Military Advances in TBI Research

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Disclosures

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• Opinions and conclusions are my own and do not reflect those of the US military or government
Why TBI?

- Recognize
- Publicize
- Learn
- Apply
War: what is it good for?

• Edwin Starr (1970):
  – (War), It ain't nothing but a heartbreaker
    (War), Its only friend is the undertaker
    War has shattered many young men's dreams
    Made them disabled, bitter and mean
    Life is much too short and precious to be fighting wars these days
    War can't give life it can only take it away

    (War) good God y'all
    (What is it good for?) Absolutely nothing, say it
    (War, what is it good for?) Absolutely nothing

• Seinfeld (1990s)
  – Original title of Tolstoy’s War and Peace
War: what is it good for?

- Last two decades of American military conflict
- Trauma registry
  - Define the injury
  - Follow the wounded in the care continuum
  - Study the outcomes
- TBI became the signature injury of OIF/OEF
  - 20-25% of service members
  - 352,612 service members 2000-2016
- Literature follows the incidence:
  - Decreased emphasis on wound healing and mortality
  - Increased literature on TBI, blast injury, and hemorrhage control

Vickers et al. J R Army Med Corps 2018
TBI in the military

- High rates of blast injury
  - 65% in Vietnam conflict
  - 81% in Iraq and Afghanistan
- Frequent occurrence of blast exposure
- Polytrauma - sustain injuries to multiple body regions
- Improved body armor, training, safety precautions protect non head/neck areas from projectiles
Blast Injury Components

Primary Injuries:
Head (ear), Lung and Organ Injuries
From Overpressure Blast Wave
Unique to High Order Explosives

Secondary Injuries:
- Produced by flying debris, bomb fragments
- Penetrating and Blunt Trauma, Fractures and Soft Tissue

Tertiary Injuries:
- Results from being thrown by blast wave
- Head Injuries including multiple fractures

Quarternary Injuries:
- All injuries not due to Primary, Secondary and Tertiary mechanisms
- Such as burns, head injuries, and exacerbation of pre-existing medical conditions

Adapted from: http://www.bt.cdc.gov/masscasualties/blastinjuryfacts.asp
TBI research in the military

- Priority focus areas
  - Prevention – partner with NFL, NCAA, universities
  - Identification / Evaluation
    - From “shell shock” to MACE (military acute concussion evaluation)
  - Acute care – screening, rest, structured return to activity, concussion care centers
  - Long term care – post-concussion symptoms, electronic record access
  - Education and Training – disseminate clinical recommendations for service members, family, veterans
  - Recognition of silent injury with chronic health implications
TBI identification

- Increased incidence
- Increased reporting (2007)

- Many occur in non-deployed
  - MVC
  - Fall
  - Recreational activities
  - Training

- Standardize care
Acute Care of TBI

• DoD Guidelines 2009
  – Standardize diagnostic criteria
    • Trauma PLUS:
      – Any period of loss of consciousness
      – Post-traumatic amnesia
      – Alteration of consciousness / mental state
      – Neurological deficits
      – Intracranial lesion
  – Classify TBI according to mechanism and severity
  – Categorize TBI symptoms as physical, cognitive, or behavioral
  – Evolve systems for types of care provided in acute and rehab stages
Concussion / mild TBI

• Concussion management algorithm 2012
  – CPGs and algorithms **mandated** for use
  – At least 24 hours of rest before return to duty
  – 2 concussions within 12 months = 7 days rest after symptoms resolution
  – 3 concussions within 12 months = re-evaluation
    • Neurologic, neuropsychological, functional assessments, neuroimaging as indicated

• Deployed service members need to complete baseline neurocognitive testing within 12 months

TBI research in the military

• Research priorities
  – Objective diagnostics – serum biomarkers, neuroimaging
  – Prevention of secondary injury
    • Hypoxia
    • Hypotension
    • Elevated intracranial pressure
  – Relationship of blast and chronic traumatic encephalopathy (CTE)
  – Prevent, identify and treat cognitive dysfunction, PTSD

Helmick et al. Brain imaging and behavior 2015
Military TBI research at UC

• Clinical registry data
  – Coordinated from point of injury, transport, recovery and rehabilitation

• TRACK-TBI (Transforming Research and Clinical Knowledge)
  – UCMC among 18 sites to enroll 3000 patients
  – Clinical course, blood samples, advanced imaging, outcomes data
  – Supported by US Army funding

• Center for the Sustainment of Trauma and Readiness Skills
  – CCATT (Critical care air transport team)
  – Care of wounded warrior en route between echelons of care
  – Teamwork and resuscitation skills
  – Joint program with the Air Force
Military TBI research at UC
Military TBI research at UC

• Unique environments / challenges
  – Far forward injury, transport, environmental stress
  – Walking wounded during aeromedical evacuation
• 90% pts < SpO2 90%
Military TBI research at UC

- Preclinical models to explore and improve care
- Unique relationship with the Air Force
- Study the stressors of flight:
  - Hypoxia
  - Hypobaria
  - Vibration
  - Noise
  - Temperature
  - Decreased humidity
  - Gravitational forces
Military TBI research at UC

- Mouse model of TBI
  - Effects on brain of time from injury to flight
  - TBI/hemorrhage model to optimize resuscitation strategies
  - Medications to reduce these effects

- Pig model of TBI
  - Porcine neurotrauma center – perfusion, oxygenation, cEEG, hemodynamics
  - Effects of vibration after TBI
  - Combination of TBI with lung injury and hemorrhage
  - Effects of altitude and hypoxia after TBI

- Facilitated collaborations – connecting the departmental silos
  - Trauma
  - Neurosurgery
  - Neurology / Physical Medicine and Rehabilitation
  - Pharmacology
  - Radiology
War: what is it good for?

- Recognition of TBI and mild TBI / concussion
- Creation of guidelines for TBI care
- Clinical outcomes data and improvements
- Engagement with civilian professional and academic partners
- Establishment of funding opportunities to explore TBI pathophysiology, prevention, diagnosis, acute treatment and rehabilitation