Traumatic Brain Injury in the Veteran Population

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Disclaimer

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The presenter has no conflict of interest to disclose
Objectives

1. Define brain injury including mechanisms of injury and severity levels.
3. Explore behavioral correlates of acquired brain injury
Brain Injury
Acquired Brain Injury

Non Traumatic Brain Injury
  1. Anoxia
  2. Infections
  3. Strokes
  4. Tumors
  5. Metabolic Disorders

Traumatic Brain Injury
  Open Brain Injury:
    Penetrating Injuries:
      1. Assaults
      2. Falls
      3. Accidents
      4. Abuse
      5. Surgery
  Closed Brain Injury
    Internal Pressure & Shearing:
      1. Assaults
      2. Falls
      3. Accidents
      4. Abuse
Acquired Brain Injury: Non Traumatic

- **Anoxia/hypoxia** - Complete or partial lack of oxygen to the brain. Drowning, cardiac arrest, suffocation, etc.
- **Stroke** - Decrease or stop in blood flow to a part of the brain.
- **Infections** - Bacterial meningitis, syphilis, west nile virus, herpes.
- **Tumors** - Abnormal growth of tissue in the brain (benign vs. cancerous).
- **Metabolic** - Problems with the brain’s cells getting the right kind of energy (i.e., chemistry is off). High blood sugar, excess body fat around the waist, abnormal cholesterol or triglyceride levels.
Traumatic Brain Injury (TBI)

- An alteration in brain function or other evidence of brain pathology caused by an external force and characterized by the following:
  a. Any period of loss or decreased consciousness
  b. Any loss of memory for events immediately before (retrograde) or after (posttraumatic) the injury
  c. Any neurological deficits and/or
  d. Any alteration in mental state at the time of injury

(National Institute for Neurologic Disorders and Stroke [NINDS] Common Data Elements [CDE] for TBI)
Types of TBI

Open

Penetration to the brain
-Causes localized brain damage
-Result in discrete and relatively predictable disabilities

Common Causes
-Assaults
-Severe falls
-Accidents
-Abuse
-Surgery

Easier to detect using imaging
Types of TBI - Closed

Internal damage to the brain; no open head wound

- Causes diffuse tissue damage
- Result in generalized and highly variable disabilities

Common causes:
- Falls
- Vehicle accidents
- Sports accidents
Classification of TBI severity: Glasgow Coma Scale

- The most recognized and widely used method for grading TBI severity
- Provides an indicator of gross neurologic status by assessing:
  - Motor functioning (6 = obeys commands fully...1- no response)
  - Verbal responding (5 = alert and oriented...0= no sounds)
  - Patient’s ability to open her or his eyes voluntarily or in response to external commands and stimuli (4=spontaneous eye opening...1= no eye opening)
Classification of TBI severity: Post Traumatic Amnesia

- Period of time after an injury when the brain is unable to form continuous day-to-day memories
- Includes a state of disorientation to time, place, and person

- Can exhibit:
  - Agitation
  - Short attention span
  - Mood swings
  - Perseverate on words, ideas, activities
  - Difficulty processing complex information
TBI - Mild (Concussion)

CONCUSSION

- Loss of consciousness or alteration of consciousness for up to 30 minutes
- OR
- PTA lasting less than 24 hours
- A CT SCAN is not indicated for most patients with a Mild TBI. If obtained, it is normal.
- GCS 13-15
Moderate TBI

- Confused or disoriented state which lasts more than 24 hours

OR

- Loss of consciousness for more than 30 minutes, but less than 24 hours

OR

- PTA lasting greater than 24 hours but less than seven days

OR

- Meets criteria for Mild TBI except an abnormal CT scan is present

A structural brain imaging study may be normal or abnormal.

GCS 9-12
Severe TBI

- Confused or disoriented state which lasts more than 24 hours
- OR
- Loss of consciousness for more than 24 hours
- OR
- PTA for more than seven days

A structural brain imaging study may be normal but is usually abnormal
- GCS 8 or less
Penetrating TBI/Open Head Injury

- A head injury in which the scalp skull and dura mater (the outer layer of the meninges) are penetrated.
- Penetrating injuries can be caused by high-velocity projectiles or objects of lower velocity such as knives, or bone fragments from a skull fracture that are driven into the brain.
TBI Prevalence

- An estimated 2.5 million TBIs occur in the United States annually
- Of the 2.5 million TBIs occurring, 2.2 (88%) were emergency department visits, 280,000 (11%) were hospitalizations, and 50,000 (2%) were deaths (CDC, 2011).
TBI Prevalence

Of hospitalized cases

- 19% are classified as severe (GCS 8 or below)
- 21% as moderate (GCS 9-12)
- 52% as mild (GCS 13-15)

(CDC, 2011)
Causes of TBI

- Motor vehicle accidents (40%-60%) (Kraus & Chu, 2005)
- Other forms of transportation (e.g., motorcycle crashes, bicycle accidents, etc).
- Falls
- Sports
- Assaults/violence
Who is at highest risk for TBI

- Males are about 1.5 times as likely as females to sustain a TBI
- Some studies have reported significantly greater incidence of TBI in ethnic minority populations, particularly within lower socioeconomic strata
- The three age groups at highest risk for TBI are
  - 0 to 4
  - 15 to 19
  - 75+
Who is at highest risk for TBI

- A high proportion of individual who sustain TBI have a criminal history
- One study found that 19.5% of 327 consecutive admissions for TBI had a preinjury criminal record (Kreutzer, Marwitz, and Witol, 1996).
- Also Learning disabilities, emotional problems, and attention deficits (Woodward et al., 1999).
TBI - Inmates

- Across various TBI studies examining offender populations, 25% to 87% of offenders reported having a TBI.

- These estimates suggest that TBI appears more frequent in offender populations (i.e., prisons) than in general population.
Problems associated with Brain Injury: ETOH/SA

- Incidence of positive blood alcohol findings (found to exceed 50% in most studies and often significantly beyond the legal intoxication limit) in motor vehicle crashes and violence-related TBI
  
  (Kraus & McArthur, 1998)

- Premorbid behavioral health problems including alcohol use can be a risk factor for TBI, particularly among older adults. (Dams-O’conner et al., 2016; Bombardier, Rimmlele, Rimmlele, and Zintel, 2002)
### DoD Numbers for Traumatic Brain Injury

#### Worldwide – Totals

<table>
<thead>
<tr>
<th>Severity</th>
<th>Count</th>
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<tr>
<td>Penetrating</td>
<td>5,215</td>
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<tr>
<td>Severe</td>
<td>4,067</td>
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<tr>
<td>Moderate</td>
<td>37,424</td>
</tr>
<tr>
<td>Mild</td>
<td>315,897</td>
</tr>
<tr>
<td>Not Classifiable</td>
<td>21,344</td>
</tr>
<tr>
<td><strong>Total - All Severities</strong></td>
<td><strong>383,947</strong></td>
</tr>
</tbody>
</table>

- **Penetrating**: 5.6%
- **Severe**: 14%
- **Moderate**: 11%
- **Mild**: 82%
- **Not Classifiable**: 9.7%

*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 - 2018 Q1, as of June 21, 2018

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**Military TBI**
TBI and Veterans

- The relative incidence of penetrating head injuries is especially high compared with civilian population.
- The incidence of TBI among US military personnel deployed to Iraq and Afghanistan is reportedly the highest of any military conflict in US history (Okie, 2005; Warden, 2006).
- “Signature Wound”
TBI and Veterans

- Approximately one out of five OIF/OEF Veterans screen positive for TBI.
- Research based on VHA administrative data indicates that 9.8% Iraq and Afghanistan Veterans who used VHA services over the period of time spanning FY 2010 through FY 2012 received a TBI diagnosis.
- Most VA patients with a TBI diagnosis also carried a mental health diagnosis, with PTSD being the most common.
An estimated 20% of Veterans who have served since 2001 report experiencing a probable Traumatic Brain Injury (Mathias & Alvaro, 2012)
Combat Injuries

- Blast exposure
- The majority of OIF-OEF injuries during combat are caused by blasts, and most are mild in severity
- Motor vehicle accidents
- Falls
Blast Exposures - 4 types

- **Primary Blast Injuries**: Due solely to the blast wave

- **Secondary blast or explosive injuries**: Primarily ballistic trauma resulting from fragmentation wounds from the explosive devise or the environment

- **Tertiary blast or explosive injuries**: The result of the victim or environmental structures, largely blunt traumatic injuries. Injuries of displacement. Either the service member is displaced by the blast or an object being physically displaced as a result of the blast and hitting the service member.

- **Quaternary explosive injuries**: Burns, toxins, and radiologic contamination.
CONSEQUENCES OF BRAIN INJURY
Brain Basics
Layman’s view of how the brain works...
And how it might look after a TBI...
Frontal lobe

Executive Functioning

- Initiation
- Problem solving
- Judgement
- Inhibition of behavior
- Planning
- Self monitoring
- Motor planning
- Personality
- Awareness of abilities
- Organization
- Attention/concentration
- Mental flexibility
- Expressive language
Temporal lobe

Learning and Memory

- Left side - verbal, right side - nonverbal
- Understanding speech and language
- Hearing, organization, sequencing
Parietal Lobe

Sensory information and integration

- Sense of touch
- Differentiation of size, color, shape
- Spatial and visual perception
Occipital lobe

- Vision and visual integration
Cerebellum

- Balance
- Coordination
- Skilled motor activity
Most Common Areas affected?
Mechanism of Damage

- Bruising of brain due to forward/backward movement against skull
- Twisting of nerve fibers due to twisting of brain within skull
- Nerve fibers are broken or stretched = temporary or permanent brain damage
Changes After TBI

In a split second...

- Who we are
- The way we think
- The way we feel
Changes After TBI
What happens in a TBI

- Nerve fibers within specific areas of the brain are severed, never to be regained.
- Nerve fibers are stretched, resulting in inefficient and slowed functioning.
- Onset of physical, cognitive and behavioral changes after the TBI reflect impaired functioning due to these broken or stretched nerve fibers.
Physical Problems

- Overall slowing
- Clumsiness
- Decreased vision/hearing/smell
- Dizziness
- Headaches
- Fatigue
- Increased sensitivity to noise/bright lights
Sleep Problems following a TBI

- Sleep disorders are three times more common in TBI patients than in the general population.
- Nearly 60% of people with TBI experience long-term difficulties with sleep.
- Sleep problems are more likely to develop as the person ages.
Traumatic Brain Injury (TBI) and Sleep

- Traumatic Brain Injury has been associated with:
  - Alterations in Circadian Rhythms
  - Disrupted Sleep Patterns
  - Diminished Sleep Quality
- 20%-94% of Veterans with TBI experience insomnia
  (Tanielian & Javcox, 2008; Mahmood et al., 2004; Farrell-Carnahan et al., 2013)
Functional Impairment: Loss of independence

Driving
Money management
Medical decision making
Preparing meals
Grocery shopping
Laundry/household chores
Cognitive Changes

➢ Attention
  ➢ Reduced concentration
  ➢ Reduced visual attention
  ➢ Inability to divide attention between competing tasks

➢ Processing speed
  ➢ Slow thinking
  ➢ Slow reading
  ➢ Slow verbal and written responses
Cognitive Changes

- **Communication**
  - Difficulty finding the right words, naming objects
  - Disorganized in communication

- **Learning and Memory**
  - Information before TBI intact
  - Reduced ability to remember new information
  - Problems with learning new skills
Cognitive Changes - Executive Functioning

- Difficulty planning/setting goals
- Problems being organized
- Concrete thinking - difficulty remaining flexible
- Problem solving deficits
- Difficulty prioritizing
- Decreased awareness of cognitive deficits in self (anosognosia)
Combined, these issues result in presentation of...

- having difficulty remembering or learning new information
- being inconsistent in their performance
- having poor judgment and decision making abilities
- having difficulty generalizing to new situations
- lacking awareness of these difficulties
Emotional/Behavioral/Social Changes - frontal lobe

- Depression
- Anxiety
- Irritability/agitation
- Impatience
- Increased Impulsivity
- Difficulty with self-initiation
- Increased risk taking
- Rapid loss of emotional control (short fuse)/self monitoring
- Increased self focus
- Socially inappropriate
- Rebellious
- Inability to get along with others
- Intolerant
Pseudobulbar Affect (PBA)

- Emotional incontinence due to a “short circuiting” of brain rendering it difficulty to control emotional response.
- Neurological condition involving involuntary, sudden, and frequent episodes of laughing or crying. Mild-severe (seizure like presentation)
- Often confused with depression which is a psychological in nature and related to a person’s emotional or mental state.
- May feel frustrated, embarrassed, confused. If untreated may negatively impact relationships, social situations, work, and quality of life. Medication (Nudexta) can help
Important points to remember

- No two brain injuries are exactly the same
- The effects of brain injury depend on factors such as cause, location, and severity
- Adjustment dependent on “before-after” changes in the person - perception.
- Brain injury does not occur in a vacuum
Long Term Challenges Post TBI

- Vocational and/or school difficulties/failure
- Family life/social relationships collapse
- Increased financial burden on families and social service systems
- Alcohol and drug abuse
- Chronic depression/anxiety
Chronic Comorbidities Following TBI: Mod-Severe

Years after Injury...

- Depression
- Aggression
- Psychosis
- Endocrine dysfunction
- Alzheimer’s-type dementia
- Parkinsonism
- Premature death
  - Open or penetrating TBI contribute to unprovoked seizures
Health Comorbidities associated with TBI

- In comparison to uninjured control groups individuals with TBI have MORE THAN TWICE the rates of:
  - Pain (Ponsford et al., 2013)
  - Growth hormone deficiency (Tanriverdi et al., 2015)
  - Insomnia and fatigue (Beaulieu-Bonneau and Morin, 2012)
  - New onset stroke (Liao et al., 2014)
  - Urinary incontinence (Keller, Liu, & Lin, 2013)
  - Epilepsy (Yeh et al., 2013)
Rehospitalization

- Greater risk of rehospitalization, with greater risk increasing around 5 years postinjury (Marwitz, Cifu, Englander, and High, 2001).
  - Infections
  - Neurological events
  - Neurosurgical procedures
  - Psychiatric events
  - Orthopedic disorders
Health Comorbidities associated with TBI

THOSE WITH TBI HISTORY

- DM-II
- HTN
- MI
- Cerebrovascular disease
- Peripheral vascular disease
- Chronic pulmonary disease
- Renal disease
- Psychiatric diagnoses
- Substance abuse disorders
- Demonstrate slower recovery from TBI
Post-Injury Study (Hammond et al., 2019)

- Most Common Comorbidities at 10 years post injury for those who sustained TBI requiring acute rehabilitation.
  - Back pain (50+)
  - HTN (50+)
  - High blood cholesterol (50+)
  - Osteoarthritis (50+)
  - DM (50+)
  - Depression
  - Anxiety
  - Fractures
  - Sleep disorders
  - Panic attacks (younger adults)
Uniquely at risk for death caused by:

- Seizure
- Accidental poisoning
- Infection (i.e., aspiration pneumonia, pneumonia, septicemia)
- Respiratory disorder
- Suicide
- Homicide
- Falls
- Vehicular collisions

(Harrison-Felix, Pretz, and Hammond, 2015)
Chronic Effects of Brain Injury: Moderate to Severe

- Associated with progressive atrophy of gray and white matter structures that may persist for months to years post injury
- Greater risk for Alzheimer’s, Parkinson’s Disease, and ALS.
- Veterans with severe TBI were 4 times more likely to have AD, whereas veterans with moderate TBI were twice as likely to have AD in late life compared with controls
Chronic Effects of Brain Injury: repetitive concussions

- Chronic Traumatic Encephalopathy - clinically characterized by mood and behavioral disturbances, progressive decline of memory and executive functioning, and cognitive deficits that eventually progress to dementia over the course of decades.

- Mood and behavioral disturbances: depression, apathy, impulsivity, anger, aggression, irritability, and suicidal behavior

- CTE can only be diagnosed definitively at postmortem neuropathological examination

- Found primarily in athletes
Factors that Impact Outcomes of Brain Injury

Medical
- Severity of injury
- Duration of LOC
- Patterns of imaging abnormalities (focal vs. disseminated)
- Location of injury
- Host Factors

Psychosocial
- Social Support
- Level of education
- Employment prior to injury
- Substance abuse (before and after)
- Personality/coping
- Mental Health
- Secondary Gain
Natural Course of Recovery

Diagram showing the natural course of recovery post-injury, with stages including pre-injury functioning, injury, coma, PTA, retrograde amnesia, and ongoing cognitive problems for Mild TBI, Moderate TBI, and Severe TBI over different time periods (3 to 12 months).
Concussion - prognosis

- Chronic symptoms from concussion are RARE
- Most patients return to normal baseline in days to up to 3 months
- Ongoing symptoms after concussion are likely co-occurring conditions and not direct symptoms

- Symptoms are most severe in the hours to days following injury and gradually improve to the degree possible
- Progressive decline is not part of the natural history of TBI of any severity.
  - indicates another problem or delayed complication
Post Concussive Syndrome

- A complex disorder in which various symptoms (e.g., headaches, dizziness, fatigue, irritability, etc.) persist for weeks, months, or a year (although rare) following mTBI/concussion.

- Quite Controversial
  - Conflicting findings regarding symptom duration
  - Absence of objective neurologic findings
  - Inconsistencies in presentation
  - Poorly understood etiology
  - Methodologic problems in the literature
Post Concussion Syndrome

- Per ICD10
- History of TBI with loss of consciousness preceding symptom onset by a maximum of 4 weeks
- 3 or more of the following categories
  - Headache, dizziness, malaise, fatigue, noise intolerance
  - Irritability, depression, anxiety, emotional lability
  - Subjective concentration, memory or intellectual difficulties w/o neuropsychological evidence of marked impairment
  - Insomnia
  - Reduced alcohol tolerance
Symptom Overlap

PTSD
- Flashbacks
- Avoidance
- Hypervigilance
- Nightmares
- Re-Experiencing Phenomenon

TBI
- Irritability
- Cognitive Deficits
- Insomnia
- Depression
- Fatigue
- Anxiety
- Headache
- Sensitivity to Light or Noise
- Nausea
- Vomiting
- Vision Problems
- Dizziness
<table>
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<tr>
<th></th>
<th>mTBI</th>
<th>PTSD</th>
<th>Pain</th>
<th>Depression</th>
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<td>Attention/Concentration</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Memory</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Fatigue</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Lightheadedness</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Sensitivity to light/sound</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Slowed thinking</td>
<td>X</td>
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<td>Irritability</td>
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<td></td>
<td>Headache</td>
<td>Dizziness</td>
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<tr>
<td>College Students</td>
<td>36%</td>
<td>18%</td>
<td>36%</td>
<td>17%</td>
</tr>
<tr>
<td>Chronic Pain Patients</td>
<td>80%</td>
<td>67%</td>
<td>49%</td>
<td>33%</td>
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<tr>
<td>Depressed</td>
<td>37%</td>
<td>20%</td>
<td>52%</td>
<td>25%</td>
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<tr>
<td>PI claimants (non-TBI)</td>
<td>77%</td>
<td>41%</td>
<td>63%</td>
<td>46%</td>
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<tr>
<td>mTBI</td>
<td>42%</td>
<td>26%</td>
<td>28%</td>
<td>36%</td>
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Research Findings

- Being DEPLOYED is associated with cognitive change (regardless of TBI hx)
- PTSD is more predictive of symptoms than history of concussion
- There is no clear difference in symptoms comparing blast to non-blast concussion
Clinical Consideration - What to do
Screenings/Treatment

- TBI
- Anxiety
- Depression
- EtOH/SA

- Has there been an event that had the potential to cause a significant force to the head?
  - If yes, was this force to the head immediately followed by:
    - A. Any period of loss of or a decreased level of consciousness
    - B. Any loss of memory for events immediately before or after the injury (post traumatic amnesia).
    - Alteration in mental state at the time of the injury (mental confusion, disorientation, slowed thinking, etc.)
MH Treatment

- Individual
- Group (psychoeducation, TBI, caregiver support)
- Couples/family
  - Communication skills
  - Interpersonal skill building
Consider Further Evaluation

- Neuropsychological evaluation
  - Help identify cognitive deficits/strengths, possible changes 2/2 TBI
  - Provide specific recommendations regarding accommodations for school and/or work to support vocational aspirations
  - Recommendations regarding additional therapies (e.g., speech therapy, occupational therapy, etc.)
Vocational Assessment/Counseling

- Testing for vocational interests, work values, and skills
- Job site evaluations
- Job task review and practice
- Work readiness assessment
- Job counseling
- Interview coaching
Resources

- Brain Injury Association (https://www.biausa.org)
- Brainline (https://www.brainline.org) - Brain Injury and PTSD, especially helpful for caregivers
- https://www.stroke.org - National Stroke Association
- https://msktc.org/tbi TBI Model Systems Knowledge Translation Center
- https://www.polytrauma.va.gov/concussioncoach.asp (concussion coach app)
Questions
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