Mild Traumatic Brain Injury:
The Military Experience and Applications for Management in the Community

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TBI “In the News”

- September 11\textsuperscript{th}, 2001
- Iraq
- Afghanistan
- NFL
- NHL
- Congresswoman Giffords
- Other media outlets
- *Signature Injury*
Goals and Objectives

- History
- Definition
- Epidemiology
- Pathophysiology
Overview

- Assessing cognitive changes
- Understanding behavioral changes
- Co-morbid factors that interfere with recovery
History of TBI Rehabilitation

- Pre-1900
  - Penetrating head injury = 70% mortality
- WWI-WWII (Germany and Austria)
  - Advent of “TBI rehabilitation”
  - Recognition of neuropsychological impairments
  - Teaching strategies of preserved skills to compensate for impairments
  - Employment and vocation as outcome measure.
History of TBI Rehabilitation

- Post WWII (United Kingdom, Russia, United States)
  - Research
    - Compensatory training (motor planning, visual perception, executive functioning)
    - Functional Prognosis (PTA)
    - Medical Complications (seizures)
  - Multidisciplinary approach
  - Standardized testing
History of TBI Rehabilitation

- Professional Development to meet veteran’s needs.
  - SLP
  - PT
  - OT
  - Vocational
  - Mental Health
  - Physical Medicine and Rehabilitation (Physiatry)

- Dedicated rehabilitation centers
  - SCI
  - TBI
  - Stroke
  - Ortho (amputations)
THEN...

- ...and NOW
Traumatic brain injury (TBI)

- Nondegenerative, noncongenital insult to the brain
- External mechanical force
- Leading to permanent or temporary impairments of function
  - Cognitive
  - Physical
  - Psychosocial
- Associated diminished or altered state of consciousness.
Defining the problem

- Head Injury Interdisciplinary Special Interest Group of the American Congress of Rehabilitation Medicine
- Traumatically induced physiologic disruption of brain function
  - LOC
  - Immediate Retrograde/post-traumatic amnesia
  - Alteration of mental state (stars, dazed, “bell rung”)
  - Focal neurologic deficits
Grading

- Mild
- Moderate
- Severe
Mild TBI

- Does not exceed
  - LOC < 30min
  - PTA < 24hr
  - GCS 13-15
  - No imaging findings

- mTBI = Concussion?
  - It depends on who you talk to...
Moderate

- LOC: 30min-24hrs
- PTA: 24hr-1 week
- GCS 9-12
- Neuroimaging evidence of intracranial trauma
Severe

- LOC: >24hrs
- PTA: > 1 week
- GCS <8
- Neuroimaging evidence of intracranial trauma
- Penetrating/depressed/displaced scull fracture
Epidemiology: GWOT

- 12-35%, 1.6 million Service Members deployed in last 11 years.
- 80% Blast related (IED, RPG, EFP, etc.)
Epidemiology

- CDC
  - 2002-2006
- Incidence 1.7 million per year (underestimated?)

![Epidemiology Diagram]

- 52,000 Deaths
- 275,000 Hospitalizations
- 1,365,000 Emergency Department Visits
- ??? Receiving Other Medical Care or No Care*
Epidemiology

- Pitfalls
  - Inconsistent definition
  - Inadequate reporting
  - Inadequate imaging
MOI

- 35.2% Falls
- 16.5% Struck By/Against
- 21% Unknown/Other
- 17.3% Motor Vehicle-Traffic
- 10% Assault
Groups at Risk

- 59% male
- 0-4, 15-19, >65 yoa
- 18% TBI ER visits 0-4 yoa
- 22% hospitalization >75 yoa
  - Highest rate of hospitalization and death
Risk Factors

- Alcohol
- Substance Abuse
- Crime
- Societal factors
Trends 1979-1992

- TBI deaths down 22%
  - GSW deaths (up 9%)
    - #1 cause of TBI deaths
    - Decreased MVA deaths (down 42%)
- 30% associated with all injury related death.
Importance

- 5.3 million Americans—2% of the U.S. population—currently live with disabilities resulting from brain injury.

- $76.5 billion total direct/indirect medical cost and lost productivity (2000)
  - LBP ~ $100 billion
Importance

- 75% of TBIs that occur each year are mild TBI.
Prevention and Education

- Airbags
- Safety belts
- Helmets
- Violence prevention programs
- Falls prevention programs
- Proper sports equipment
- Combat protective equipment
Goff, et. Al.

Weight Supported by Neck
1) Kevlar Helmet- 4.2 lbs (1.9 kg)
2) Night Vision Goggles- 1.5 lbs (.68 kg)
3) Tactical Kevlar Light- 4 oz (12.5 grams)
Total weight = 5.95 lbs (2.69 kg)

Weight Supported by Back/ Shoulders
4) Body Armor System- 35 lbs (15.9 kg)
5) Tactical Load Vest- 2 lbs (0.90 kg)
6) 12 Magazines of ammunition- 15 lbs (6.8 kg)
7) 4 Fragmentation grenades- 6 lbs (2.7 kg)
8) 2 Flash Bang grenades- 2 lbs (0.90 kg)
9) 2 First Aid Kits- 2.2 lbs (1 kg)
10) Multi-purpose tool- 1 lb (0.45 kg)
11) Seatbelt Cutter- 6 oz (170 grams)
12) Back-pack Hydration style with 3 liters- 8 lbs (3.6 kg)
Total Weight = 71.53 lbs (32.5 kg)

Weapon Systems
13) Rifle- 6.9 lbs (3.1 kg)
14) Scope- 7 oz (198.5 grams)
15) Night Vision/ Laser Emitter- 7.5 oz (212.6 grams)
16) Tactical Mount Light- 1 lb (0.45 kg)
17) Foregrip/Tripod- 1 lb (0.45 kg)
18) Pistol- 3.1 lbs (1.4 kg)
19) 2 Magazines of ammunition- 2 lbs (0.90 kg)
20) Holster- 1.4 lbs (63 grams)
Total Weight = 16.40 lbs (7.43 kg)

ACU Uniform
21) Combat Shirt- 10 oz (283.5 grams)
22) Trousers- 1.2 lbs (0.54 kg)
23) Rigger Belt- 6 oz (170 grams)
24) Combat Boots- 4.4 lbs (2 kg)
25) Knee Pads- 1.2 lbs (0.54)
26) Gloves- 5 oz (141 grams)
27) Ballistic Eyewear- 1 oz (28.3 grams)
Total Weight = 8.15 lbs (3.7 kg)
http://en.wikipedia.org/wiki/MRAP

http://defensetech.org/2007/08/30/amazing-mrap-survival-photos/
Pathophysiology

- Self limiting
- Short lived
- Spontaneous resolution
- Transient disturbances
- Observation
- Underreported and underestimated
Pathophysicsology

- "mild" = absence of cranial lesion
  - "mild" describes mechanism of injury
- "mild" =/= 100% normal outcome or predict prognosis
- Typical resolution in 1-12wks
  - 15% remain symptomatic
Pathophysiology

- Diffuse Axonal Injury
- Spectrum of severity

http://www.braininjury.com/injured.shtml
http://www.uihealthcare.com/topics/medicaldepartments/neurosurgery/braininjury/03whattypesbraininjuries.html
Pathophysiology

- Neurochemical/Neurometabolic events
  - Release of excitatory amino acids (EAA)
    - Glutamate
    - Activation of NMDA receptors
    - Influx of calcium
    - Impairment of mitochondrial activity
Pathophysiology

- Neurochemical/Neurometabolic events
  - Imbalance of ATP consumption/production
  - Compromises synaptic plasticity
    - Focal neurologic and other cognitive/behavioral deficits
- N-acetylasperate (NAA)
  - Brain specific metabolite
  - Low levels suggest neuronal injury
    - Stroke, MS, dementia
Pathophysiology

- Neurochemical/Neurometabolic events
  - N-acetylasperate (NAA)
    - Brain specific metabolite (neuronal mitochondria)
      - High energy cost
    - Low levels suggest neuronal injury
      - Stroke, MS, dementia
      - Hypoxic/ischemic/toxic
  - Proton magnetic resonance spectroscopy (1H-MRS)
Pathophysiology

- **Neurochemical/Neurometabolic events**
  - N-acetylaspartate (NAA)
    - Animal models
      - Correlated with severity
      - Mild TBI vs. sham head injury
  - Brain vulnerability vs. Second Impact Syndrome
    - SIS is FATAL and rare (cerebral edema)
    - Changes in ATP/NAA in repeated mTBI models
- Resolution over time?
  - ~30 days
Pathophysiology

- Genetic expression
  - Increased ASPA gene expression
  - Decreased NAA production (depressed mitochondrial function)
Pathophysiologiat

- Clinical/Research applications
  - Monitor NAA levels
  - Determine window of clearance
  - Treatment targeting mitochondrial function
Modern State of TBI Surveillance

- DVBIC (DVHIP) – 1992 (GW)
- TBI Act of 1996
  - CDC
- DVBIC 2008 (GWOT)
  - “Signature Injury”
The DoD Approach

- Office of Neurotrauma, Navy Medicine West SoCal
  - Naval Medical Center San Diego
  - Naval Hospital Camp Pendleton
  - Naval Hospital Twentynine Palms
The NMCSD TEAM

- **DVBIC**
  - Multicenter network
  - Collaboration between DoD and VA entities
  - DCoE PH/TBI
- **Comprehensive Combat and Complex Casualty Care (C-5) Program**
  - Case Management and Primary Care model with a rehabilitation focus.
  - Management of all overseas/deployed service member who medically evacuated or transported to NMCSD.
  - Polytrauma Rehabilitation
The Approach

- VA-DoD CPG
  - Primary Care Model

- SATEPS
  - Screening
  - Assessment
  - Treatment
  - Education
  - Patient Follow-up
  - Surveillance
VA/DoD CPG

- Adult injury
- Apply to all medical providers
- Does not address acute management or mod/sev TBI.
VA/DoD CPG

- Establish accurate diagnosis
- Evidence based management and treatment
- Early intervention
- Multidisciplinary approach
VA/DoD CPG

- Adult injury
- Apply to all medical providers
- Does not address acute management or mod/sev TBI.
VA/DoD CPG

- Patient screening
- Patient education
- Early intervention
- Symptom management
  - Somatic
  - psychiatric
- RTD ASAP
  - Psycho-social support for refractory symptoms
  - Secondary gain?
- Continuity and Follow up.
Core Components

- **Screening:**
  - DVBIC TBI Screening Tool, TBI Severity Score

- **Assessment:**
  - Medical Exam

- **Treatment:**
  - 20 week care plan, VA DoD CPG, Interdisciplinary Team
Core Components

- **Education:**
  - Face to face with provider, DVBIC

- **Patient Follow-up:**
  - Interdisciplinary Team

- **Surveillance:**
  - Demographics, Tracking, Metrics
Military Demographics

- Navy Medicine West
TBI Patients Identified
n=2079

NHCP
NMCSD
NHTP

FY10
FY11 (3Q)

638
739

298
188

106
110

NHCP
NMCSD
NHTP
TBI Demographics

n=492

- USMC: 89%
- mTBI: 95%
- mTBI Symptomatic: 72%
- Blast: 74%
- Prev HI: 60%
TBI in the Community

- MVA
- Falls
- Violence
- Sports
  - Amateur Athlete
    - Baby Boomers
    - Gen-Xers
    - Millennials
  - Alcohol
Screening

- Neurosurgery/Neurology/PM&R
- SLP
- OT
- VT
- Optometry
- Dental
- Mental Health
- ENT/Audiology
- Neuropsych (>3-4 months)
Common Symptoms

- Post Concussive Syndrome (11-64%):
  - Headache
  - Dizziness,
  - Insomnia
  - Anergia
  - Irritability,
  - Anxiety
  - Dysphoria
  - Apathy
Management

- Also commonly seen in:
  - chronic pain
  - anxiety/depression
- Service Member without body or brain injury
  - headaches 8%
  - sleep disturbance 24%
  - fatigue 25%
  - memory difficulty 7%
  - irritability 24%
Symptoms of PTSD & TBI

PTSD
- Flashbacks
- Avoidance
- Hypervigilance
- Nightmares
- Re-experiencing phenomenon

TBI
- Headache
- Sensitivity to light or noise
- Nausea vomiting
- Vision Problems
- Dizziness

Common Symptoms
- Cognitive Deficits
- Irritability
- Insomnia
- Depression
- Fatigue
- Anxiety
Treatment

- NO MAGIC CURE FOR CONCUSSION...except time
  - Manage the symptoms
  - Develop compensatory strategies
Treatment

- TBI education (TEAM)
  - Empower patient and hold them accountable for recovery
  - Support improvements in function
  - Rehabilitation plan
  - Return to work/school plan.
  - Resist conveying that all difficulties are psychiatrically driven
  - Offer reasonable explanation for cognitive complaints
  - Be weary of secondary gain (36% MEB non-credible cognitive findings)
Conclusion

- MUST HAVE COORDINATED EFFORTS:
  - Improve symptoms
  - Maximize function
  - Return to work
  - Improve quality of life

- Multi-disciplinary efforts
References

- www.Dvbic.org
Cognitive Symptoms reported following concussion/mTBI

- Impaired memory
- Trouble concentrating
- Difficulty finding words
- Slowed overall processing
- Impaired organizational and problem solving skills
Neuropsychological Evaluation

Context of referral
- Self-referred
- Provider referred
- Medical Board

Pre-morbid Functioning
- Rank
- ASVAB scores
- Education
Credible vs. Non-credible Clinical Presentation

- Undocumented or questionable mild head injury
- Marked discrepancy between the individual’s claimed injury and the objective test findings
  - Implausible test results when compared to the medical history
Credible vs. Non-credible Clinical Presentation

- Excessive inconsistencies in test data
  - Poor performance on obvious, but not less obvious tasks of same function

- Symptom validity tests
  - Valid vs. invalid test performances
  - Will see terms: “inconsistent,” “invalid,” “results cannot be interpreted”
  - Effort vs. malingering
Credible vs. Non-credible Clinical Presentation

- Evaluate symptom complaints within the context of historical data, behavioral observations, and current “real world” functioning
- Be wary of a delayed onset of symptoms
- Assess for secondary gain
  - Litigation
  - Medical board
Neuropsychological Test Performance in Soldiers w/ Blast-Related Mild TBI (Brenner, et al., 2010)

- Exploratory study to examine whether persistent mTBI-related symptoms or PTSD negatively impacted test performance

- Compared 27 SM’s w/enduring mTBI symptoms to 18 SM’s w/o symptoms

- Results:
  - Presence of mTBI symptoms did not impact test performance
  - No significant differences between soldiers with and w/o PTSD were identified
Symptom validity test performance in U.S. veterans referred for evaluation of mild TBI

Armistead-Jehle (2010)

Medical Symptom Validity Test (MSVT)

58% scored below the cut scores on subtests more sensitive to effort than neurological insult

Those with service connection failed at a higher rate
Maybe it is not secondary gain?

- “Good Old Days” Bias Following Mild Traumatic Brain Injury
  - *The Clinical Neuropsychologist*

Research suggests that people who sustain an injury often underestimate past problems ("good old days")
“Good Old Days” Bias Following Mild Traumatic Brain Injury” Iverson, et al.(2010)

- Sample: 90 temporarily fully disabled individuals from a mTBI receiving Worker’s Compensation
- Patients provided post-injury & pre-injury retrospective ratings on the British Columbia Post-concussion Symptom Inventory
- Compared ratings with 177 healthy controls
“Good Old Days” Bias Following Mild Traumatic Brain Injury” Iverson, et al.(2010)

- mTBI patients endorsed fewer pre-injury symptoms compared to the controls
- Those who failed effort testing, reported fewer symptoms pre-injury compared to those who passed effort testing
- Many mTBI patients reported their pre-injury functioning as better than the average person
Important Facts

- Look for documentation
- Be wary of delayed symptoms or worsening of symptoms
- Are the symptoms in line with the medical history?
- Cognitive/psychiatric evaluations should contain formal SVT’s and embedded measures
- Avoid a “knee-jerk” assumption of secondary gain
- Consider the unknowns of blast-related TBI
- Never base conclusions on one test score
- Assess “real world” functioning
Co-morbid Complications

- TBI
- PTSD
- Substance Abuse
- Alcohol Abuse
- Chronic Pain
- Medication
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 had recent mental health problems.
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
- Presence of a mental disorder increases likelihood of aggression
Behavioral Aspects of TBI

- Changes in cognitive abilities
- Poor impulse control
- Acting out Behavior
The Amygdala

- Linked to the frontal lobe
- Primary role is in the acquisition and the physiological expression of conditioned fears
- It processes and stores memories of emotional events
  - Stores feelings and physiologic responses associated with the event (fear with increased HR)
- The stored memory can later be triggered

Phelps, 2004
The Amygdala

- Flight and fear responses ("freezing")
- Has a distinct difference from a conscious feeling of fear
- Defensive or aggressive reactions
- Has a sensory input system
Aggression and Violence Interaction: PTSD & TBI

Increased activation
(limbic system)

Decreased Inhibition
(frontal lobes)
Increased Violence Potential

- History of Violence
- Substance Abuse Disorder
- Major Mental Illness
References


