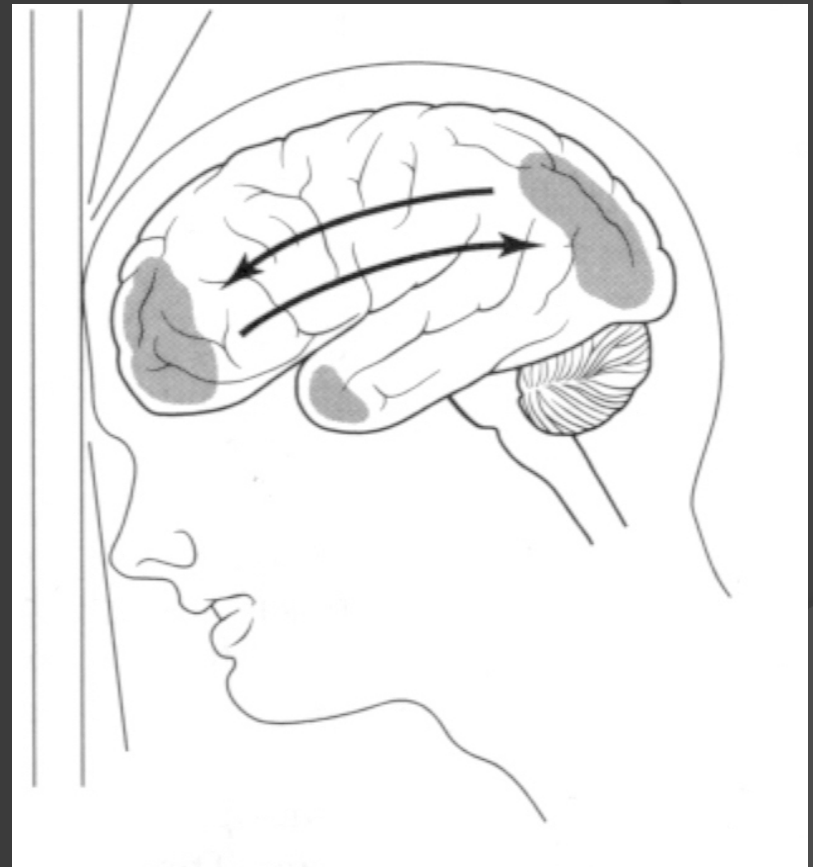
Gunshot Wound

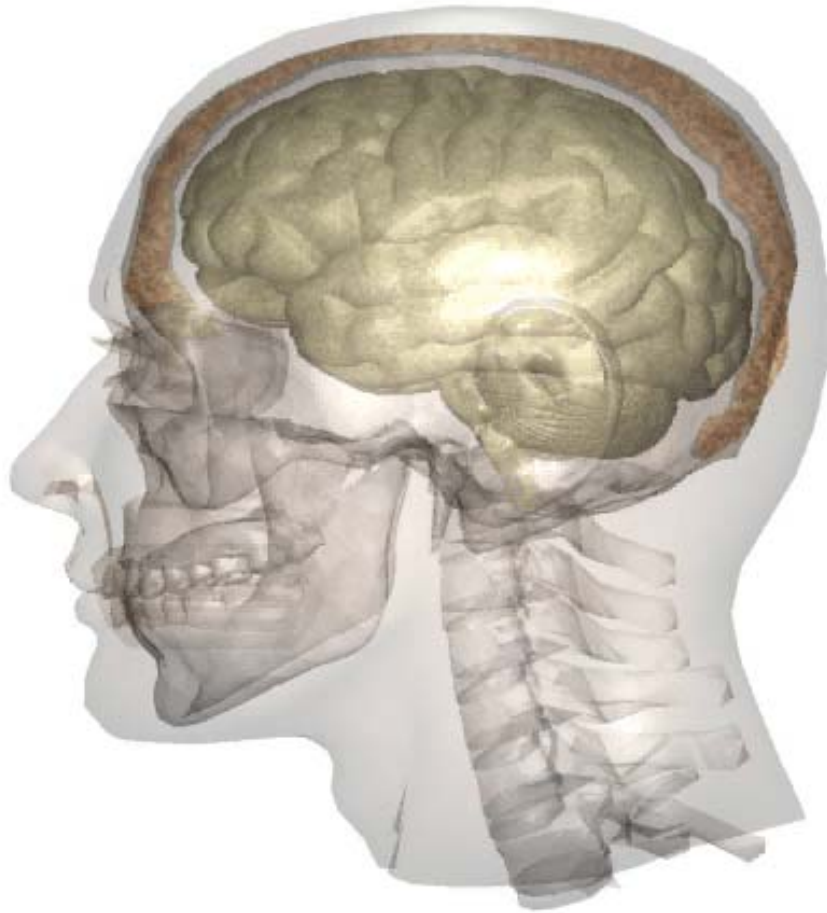


Diffuse Axonal

Acceleration/Deceleration

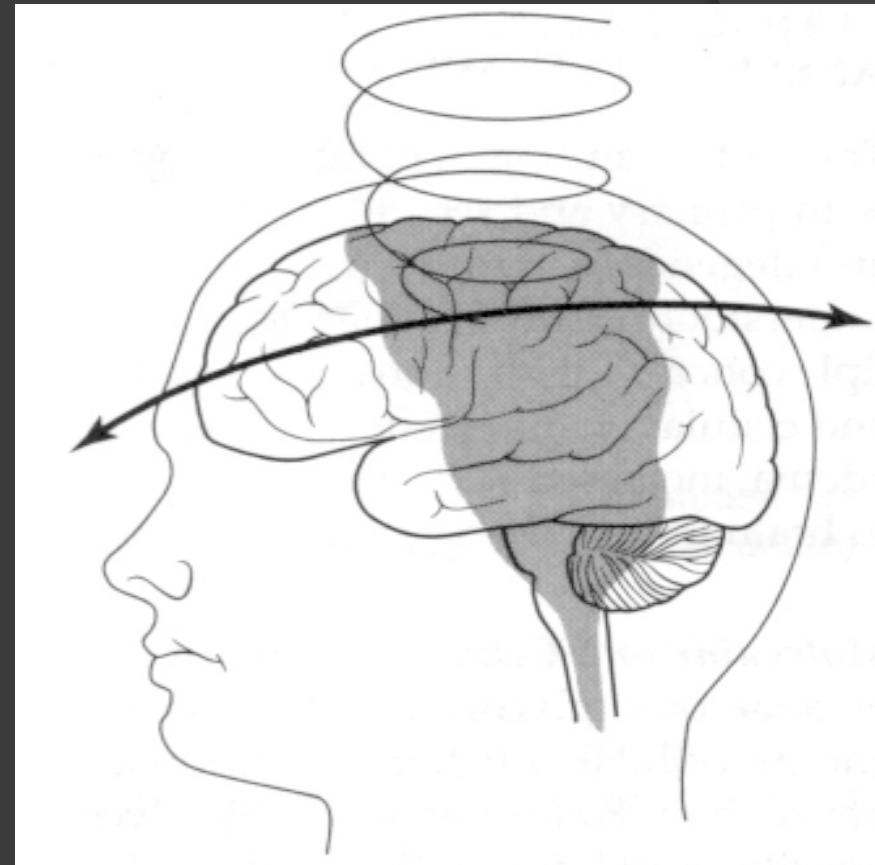
- ⦿ Rapid change in velocity
- ⦿ MVA's involve 3 collisions
 - Car into object
 - Occupant into car interior
 - Brain into skull

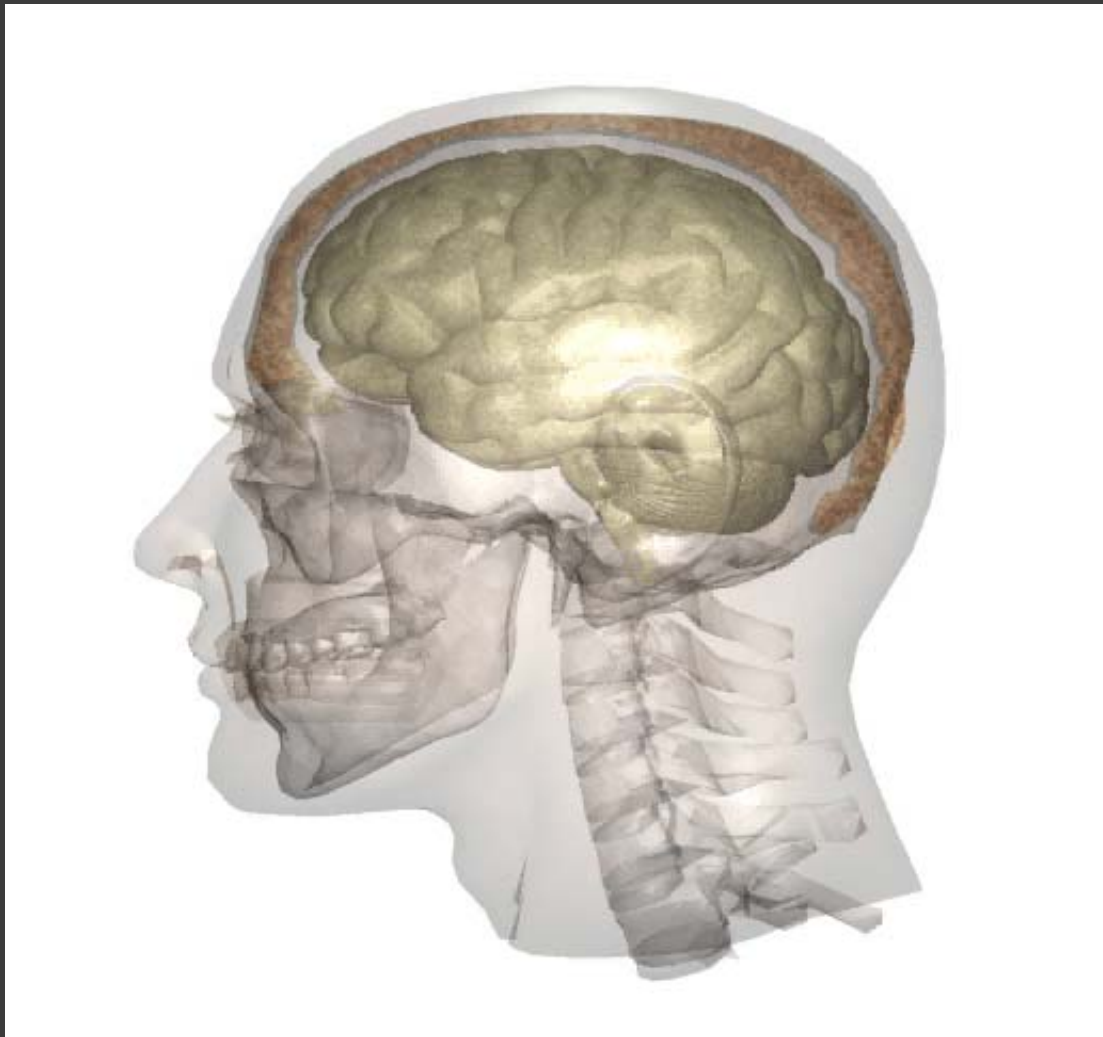




Rotational

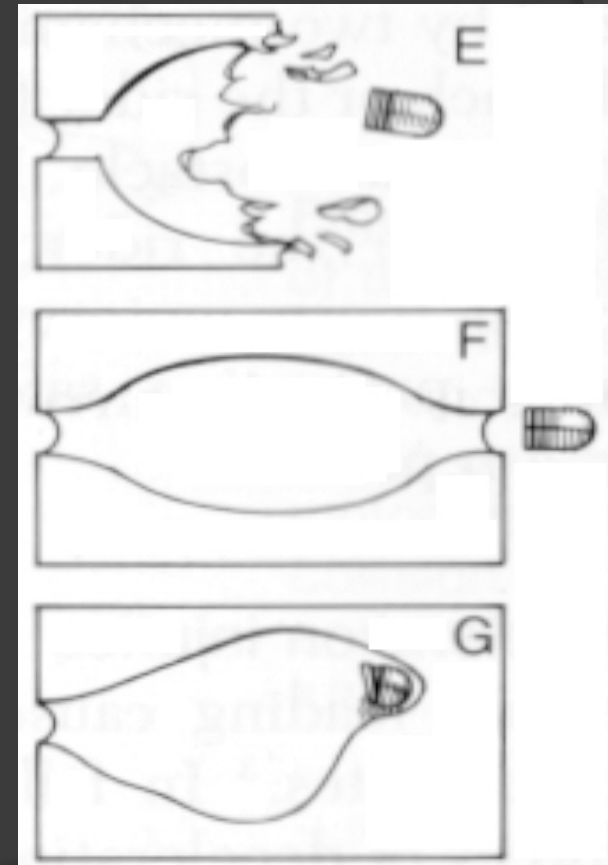
- Produces distortion of brain and tension
 - Stretching of tissue
 - Shearing of tissue
- Can cause damage to axons leading to poor outcomes without evidence of lesion on CT scan

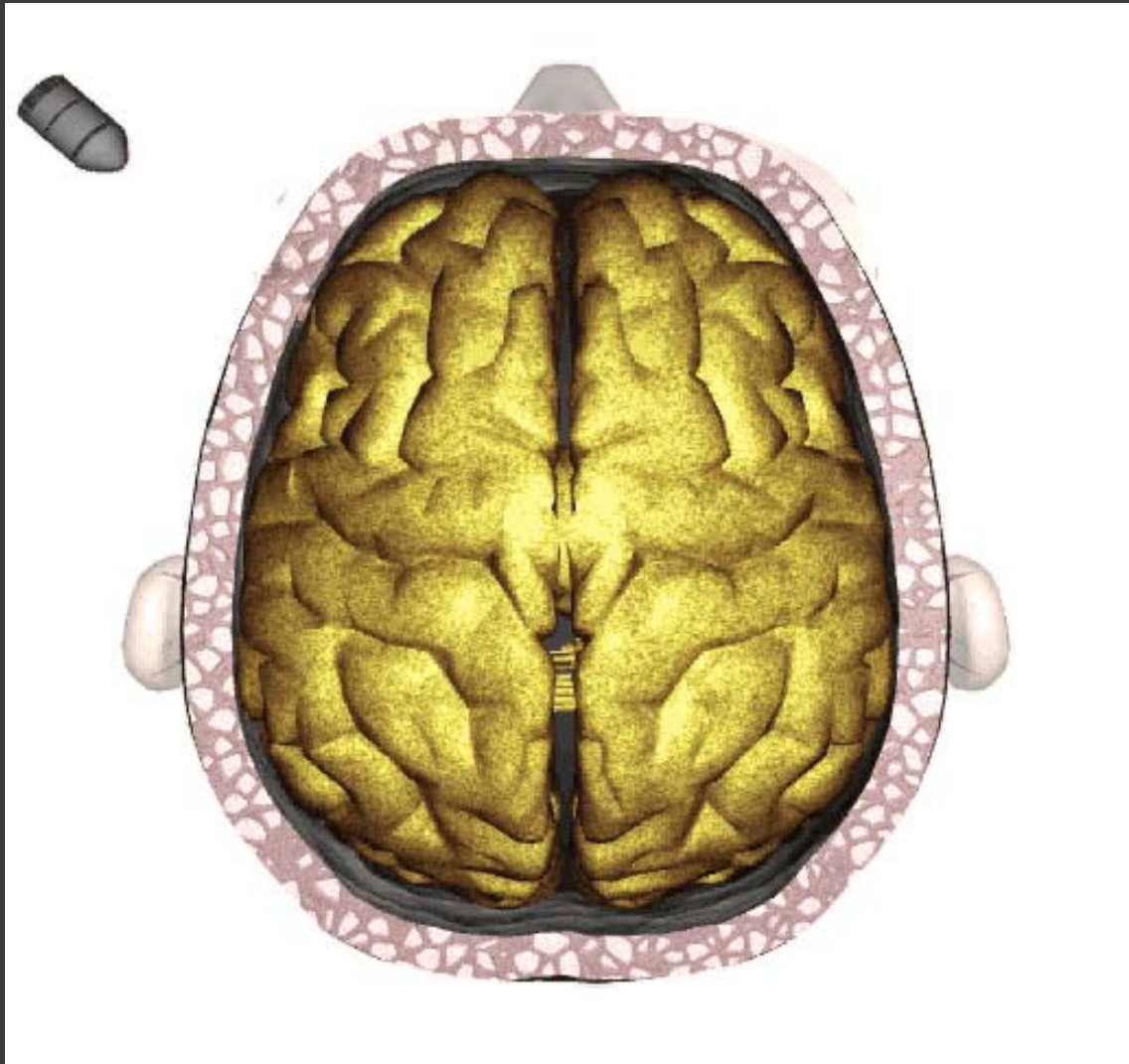




Penetrating

- Produced by foreign objects set in motion
- Energy is created and dissipated by the object into surrounding tissue





Classifications of TBI Severity

⦿ Assessed by:

- Loss of consciousness (LOC)
- Glasgow Coma Scale (GCS)
- Posttraumatic Amnesia (PTA)

Loss of Consciousness (LOC)

- < 30 minutes = mild TBI
- > 30 minutes-24 hours = moderate TBI
- >24 hours = severe TBI

*Not medically induced LOC

Glasgow Coma Scale (GCS)

- GCS assesses gross neurologic status across 3 core areas
 - Motor function
 - Verbal responding
 - Ability to open eyes voluntarily or in response to external commands

GCS was designed to assess level of consciousness in the field/critical care environment

Posttraumatic Amnesia (PTA)

⦿ Assessed by:

- Loss of memory surrounding the event
 - last memory before the event
 - first memory following the event
- Often confused with loss of consciousness

TBI Severity Scale

Severity	GCS	LOC	PTA
Mild*	13 – 15	< 30 mins	< 24 hrs
Moderate	9 – 12	>30 mins – 24 hrs	24 - < 7 days
Severe	3 – 8	> 24 hrs	7 days or more

* Includes those with no LOC and/or PTA, and/or those who were “dazed” briefly, or had their “bell rung”

Military: Severe TBI

- Neuroimaging is typically abnormal
- Medically evacuated out of theatre
- Require intensive rehabilitation
- Unlikely to return to full duty status
- Persistent impairments in functioning

Military: Moderate TBI

- Neuroimaging may be abnormal
- Typically evacuated out of theatre
- Less intensive rehabilitation services
- Return to duty rates are variable
- At risk for disciplinary issues, work performance problems, and family distress

Military: Mild TBI (mTBI)

- Frequently medically managed in theatre and returned to duty
- Typically do not require rehabilitation
- At risk for disciplinary issues , may have changes in work performance, and family discord
 - Changes may not be evident in theatre
 - Changes may be due to other factors (e.g. PTSD, depression)

Pathophysiology of mTBI

- A “neurometabolic cascade” leaves the brain in a state of neurophysiologic disarray during the acute phase after injury
- Functional neuroimaging studies in animals and humans have demonstrated the brain’s return to normal neurophysiologic functioning within days to weeks
- mTBI is a transient process followed by spontaneous recovery



Concussion and mTBI

- The terms *concussion* and *mTBI* can be used interchangeably
- The term *mild TBI* refers only to the initial injury severity and should not be interpreted referring to the level of severity of the symptoms
- Symptoms associated with mTBI are not unique

Grades of Concussion

- Grade 1: a brief period of confusion lasting < 15minutes; w/o LOC
- Grade 2: Confusion lasting longer than 15 minutes; w/o LOC
- Grade 3: with LOC

Blast-Induced Traumatic Brain Injury (bTBI)

Blast-Induced Traumatic Brain Injury

- Throughout OIF and OEF, explosive devices have become more powerful, their detonation systems more creative, and their additives more devastating.
- According to the DoD, over 73% of all US military casualties are caused by explosive weaponry



Blast-Induced Traumatic Brain Injury (bTBI)

- Pathophysiology of blast-related TBI is complex and not fully understood
- Rapid pressure changes create shear or edema of neurons



Primary: Direct exposure to over pressurization wave

Kevlar Body Armor

- ⦿ Protects the torso and head from penetrating wounds
- ⦿ May intensify the blast wave
 - Body armor constitutes improved contact surface for shock-front-body interaction and energy transfer
 - May serve as a reflecting surface that concentrates the power of the explosion as the blast wave resonates internally

(Cernak, et al. 2009)

Blast Wave

- Is the main determinant of the primary blast injury
 - Consists of the front of high pressure that compresses the surrounding air and falls rapidly to negative pressure
 - Travels faster than sound and in a few milliseconds damages the surrounding structures

Magnitude of Damage from the Blast Wave

◎ Dependent on five factors

- The peak of the initial positive-pressure wave
- The duration of overpressure
- The medium of explosion
- The distance from the incident blast wave
- The degree of focusing because of confined area*

*explosions near or within hard solid surfaces become amplified 2-9x due to shockwave reflection

Blast Wind

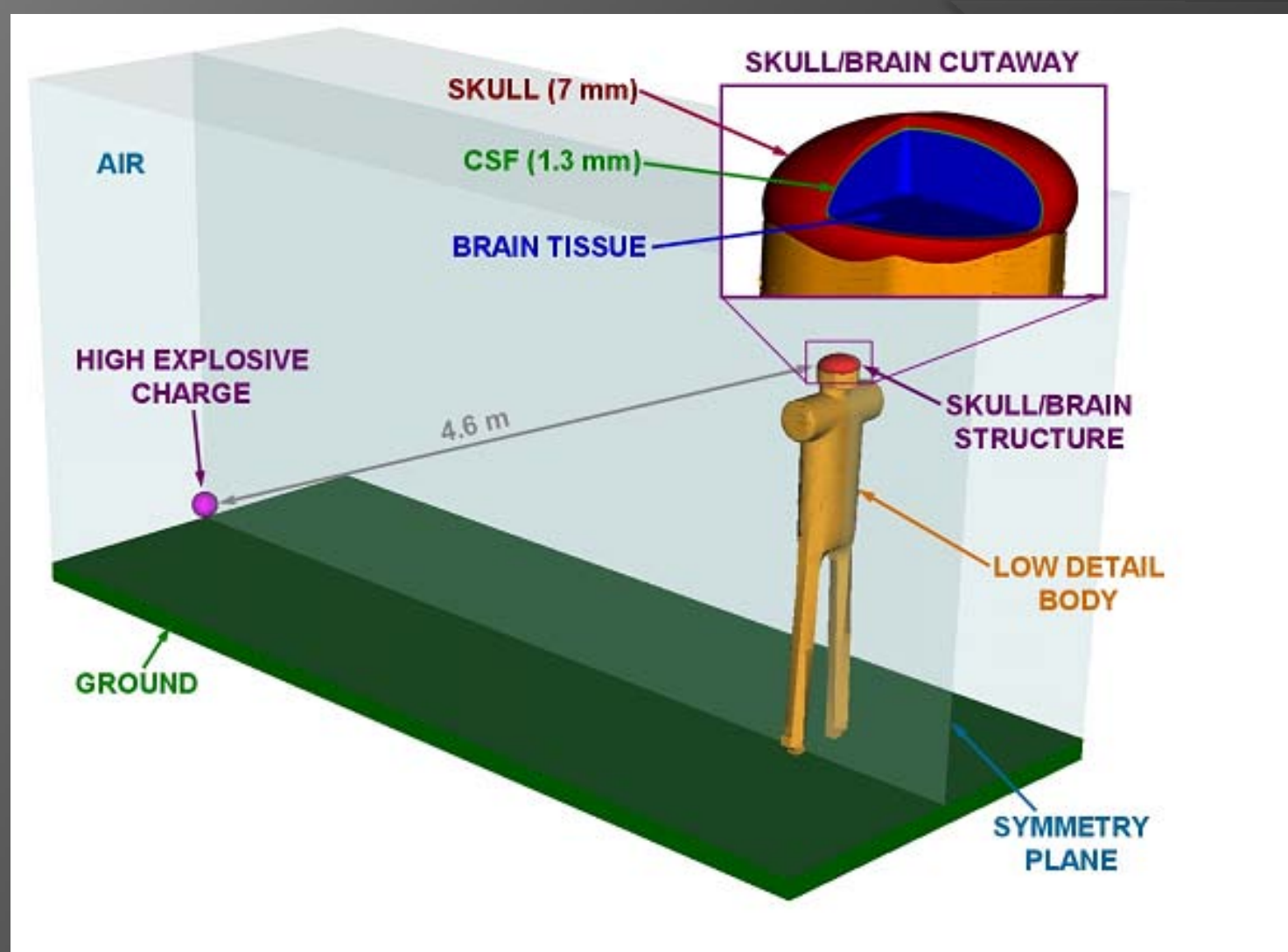
- Following the blast wave, the wind is generated by mass displacement of air by expanding gases
- It may accelerate to hurricane proportions and is responsible for disintegration, evisceration, and traumatic amputation of body parts
- There is typically exposure to the blast wave and the high-velocity blast wind

Blast-Induced Injuries

- Primary (nonpenetrating): blast wave travels through the air or water, impacting the body and causing internal damage, with no visible external signs of injury
- Secondary: the blast wave propels objects, or fragments, that impact the body and cause injury

Blast-Induced Injuries

- ④ Tertiary: the incoming blast wave displaces the body and imparts injury upon its impact with solid objects
- ④ Quaternary: other conditions that develop from exposure to blast
 - Flash burns
 - Crush injuries
 - Toxic by-products

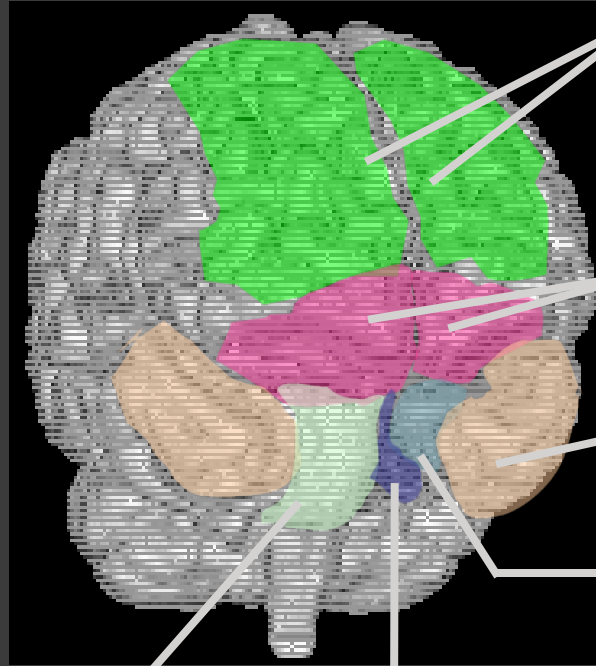


Simulation Geometry: A 2.3 kilogram spherical charge of C4 high explosive is located 4.6 meters from a head consisting of three components—the skull, CSF layer, and brain tissue—that are supported by a low detail body structure.

Source: Moss, W., King, M., & Blackman, E. (2009). Skull flexure from blast waves: A mechanism for brain injury with implications for helmet design. *Physical Review Letters*, 103(10), 108702.



Regional Cortical Vulnerability to TBI



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

Orbitofrontal cortex
(emotional and social responding)

Anterior temporal cortex
(memory retrieval, sensory-limbic integration)

Amygdala (emotional learning and conditioning, including fear/anxiety)

Ventral brainstem
(arousal, ascending activation of diencephalic, subcortical, and cortical structures)

Hippocampal-Entorhinal Complex (declarative memory)



Cumulative Brain Injury

- ⦿ Single concussion increases the risk of additional concussions
- ⦿ Slower and more difficult recovery times reported with subsequent concussion(s)
- ⦿ More severe symptoms

Second-Impact Syndrome (SIS)

- SIS is a condition that can develop if a subsequent head injury occurs before full recovery
- Can lead to a worse clinical outcome
- Can lead to death

**80% OF ALL TBI'S
ARE MILD!**



Blast Injuries
account for more
than 50%
of mild TBI seen by
DVBIC



Symptoms Reported Following Concussion/mTBI

⦿ Physical

- headaches
- dizziness
- sensitivity to light or noise
- impairments in vision and hearing
- problems with balance
- fatigue

Symptoms Reported Following Concussion/mTBI

⦿ Cognitive

- impaired memory
- concentration
- word finding difficulty
- slowed overall processing
- impaired organizational and problem solving skills

Symptoms Reported Following Concussion/mTBI

⦿ Behavioral

- difficulty being around people
- personality changes
- irritability, frustration, “short-fuse”
 - may result in “acting out” behavior

mTBI Recovery Course

- ⦿ Sports-related single uncomplicated mTBI: recovery within 1 week
- ⦿ Non-sports-related concussion: recovery is generally within 1 month
- ⦿ 10-20% continue to report post-concussion symptoms for months or years post injury

⦿ Vanderploeg, Belanger & Curtiss (2006)

mTBI Recovery Course

- Memory is the most susceptible to change after MTBI, but shows recovery within days
- Headache is the symptom that tends to linger the longest and be most problematic in terms of clinical management
- Delayed sx onset is rare
- Sxs persisting beyond the expected recovery are often attributable to non-injury related factors



Postconcussion Syndrome

DSM-IV Research Criteria

- ⦿ 3 or more sx's occur shortly after the trauma and persist for at least 3 months
 - Becoming easily fatigued
 - Disordered sleep
 - Headache
 - Vertigo or dizziness
 - Irritability or aggression on little or no provocation
 - Anxiety, depression, or affective instability
 - Changes in personality (e.g. social or sexual inappropriateness)
 - Apathy or lack of spontaneity

Postconcussion Syndrome

- It is well documented that PCS sx's are not specific to mild TBI and occur at a similar frequency in the general population
- All sx's can be amplified by sx exaggeration if compensation and pension play a role in the clinical picture
 - VA ratings
 - AD may have incentive to avoid redeployment

Belanger, et al (2009)

Possible explanations for Persistent Postconcussive Syndrome

- ⦿ PTSD overlay
- ⦿ “Motivation Disorder”
 - Conscious or unconscious desire to assume the “patient role”
- ⦿ Malingering
- ⦿ Pre-morbid characteristics

Mood Disorders Associated with TBI

- Adolf Meyer (1904) referred to these symptoms as “traumatic insanities.”
- Major depression occurs in 25% of TBI patients
- Mania is less common after TBI, but much more common than in the general population (9% of TBI patients)
- Anxiety disorders occurs in 11%-70% in TBI patients



Management of Concussion/mTBI

- ◎ A recent systematic review of treatments for mild TBI (Cooper, 2005, Brain Injury)
 - Medication
 - Cognitive rehabilitation
 - Educational intervention
- ◎ Strongest evidence is in support of the effectiveness of early patient education.
- ◎ Provide expectation for recovery.
 - DVBIC: focus on education & expectation for recovery.

Management Concussion/mTBI

Treatment:

- Most symptoms following a single mTBI can be managed w/o specialty intervention
- Provide education that normalizes symptoms and emphasizes recovery
- Discuss compensatory strategies and environmental modifications
- Protect the patient from further injury

Management Concussion/mTBI

- ⦿ Early educational intervention
- ⦿ Encourage good health habits:
 - No alcohol
 - Improved sleep habits
 - Stress reduction
 - Graduated exercise regimen (monitored)
 - pacing activities
 - Medication (monitored)
 - Discourage excess use of caffeine and other stimulants

Management of Concussion/mTBI

- ⦿ Treatment of concussion/mTBI should be symptom –specific
- ⦿ Medications may be considered for headaches, pain, depression/anxiety, sleep, & poor emotional control
 - If possible, avoid medications that lower the seizure threshold, can cause confusion, dizziness, or have sedating properties

Posttraumatic Stress Disorder

Posttraumatic Stress Disorder (PTSD)

Invisible Injury

- An Anxiety Disorder
- PTSD is unique among psychiatric disorders in that the symptoms are directly linked to a traumatic event
- 5th most common psychiatric disorder (5% of Americans)
- 20 years after Vietnam, 15% of combat veterans still have PTSD (National Vietnam Veteran Readjustment Study, 1990)

Definition and History

- ⦿ Characterized by reexperiencing symptoms, avoidance behaviors, and elevated arousal
- ⦿ To meet diagnostic criteria:
 - The symptoms must cause marked impairment in functioning
 - Symptoms persist for at least one month following the trauma



RAND Study (2008)

Posttraumatic Stress Disorder

- Survey of 1,965 members from 24 U.S. communities
 - 50% witnessed a friend seriously injured or killed
 - 45% saw dead or seriously injured noncombatants
 - 10% reported they were injured and required hospitalization
- Tanielian & Jaycox. RAND Corp 2008

New England Journal of Medicine (2004)

Posttraumatic Stress Disorder

- 90% of returning service members reported seeing dead bodies or human remains
- 50% reported being responsible for the death of an enemy combatant

- Hoge, Castro, Messer, McGurk, Cotting, & Koffman. N Engl J Med. 2004

Symptoms of PTSD

⦿ Emotional

- Irritability
- Mood swings
- Increased Aggression
- Withdrawal/Avoidance

Cognitive

- Forgetfulness
- Attentional Problems
- Concentration

⦿ Physical

- Difficulty sleeping
- Over arousal

Epidemiology of Trauma Exposure and PTSD

- ◎ 25% of those experiencing one or more traumatic events will develop PTSD
- ◎ Risk factors:
 - Type/severity of trauma
 - Pretrauma individual characteristics
 - Peri- and post-trauma variables

Peri-trauma and Post-trauma Risk Factors

Results of a 2003 study indicated that peri-trauma and post-trauma factors such as:

- trauma severity (peri-trauma)
- low levels of social support (post-trauma)
- subsequent life stresses (post-trauma)

Are stronger predictors of developing PTSD than pretrauma factors

Management of PTSD

- ⦿ VA treatment designed after Vietnam
- ⦿ Mixing cohorts from different military eras may be problematic:
 - Draft vs. enlisted personnel
 - Effects of multiple deployment
 - Difference in stages of symptoms
 - Acute vs. chronic
 - Difference in life stages and interests

Management of PTSD

⦿ Individual Therapy

- In addition to PTSD symptoms, address service member's "identity"
 - Support a soldier role vs. a patient role

⦿ Group Therapy

- Matched peers

⦿ Medication

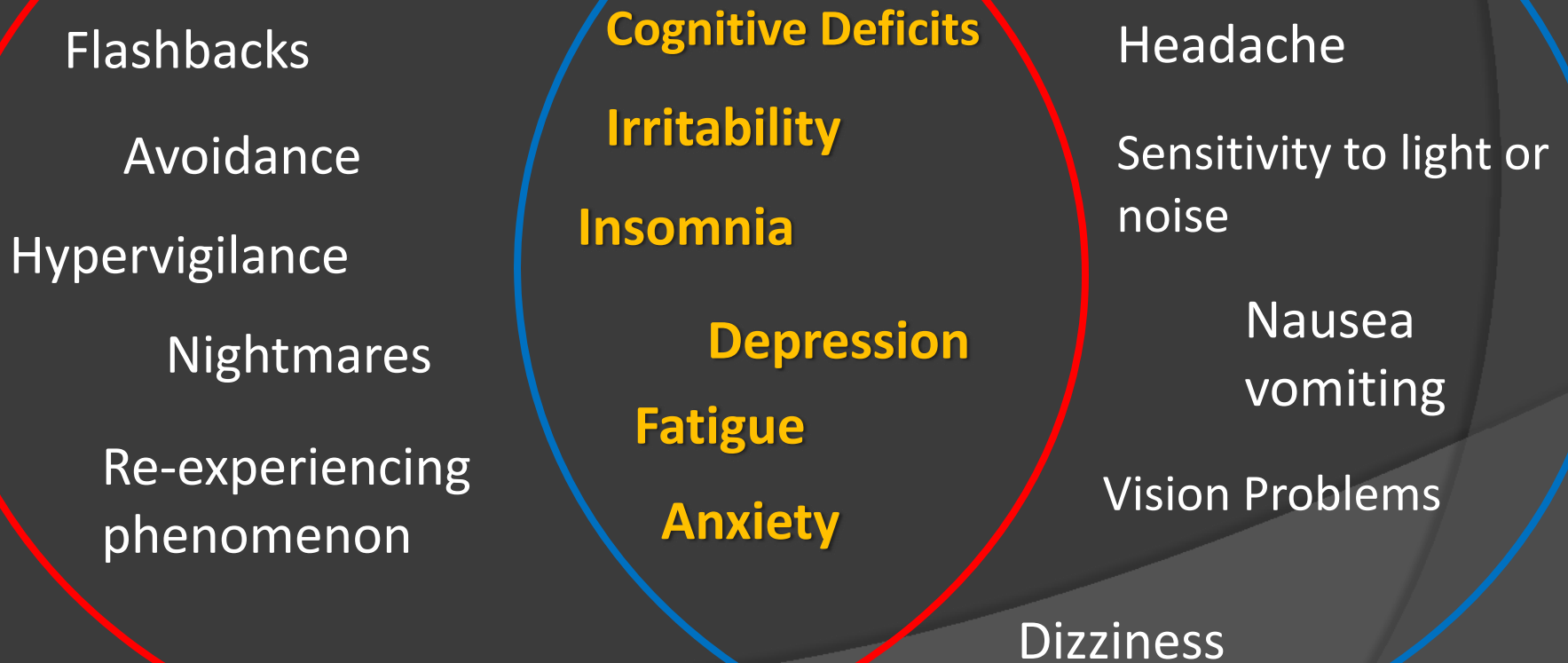
- To decrease hyperarousal

⦿ Studies have indicated that the presence of PTSD can worsen the cognitive symptoms of brain injury

Functional Outcome after PTSD

- ⦿ Often a chronic disorder with a fluctuating course in which symptoms can wax and wane over a lifespan
- ⦿ The pattern of symptom expression varies over time
 - May fluctuate in relation to ongoing life stressors
 - Exposure to reminders of the traumatic event may trigger symptoms

Symptoms of PTSD & TBI



Violence Potential associated with Traumatic Brain Injury



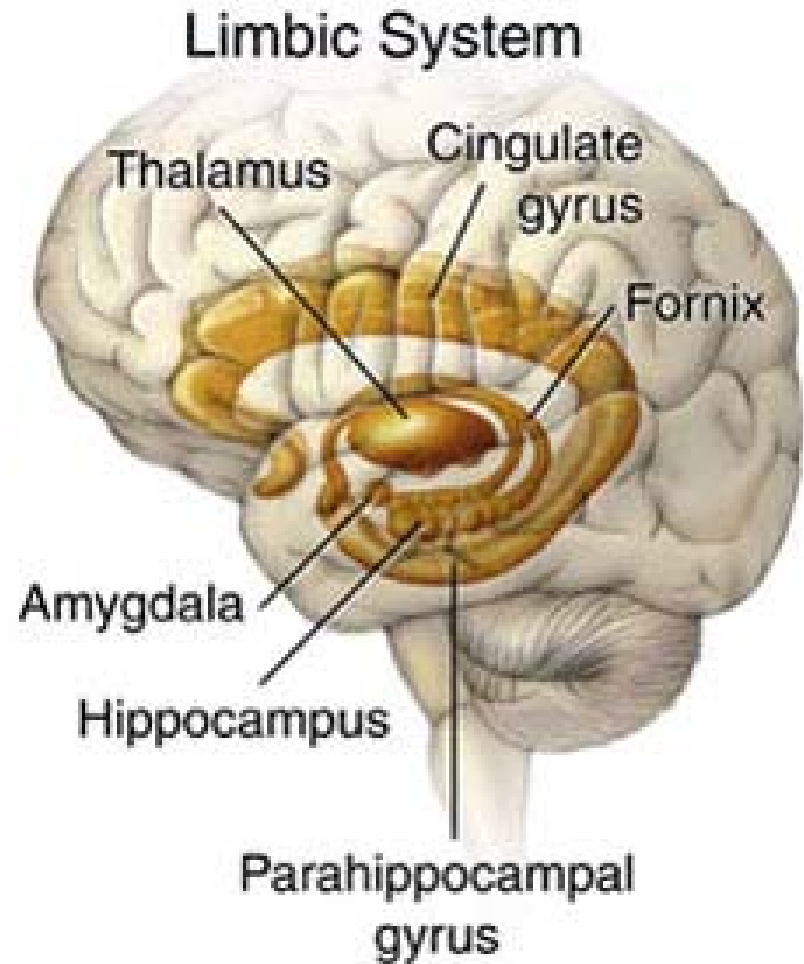
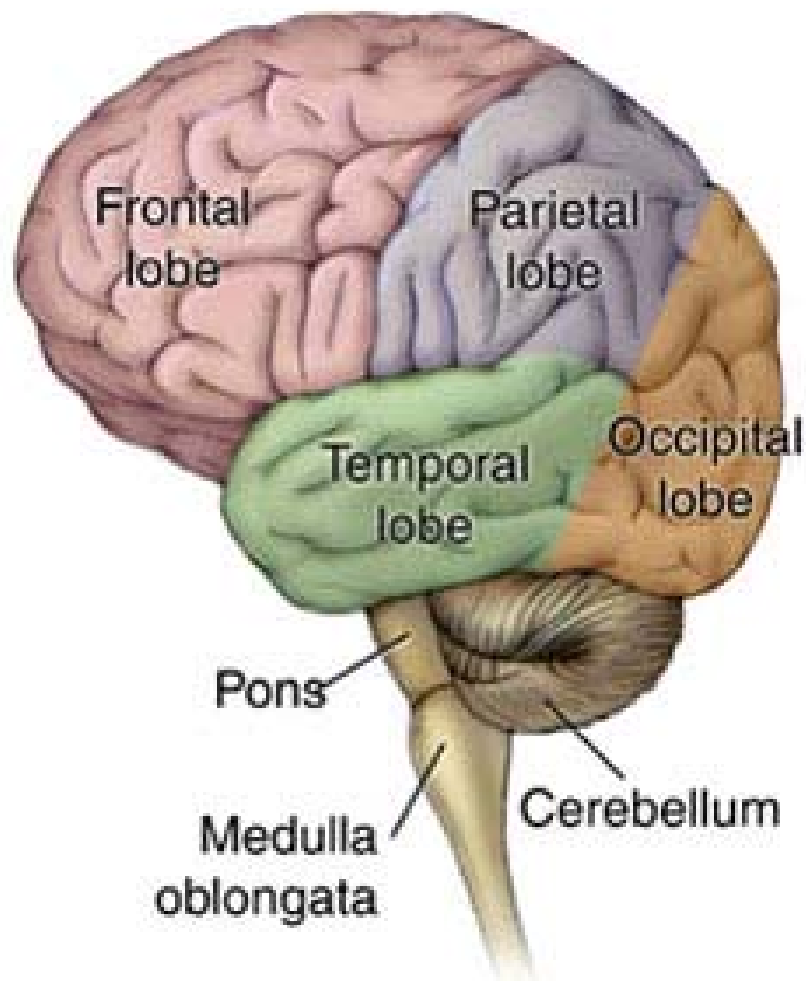
Veterans in State & Federal Prison 2004

U.S. Department of Justice (May 2007)

- In 2004: male veterans had lower incarceration rates than nonveterans; due in part to age differences
- 65% of male veterans in 2004 were at least 55 years old
- More than half of veterans in state prisons were serving for a violent offense
- More likely to have recent mental health problems

Frontal Lobe Functions

- ◎ Abstraction, judgment, planning, sustained motivation, & self-regulation
- ◎ Prefrontal development is not solely dependant on neurological development:
 - Learning, experience, and psychological factors are important
 - Last area of the brain to fully develop



Source: American Health Assistance Foundation. Anatomy of the Brain Webpage.
<http://www.ahaf.org/alzheimers/about/understanding/anatomy-of-the-brain.html>



Frontal Lobe Functions

- Have an inhibitory effect on other areas of the brain
- Serves to “filter out” non-relevant information; allowing one to be independent from environmental stimuli
- Frontal lobe lesions = “environmental dependency syndrome”
 - Can lead to an exaggerated response and action far exceeding the normal reaction
 - Peer influence



Frontal Lobe Impairment

⦿ Aggression

- Brain's loss of ability to maintain emotional control (loss of the “filter”)
- Because of lack of planning ability, unable to anticipate the impact of their behavior and consequences
- Can lead to an exaggerated response and action far exceeding the normal reaction



Frontal Lobe Impairment

- ⦿ Does not always lead to violence or aggression
- ⦿ Substantially affected by
 - Timing of the injury
 - Severity of the injury
 - Cause of the injury
 - Nature of the premorbid personality of the individual

Golden, et al., 1996

Temporal Lobe Functions

- ⦿ Interpreting & processing auditory information
- ⦿ Memory
- ⦿ Language comprehension
- ⦿ Limbic System (“emotional brain”)
- ⦿ Plays a role in emotion and learning

Temporal Lobe Impairment

- ⦿ Makes its appearance as a true learning disorder
 - Problems learning and memory
 - Problems with expressive and receptive speech



Temporal Lobe Impairment

- ⦿ Limbic System (“emotional brain”)
 - Hippocampus
 - Amygdala
- ⦿ May have episodes of unprovoked or exaggerated anger
- ⦿ Auditory or visual hallucinations
- ⦿ Delusions

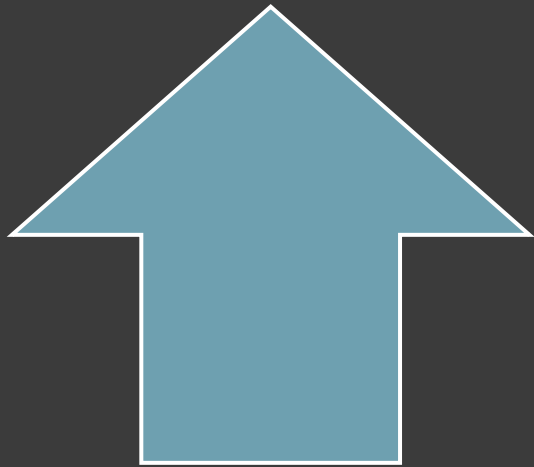


Temporal Lobe Impairment

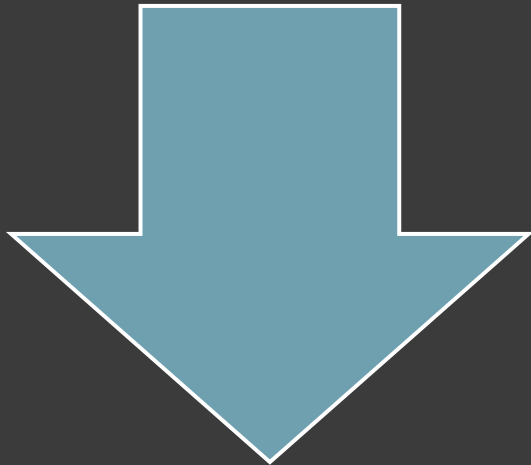
- ⦿ Aggression following temporal lobe damage involves a loss of behavioral control
 - Does not have the clear goals that frontal lobe aggression appears to demonstrate
 - Unpatterned
 - Not confined to particular situations, times or individuals
 - Occurs with minimal provocation
 - Without premeditation



Aggression and Violence



Increased
activation
(limbic system)



Decreased
Inhibition
(frontal lobes)

Violence as a Cause of TBI

- The exact number of violence-related TBIs each year is unknown
- CDC estimated 11% of TBI deaths, hospitalizations, & ED visits are related to assaults
- Underestimation: excludes concussions caused by violence that may go unreported

Langlois et al., 2004

Violence as a Cause of TBI

- *Intimate Partner Violence (DV)*
- Strangulation or blows to the head may occur in 50-90% of IPV assaults against women (Wolf et al., 1997; Greenfield et al., 1998)
- Multiple TBIs, including concussions are frequently reported by incarcerated women with IPV histories

Violence as a Consequence of TBI

- Violence is not only a cause, but also a consequence of TBI
- TBI related cognitive & behavioral problems can result in aggressive behavior
- Lack of insight and judgment can lead to victimization

Violence as a Consequence of TBI

⦿ *Aggressive Behavior*

- Diminished coping abilities
- Impulse control problems
- Increased irritability, even with concussion
- TBI has been seen as a “significant predictor” of domestic violence
 - 50% of batterers had suffered significant head injury (Rosenbaum et al., 1998)

⦿ *Associated with recidivism*



Violence as a Consequence of TBI

- ⦿ Not all brain-injured individuals are violent or aggressive
- ⦿ Age of injury plays a role
- ⦿ History of aggression
- ⦿ Use of alcohol or drugs increases likelihood of aggressive acts



TBI in the Prison Population

- ◎ TBIs in the jail & prison population has been estimated between 25-87%
 - Compared to estimated 8.5% in the general population (Silver et al., 2001)
- ◎ Survey of male state prisoners in MN: 82% reported at least one head injury in their lifetime
- ◎ Majority of TBI's were caused by assaults

TBI in the Prison Population

- Inmates with head injuries may have seizures or mental health problems
- Female prisoners likely to have a pre-crime TBI history (Brewer-Smyth, 2004)
- Children & teen-agers convicted of a crime are more likely to have sustained a TBI pre-crime (Leon-Carrion, Ramos & Blows, 2003)

TBI in the Prison Population

- Significantly more likely to have problems with ETOH or drugs
- Cognitive problems associated with TBI may affect successful rehabilitation
(Valliant, et al., 2003; Corrigan, 1995)
- Strongly associated with perpetration of IPV and other violence in male prisoners (Cohen et al., 1999)

TBI-Related Problems and Incarceration

- Irritability and anger can lead to an incident
- Attention deficits may interfere with job duties or response to directions, and may be misinterpreted as deliberate defiance
- Memory deficits can make it difficult to understand and remember rules
- Slowed verbal & physical responses may be interpreted as uncooperative behavior

Risk Assessment

- ⦿ Mood swings
 - Irritability, short-fuse
 - Chronic pain
- ⦿ Changes in behavior
 - Isolating behavior (possible SI)
 - Marital problems (possible DV)
- ⦿ Substance abuse
 - Can lead to violence and/or self-harm
- ⦿ Unresolved rage
 - Adrenaline let down
 - Hyperarousal associated with PTSD

Assessment of Combat Related Injuries

Clinical Interview

- ◎ Obtain combat history
 - Job duties, length & number of deployments
- ◎ Obtain documented medical history
 - Consider what is not documented
 - TBI and/or PTSD: when did the symptoms begin?

Clinical Interview

⦿ Description of event

- Distance from blast
 - How many could you feel (vibration or pressure) but did not physically move you
 - How many were close enough or strong enough to move you
 - How many were close enough or strong enough that they not only moved you, but caused you physical injury
- Vehicle damage
- Other casualties

Clinical Interview

- ⦿ Disciplinary actions
 - During deployment? Legal issues?
- ⦿ Adjustment to civilian life
 - Employment: Problems?
 - Relationships: DV?
 - Alcohol use: provide education

Clinical Interview

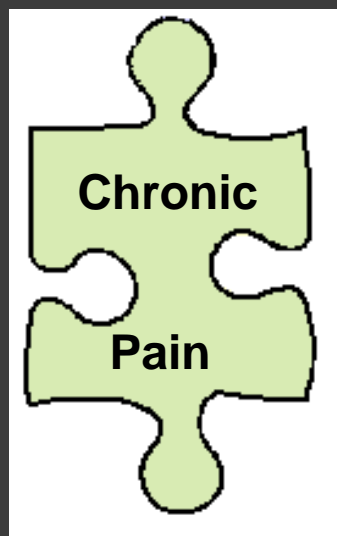
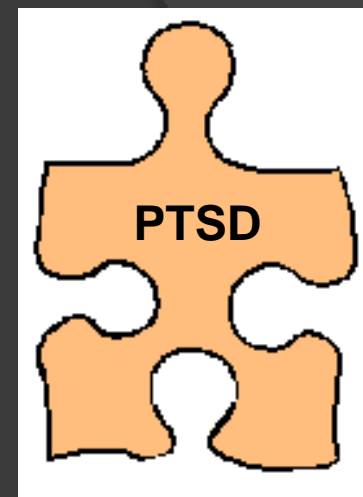
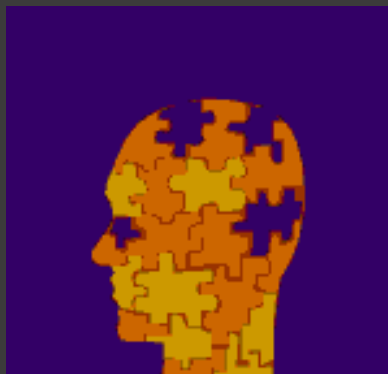
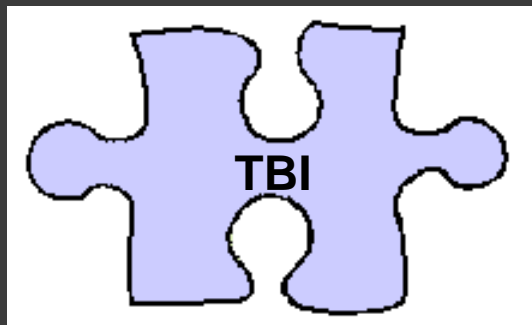
- ④ Identify and discuss factors that are possibly impacting functioning and treat the symptoms
 - Chronic pain (migraines)
 - Substance abuse
 - Medication on cognitive functioning
 - Sleep deprivation

Therapeutic Emphasis

- Focus on education of disorders
- Provide an expectation for recovery
- Provide compensatory strategies for cognitive deficits
- Address service member's identity
- Support a service member or veteran's role vs. a patient role

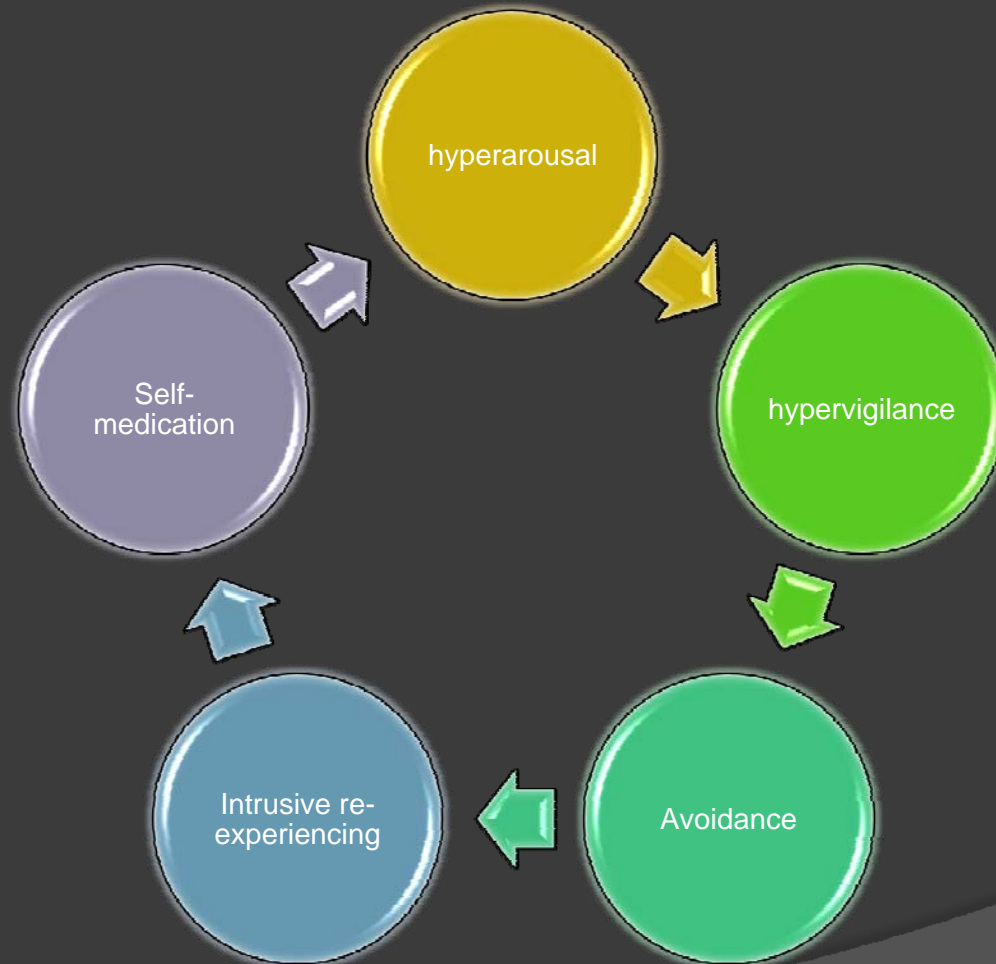
Consultation and Referral

- Refer to specialists for persistent or chronic symptoms when:
 - An atypical pattern or course (worsening or variable symptom presentation) is demonstrated
 - Difficulties in return to pre-injury activity
 - A referral to mental health should be considered for patients with persistent behavioral problems





PTSD & Substance Use Cycle



Management of Persistent Symptoms

- ⦿ Our goal is to encourage appropriate interventions to break the cycle
 - Discuss referrals to psychiatry in the context of “mind-body” connections
 - When asked: “Doctor, do you think it is all in my head?” answer yes! Because the brain interprets symptoms

Management of Persistent Symptoms

⦿ Treatment interventions

- Cognitive behavioral therapy (CBT) to reframe faulty beliefs
- Treatment should focus on determining the meaning of the symptoms to the patient
- Education is important in the acute and chronic phases of symptom presentation

Future Concerns:

Adjustment to civilian life

- ⦿ Physical Limitations
- ⦿ Cognitive impairment
- ⦿ Occupational concerns
- ⦿ Emotional effects of combat
- ⦿ Self-medication
- ⦿ Availability of Social Support
- ⦿ Irritability associated with both brain injury & PTSD can lead to aggression
 - Increases the probability of violent behavior

Important Facts

- Concussion/mTBI is a common injury, with a time-limited and predictable course
- The majority of patients do not require any specific medical treatment
- The vast majority improve w/o lasting clinical sequelae
- Patients should be reassured that the condition is transient and full recovery is expected



Important Facts

- ⦿ Blast exposure does not = TBI
- ⦿ Exposure to trauma does not = PTSD
- ⦿ Multiple deployment increase vulnerability for blast and trauma exposure
- ⦿ Multiple concussions increase vulnerability to persistent impairment and longer recovery
- ⦿ TBI and co-existing psychiatric disorders interact to result in worse outcome

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