Post-Traumatic Stress Disorder and Traumatic Brain Injury – Current Issues

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Key Iraq wound: Brain trauma
By Gregg Zoroya, USA TODAY

“A growing number of U.S. troops whose body armor helped them survive bomb and rocket attacks are suffering **brain damage** as a result of the blasts. It's a type of injury some military doctors say has become the **signature wound of the Iraq war.**”
Types of Explosive Blasts
Explosives Classification by Speed of Explosion
High-order (HE) versus Low-order (LE)

- High-order Explosives (HE) = detonated
  - Supersonic – Explosion is faster than the speed of sound
  - Characterized by blast over-pressurization impulse wave
  - HE does not mean “large” – a hand grenade is a HE
  - HE blast injuries are characterized as
    a) Primary, b) Secondary, c) Tertiary, d) Quaternary
  - E.g., all military bombs, TNT, Dynamite, Semtex, ANFO
Idealized blast overpressure waveform seen only in high-order explosives (HE)

- **PRESSURE**
  - 0 ATM: Zero Atmosphere Pressure
  - VACUUM: Zero ATM

- **TIME** (microseconds)

- **Detonation**

- **PEAK OVERPRESSURE**

- **POSITIVE PHASE OVERPRESSURE DURATION**

- **NEGATIVE PHASE**

Horrocks, CL. Blast Injuries: Biophysics, Pathophysiology and Management Principles.
Explosives Classification by Speed of Explosion

High-order (HE) versus Low-order (LE)

- **Low-order Explosives (LE) = deflagration – not detonation**
  - **Subsonic** – explosion occurs < the speed of sound
  - NO blast over-pressurization wave
  - LE does not mean “small” – **9-11 attacks involved**
  - LE injuries can be characterized as
    a) shrapnel, b) blunt, c) crush, d) burn
  - E.g., Napalm, gunpowder, Molotov cocktail, many petroleum-based
Blast-Injury Vocabulary

Specific for High-order Explosives (HE)

1. **Primary (1°) Blast Injury** (e.g. blast brain or blast lung)
   - over-pressurization impulse wave – often fatal
2. **Secondary (2°) Blast Injury** (e.g. glass shards)
   - penetrating shrapnel and debris
3. **Tertiary (3°) Blast Injury** (e.g. traumatic amputation)
   - blunt - blast wind throws the individual
4. **Quaternary (4°) Blast Injury** (miscellaneous)
   - burns, fume poisonings, suffocation, building collapse, crush injuries, chronic disease flare, mental health
Primary Blast Injury
associated exclusively with high-order (HE) explosives

1. Caused by the over-pressure blast wave
   - Invisible, supersonic

2. Lethal radius rapidly diminishes with distance
   - $1 / \text{radius}^3$. Lethal radius is 3x in water

3. Affects most air filled structures
   - Lungs, GI tract, Sinuses, Middle ear (TM rupture)
   - But also brain (blast brain)
Blast Brain – A Type of Traumatic Brain Injury

- Blast over-pressure wave – not always a straight path
  - Dampened, reflected, or amplified off solid surfaces
  - Helmets, Kevlar stop shrapnel, but magnify blast waves
War Injuries: Explosive Blasts

- Most common cause of injury
- 64% of war injuries caused by blasts
- 41% of blast injured at Walter Reed had TBI (01/05 - 02/06)
Traumatic Brain Injury
Traumatic Brain Injury

- Insult to the brain caused by an external physical force
- Produces a diminished or altered state of consciousness
  - Dazed and confused for several minutes or
  - Knocked out / Rendered unconscious and/or
  - With memory gaps for some or all of the immediate period before or after the event
- Can result in impairments in physical, cognitive, behavioral, and/or emotional functioning
But is this true of blast injury?
Associated Symptoms of TBI

- **Cognitive**
  Memory deficits, poor concentration, thinking problems

- **Emotional-Behavioral**
  Depression, anxiety, irritability, mood swings
  Impulsivity, apathy, agitation, aggression

- **Physical**
  Headache, dizziness, fatigue, noise/light intolerance, insomnia/sleep disturbance
Mild TBI

- 80% of TBI
- There is no symptom that is unique to or diagnostic of mild TBI
- Many postconcussion symptoms occur in normal healthy individuals
- All symptoms/problems overlap with one or more other conditions
  - (PTSD, depression, anxiety, chronic pain, somatoform disorder, chronic health conditions)
What about Traumatic Brain Injury and Posttraumatic Stress Disorder?
Diagnostic Criteria for PTSD

A. Exposed to traumatic event

- The person experienced, witnessed, or was confronted with an event involving actual or threatened death, serious injury or a threat to physical integrity of self or others

- The person’s response involved intense fear, helplessness or horror
B. The traumatic event is reexperienced in one or more of the following ways

- Recurrent images, thoughts or perceptions
- Recurrent distressing dreams of the event
- Acting or feeling as if the event was recurring
- Intense psychological distress OR physiologic reactivity at exposure to cues that symbolize or resemble an aspect of the event
Diagnostic Criteria for PTSD

C. Persistent avoidance of stimuli associated with trauma and numbing as indicated by 3 or more:

- Avoiding thoughts, feelings, or discussion, activities, places or people that bring back recollections; sense of foreshortened future
- Inability to recall; restricted affect
- Diminished interest or participation
- Feeling detached or estranged
Diagnostic Criteria for PTSD

- **D. Persistent symptoms of increased arousal by 2 or more:**
  - Difficulty falling or staying asleep
  - Irritability or outbursts of anger
  - Difficulty concentrating
  - Hypervigilance
  - Exaggerated startle response

- **E. Duration for more than 1 month**
PTSD: Associated Features

Feelings of depression
Feelings of guilt related to the trauma
Feelings of shame
Thoughts of suicide
  Rate of suicide 6 times greater than individuals without PTSD
  Highest rates of suicide attempts of all the anxiety disorders
Co-Morbidities: Depression, Substance Abuse, Mood cycling, Panic and anxiety symptoms
PTSD and TBI symptom Comparison

**PTSD**
- Insomnia
- Memory Problems
- Poor concentration
- Depression
- Anxiety
- Irritability
- Stress symptoms
- Emotional numbing
- Avoidance
- Intrusive symptoms

**Mild TBI**
- Insomnia
- Impaired Memory
- Poor concentration
- Depression
- Anxiety
- Irritability
- Headache
- Dizziness
- Fatigue
- Noise/Light intolerance
TBI and PTSD: Literature

- Development of PTSD symptoms after a blast injury may be related to the severity of the injury, although research findings about this are mixed [Bryant 2001, Bontke 1996, Glaesser 2004, Williams 2002, Bryant 2000]

- Some researchers have argued that impaired consciousness precludes experiencing the trauma event [Bryant 2001, Mayou 1993, Price 1994, Sbordone 1995]
TBI and PTSD: Literature

- In general research supports the occurrence of PTSD following mild TBI
  - Incidence 13%-27%
  - Prevalence 3%-59%

- There is evidence for association of TBI with other MH disorders:
  depression, anxiety disorders and bipolar disorder
  [Van Reekum 2000]
TBI and PTSD: Literature

- Risk factors for PTSD after a head injury [Review: Kim et al 2007]
  - Early post injury depression and anxiety
  - Female
  - Avoidant coping
  - Left temporal lesion [Vasa 2004]

- These studies have methodologic limitations
TBI and PTSD

- Cognitive symptoms after TBI are usually transient
- Risk factors for persistent cognitive symptoms after a mild TBI
  - History of depression and anxiety
  - Expectations
- Data are preliminary and studies are limited in number
Case Examples
Case 1: TBI, PTSD or both?

- OIF, two tour veteran, early 20’s, 100% service connected for PTSD; discharged from the military after hospitalization for PTSD, depression
- His unit was in Al Anbar province just before and during the siege of Fallujah
- TBI event and multiple trauma events
Case 1: TBI, PTSD or both?

- **TBI event**
  - Providing security near a tank which fired a round
  - He was hit by a shock wave, blown off his feet, hit the wall
  - Lost consciousness for about 5 minutes, rejoined firefight when he regained consciousness, was nauseated, vomited for two hours
Case 1: TBI, PTSD or both?

- **TBI event**
  - Did not seek medical attention
  - Current complaints: Memory problems, problems with balance and speech, blacks out if physically active
Case 1: TBI, PTSD or both?

- **Primary Emotional Trauma Event**
  - Clearing city of insurgents/house to house
  - Insurgents began to lob grenades when they entered the house
  - Close fighting, nearly hand to hand
  - Half of platoon wiped out – nine died, 10 injured
  - Emotionally numb; extreme helplessness
Case 1: TBI, PTSD or both?

- **Other Emotional Trauma Events**
  - On convoy, roadside bomb went off
  - Three injured, two killed, body parts scattered everywhere
  - He had shrapnel injuries
  - Extreme fear helplessness, horror
Case 1: TBI, PTSD or both?

- **Clinical Presentation**
  - Separated from wife, in marital counseling, domestic violence charge which was dropped, concerned about being a good father to his one year old daughter
  - Medically healthy, no current use alcohol or drugs; experimented in high school, up to 20 beers/night on weekends in military
  - Background: Middle class, intact, loving, caring family
Case 1: TBI, PTSD or both?

- **Clinical Presentation**
  - “C” student in school, some truancy, low ASVAB scores
  - Neuropsychological Testing: Average IQ, substantial deficits in verbal memory and intact non-verbal memory; good executive functioning, perceptual reasoning and visual attention; considerable discrepancy between right and left hemispheric functions
  - Normal neurological exam and brain imaging, including Magnetoencephalogram (MEG)
Case 1: TBI, PTSD or both?

- **Treatment**
  - Vocational rehabilitation counselor; organizational aids (Palm Pilot); Supportive psychoeducation (Brain Injury program), School assistance, such as audiotaping of classes
  - Treatment for PTSD and depression including verbal modalities and medication (SSRI)
Case 1: TBI, PTSD or both?

- Follow-up (6-9 months later)
  - Sporadic attendance with vocational and unclear success in college
  - Active attempts to return to active duty: verbalized that he felt a structure, a purpose and camaraderie
  - Second team meeting: Verbalization of his desires and needs and reformulation of plan
Major Issues

- Diagnosis is complex; Need detailed history from childhood forward
- Comprehensive assessment reveals PTSD, but no clear evidence for blast-related injury
- The assessment gives clear indications of emotional and cognitive strengths and weakness
- Treatment must be appropriate to developmental stage
- Expectations for recovery
Case 2: Moderate/severe TBI and Depression

- OIF veteran, late 30’s, mechanical head injury with loss of consciousness greater than 30 minutes, unable to continue military job
- Living situation: Divorced from wife, attempted to work at civilian job, but was unable
- Depressive symptoms, intrusive imagery, suicidal ideation
Case 2: TBI, Depression, PTSD

- Clinical Presentation
  - Neuropsychological testing unequivocal
  - Significant depressive symptoms
  - PTSD symptoms
  - Suicidal thoughts, no plan
Case 2: TBI, Depression, PTSD

- Clinical Presentation
  - Neuropsychological testing unequivocal
  - Significant depressive symptoms
  - PTSD symptoms
  - Suicidal thoughts, no plan
Case 2: TBI, Depression and PTSD

- **Progression of Events**
  - Preceded head injury – PTSD symptoms prior to head injury
  - His career trajectory changed following the head injury
  - The patient was grappling with his losses: cognitive, career, interpersonal
  - He met diagnostic criteria for major depression (SCID)
Case 2: TBI, Depression and PTSD

- **Treatment**
  - Physical therapy (help with balance) and cognitive retraining
  - Career counseling
  - Antidepressant (SSRI) for major depressive episode
  - Verbal treatments
Major Issues

- Diagnosis is complex; Need detailed history (timeline) is important
- Moderate TBI can be associated with significant cognitive changes and feelings of loss
- The assessment gives clear indications of mental health diagnoses and cognitive strengths and weakness
- Recovery and adaptation are possible
PTSD Comorbidity in OEF/OIF

PTSD

Major Depression

Traumatic Brain Injury
Treatment of PTSD

- Growing evidence base for PTSD treatments
  - Exposure-based psychotherapies \( \sqrt{\checkmark} \)
    - Additional benefits of cognitive restructuring?
  - Pharmacotherapies
    - Selective serotonin reuptake inhibitors \( \sqrt{\checkmark} \)
    - MAOIS \( \checkmark \)
    - Other antidepressants \( \checkmark \)
    - Anticonvulsants
    - Adjuncts
      - Prazosin \( \checkmark \)
      - Atypical antipsychotics \( \checkmark \)

- Pharmacotherapy alone usually inadequate to obtain optimal outcomes
  - Combined Rx + exposure-based therapy
    - Studies ongoing
Questions for Further Research

- What are the consequences of blast injuries to the brain?
- What is the relative comorbidity of PTSD and blast TBI?
- Can they be differentiated?
- What are optimal treatments?