

Neurocognitive Assessment of Sports Concussion and CTE: From Dings to Dementia

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University of Virginia TBI Study

Glasgow Coma Scale: All Head Injury Admissions (n = 1248)

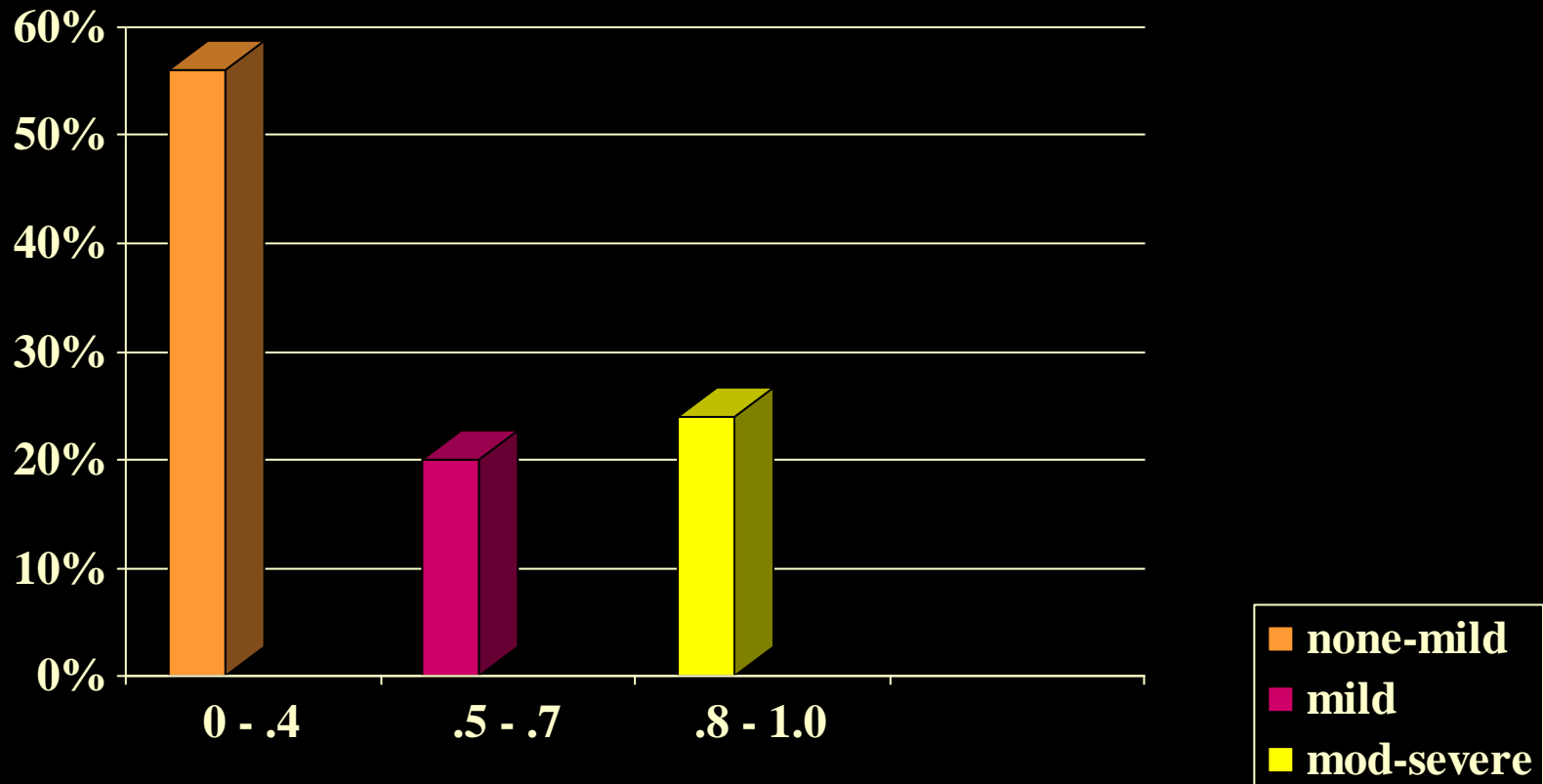
<u>Glasgow Coma Scale Population</u>	<u>No. Patients</u>	<u>% of</u>
3 - 8	260	21%
9 - 12	304	24%
13 - 15	684	55%

University of Virginia TBI Study (1981)

3 months post injury – 34% of mild head injured patients who were previously employed had not returned to work (n=310)

Percentages of Mild Head Injured Patients Across the Halstead Impairment Indexes

Rimel et al 1981, Barth et al 1983)

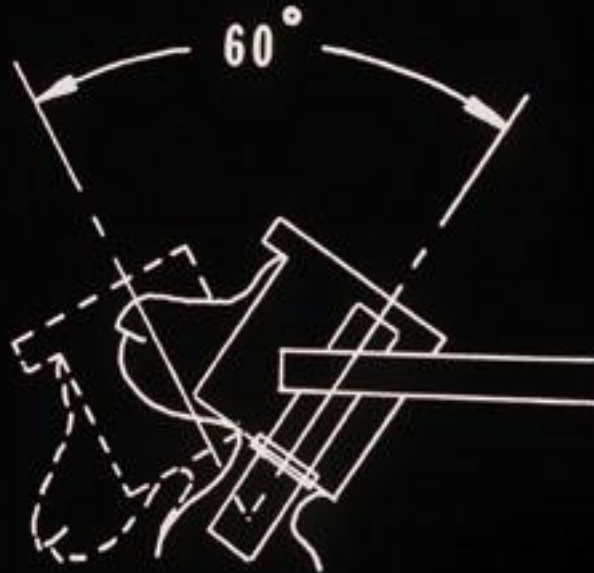


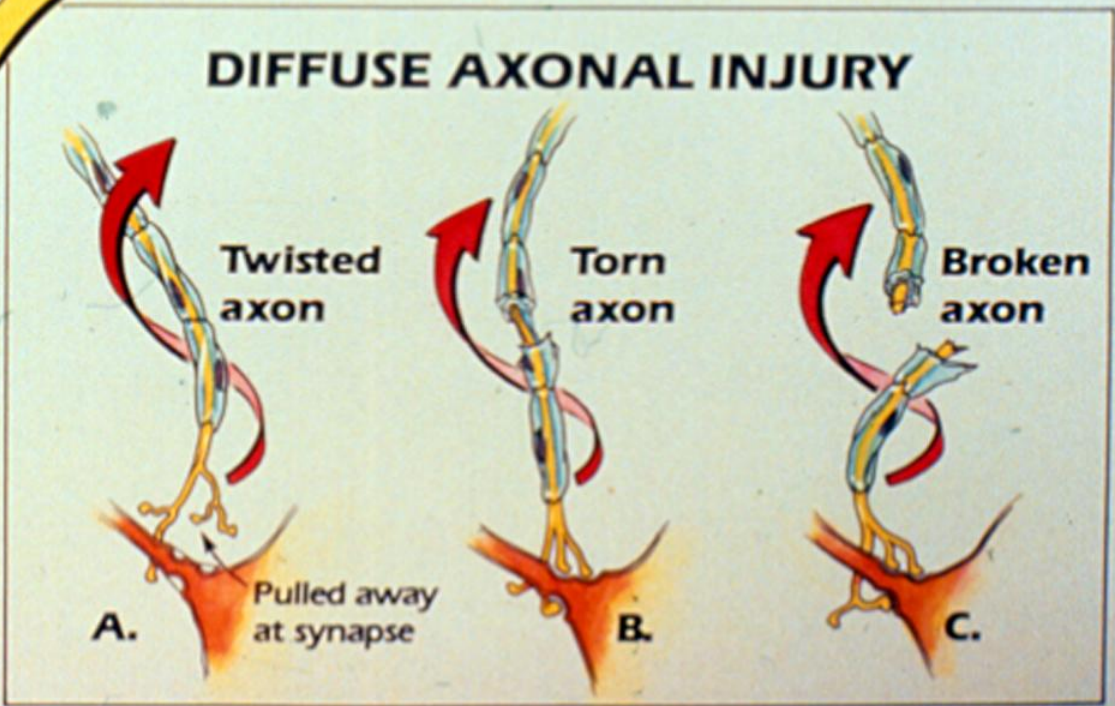
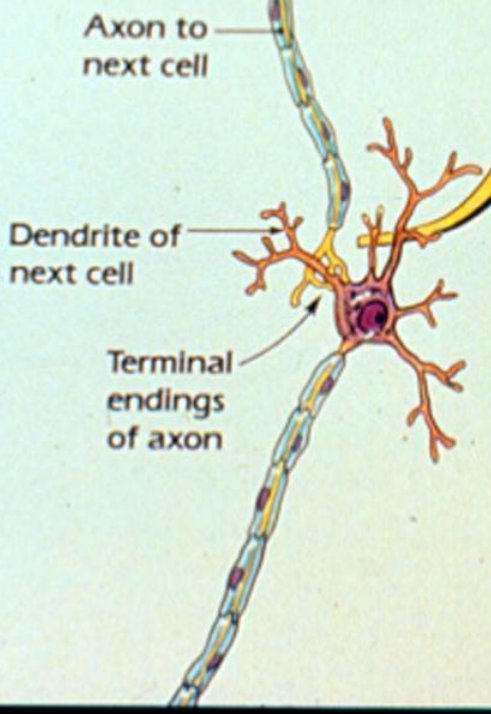
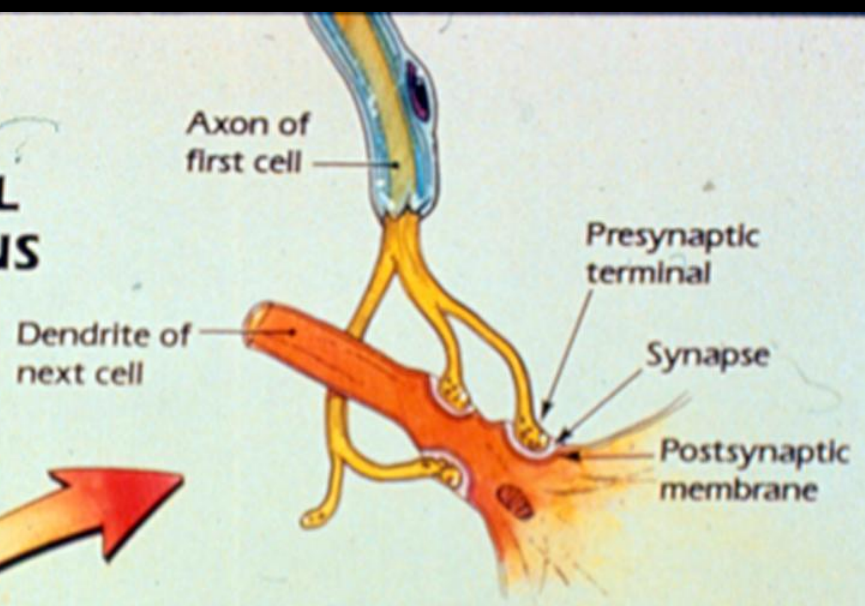
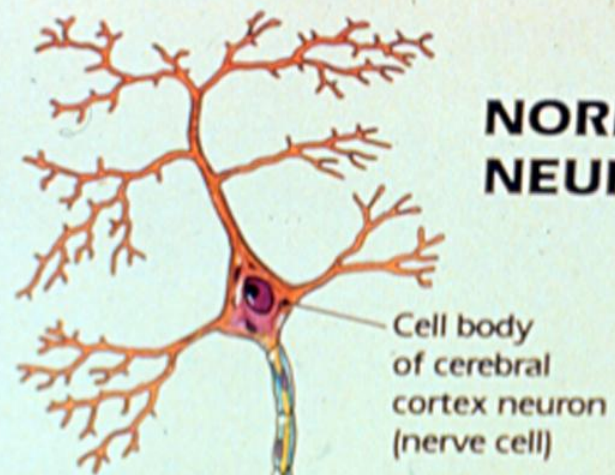
Mild Head Injury: The Silent Epidemic

Wall Street Journal, 1982

**Axonal degeneration induced by experimental
noninvasive minor head injury**

**John A. Jane, M.D., Ph.D., F.R.C.S.(C), Oswald Steward, Ph.D.,
and Thomas Gennarelli, M.D.**





Neurochemical Model of Concussion in Fluid Percussion

David Hovda, Ph.D., UCLA Dept. of Neurosurgery

- Increase in extracellular potassium and sodium, and intracellular calcium
- Initial hypermetabolism and hyperglycolysis to restore homeostasis
- Subsequent hypometabolism:
 - Uncoupling of cerebral blood flow and glucose utilization creates relative ischemia in regard to metabolic demands of tissue

**University of Virginia Study of Mild
Head Injury in Football: Baseline and
Post Concussion Neurocognitive
Assessment**

SLAM

*Sports as a Laboratory
Assessment Model*

[1989]

The logo features the word "SLAM" in a bold, yellow, serif font, centered on a horizontal line. The line has a color gradient from dark purple on the left to bright yellow on the right, ending in a stylized arrowhead shape. The arrowhead is filled with a gradient from dark brown to light brown, with a bright yellow tip.

SLAM

- Focus on Sports Concussion as a Laboratory for Clinical Research
 - Application to MTBI in the general population
- Focus on Sports Concussion as a Sports Medicine Issue
 - Improving sports safety/reducing risk

University of Virginia Football Study

(Barth, 1989; Macciocchi, 1996)

Evidence Level 1

TOTAL

2350 Players

Post-injury Protocol:

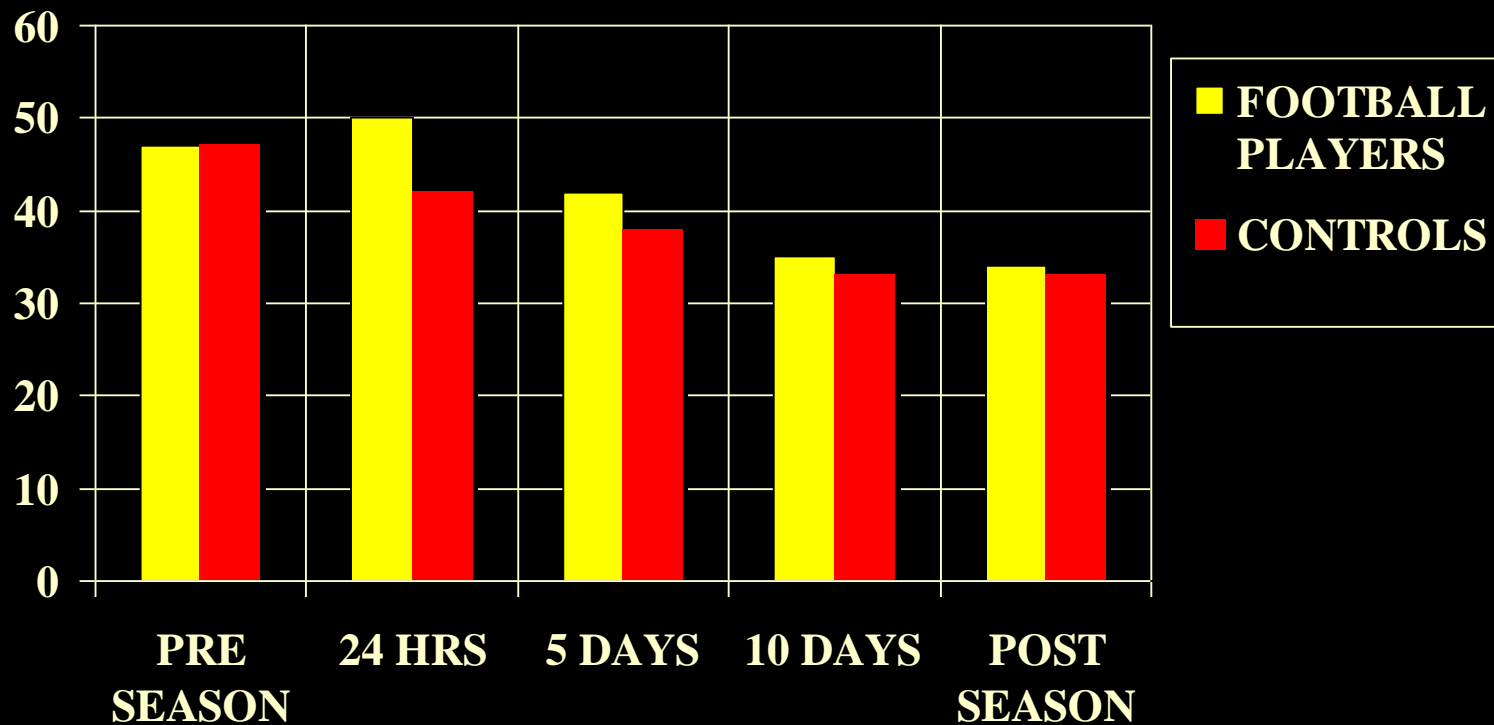
Head Injuries 195

Orthopedic Injuries 59

Student Controls 48

TRAIL MAKING B

Pre-Season and Post-Injury Performances (Timed in Seconds)



Percentage of Players Reporting Symptoms Following Mild Concussion

	Pre-season	24-Hours	5 Days	10 Days
Headaches	27.0	70.6	54.3	27.2
Memory	2.3	33.9	26.7	8.8
Dizziness	2.3	34.8	21.6	9.4

UVA Mild Head Injury in Football

(Barth, et al., 1989)

- 10 University Prospective Study (n=2350)
- 195 Concussions
- 107 Student/Red Shirt Athlete Controls
- Single Concussion:
 - Attention and Complex Problem Solving Deficits
 - Inability to Take Advantage of Practice Effect
 - 5 to 10 Day Recovery Curve

Virtually every college, high school, and professional study since the UVA study has found similar recovery curves following mild concussion [3 to 10 day recoveries]

Acceleration-Deceleration Mild Head Injury and Concussion Assessment

Sideline and In-Theater Screening:

- Standardized Assessment of Concussions (SAC)
(McCrea, Kelly, Kluge, Ackley, and Randolph, 1997)
- Military Acute Concussion Evaluation (MACE)

Computerized Assessment in Acceleration Deceleration Concussion

- **ANAM:** Automated Neuropsychological Assessment Metric – Bleiberg (DoD)
- **ImPACT:** Immediate Post Concussion Assessment and Cognitive Testing - Lovell (U of Pittsburgh)
- **CRI:** Concussion Resolution Index – Erlanger (HeadMinder)

Critical Issues in Sports Mild Head Injury

- Severity of concussion
- When is it safe for a player to return to play?
- What are the effects of multiple concussions? Timing of concussions? Latency effects?

Evidence Based Science and Medicine

- In this era of evidence based medicine, those who must make critical return-to-play decisions are left in the unenviable position of choosing between scientism or potential charlatanism.
- Do we ignore a potential problem because we have little scientific data, or do we over-react to sensational headlines based upon single case observations?

The Dangers of Charlatanry or Scientism: Striking a Balance

To avoid decisional paralysis and harm to the athlete, we must **strike a balance** between what we know with reasonable certainty and what we observe and hope to better understand.

The Importance of Return-To-Play Decisions: Striking Another Balance

- **Avoid potential negative outcomes**
 - Protect the health of the athlete and avoid:
 - Second Impact Syndrome
 - Chronic Traumatic Encephalopathy
 - Severe Emotional Problems
 - Acute and Chronic Cognitive Deficits
- **Carry out the mission/goal**
 - Return to game and play well
 - Not be lost for future games

Potential Negative Medical Outcomes Associated With Return-To-Play Decisions:

SECOND IMPACT SYNDROME

- Occurs in athletes with prior concussion following relatively minor second impact (controversial and based upon single case studies)
- Catastrophic increase in intracranial pressure due to dysfunction of autoregulation of cerebral circulation
- Most often occurs in athletes < 24 years old

LOW INCIDENCE – HIGH POTENTIAL ACUTE IMPACT

Schneider, 1973; Saunders; 1984; Cantu, 1998.

Evidence Level 4

Potential Negative Medical Outcomes Associated With Return-To-Play Decisions:

CHRONIC TRAUMATIC ENCEPHALOPATHY

- Progressive degenerative neurological process found in some athletes who sustain multiple concussions and sub-concussive blows. This early degenerative process is characterized by cerebral atrophy and increased levels of tau protein, as well as cognitive impairment (dementia) and, in some cases, depression.

LOW-MOD INCIDENCE – HIGH POTENTIAL CHRONIC IMPACT

McKee /Cantu, 2009; Omalu,/DeKosky 2005.

Evidence Level 3 & 4

Potential Negative Medical Outcomes Associated With Return-To-Play Decisions:

SEVERE EMOTIONAL PROBLEMS

DEPRESSION

LOW INCIDENCE – HIGH POTENTIAL CHRONIC IMPACT

Guskiewicz, 2003; Guskiewicz, 2007.

Evidence Level 2 & 3

Potential Negative Medical Outcomes Associated With Return-To-Play Decisions:

ACUTE AND CHRONIC COGNITIVE DEFICITS

Acute cognitive deficits 3 to 10 days post single concussion.

HIGH INCIDENCE – HIGH ACUTE LOW-CHRONIC POTENTIAL IMPACT

Barth, 1989; Lovell, 2003.

Evidence Level 1 & 2

Possible chronic cognitive deficits with multiple concussions.

LOW-MOD INCIDENCE – HIGH CHRONIC POTENTIAL IMPACT

Guskiewicz, 2005; Collins, 1999.

Evidence Level 2 & 3

Mild Head Injury Outcome

- Most mild head injured patients recover fully and quickly (within 3 months).
- Many mild head injury patients experience significant neurocognitive deficits which can last several weeks or months.
- Longer periods of disability are related to individual recovery curves and individual vulnerability

Lessons Learned From Clinical Experience Outside of Sports: Individual Vulnerability Factors and Outcome

- More severe concussion
- Multiple concussions
- Age
- Pain
- Premorbid health/conditioning
- Premorbid intellectual/cognitive functioning/LD/ADD

Lessons Learned From Clinical Experience Outside of Sports: Individual Vulnerability Factors and Outcome

- Alcohol/substance use/abuse
- Depression
- Sleep disturbance
- Support systems to allow rest and recovery
- Information provision and positive expectations
- Genetics?

Return to Play and Practice

What Do We Know With Reasonable Certainty?

- Single uncomplicated concussion often results in acute neurocognitive and balance deficits and a rapid (3 to 10 day) recovery curve.
- Once an athlete has sustained a concussion, the risk for subsequent concussion increases 3 to 6 fold.
- Multiple concussions may increase the severity and duration of cognitive symptoms (multiple concussions may result in CTE).
- Children are likely at greater risk for slower recovery.

Return to Play: Consensus Statements

Evidence Level 5 [Expert Opinion]

- American Academy of Neurology Practice Parameters (1997)
 - Severity grading; no symptom return to play (presently being revised)
- Vienna Conference on Sports Concussion (2002)
 - Importance of neurocognitive assessment
- Prague Conference on Sports Concussion (2004)
 - Simple vs. complex concussion
- Zurich Conference on Sports Concussion (2009)
 - Neurocognitive assessment important (verify athlete self report)
 - Individually based decisions (one size does not fit all)
- NCAA and AAN Sports Concussion Guidelines (2010)
 - Diagnosis of concussion = remove from game no matter how fast symptoms clear

Conservative Approach to Return to Play and Practice

- Every player is different and decisions should be made by the medical/athletic training staff (and the player), taking individual history into account.
- If concussion is diagnosed, the player should be removed from play for that game/practice and until symptom free with exertion. Rest is recommended.
- When symptom free, neurocognitive retesting should be implemented to check against baseline test scores to mitigate inaccurate player symptom report.

Conservative Approach to Return to Play and Practice

- Since there is no scientific evidence to support a cut-off for too many concussions in a season or in a lifetime, decisions should be made by the medical/athletic training staff (and the player), taking individual history into account.
- Consideration should be given to a full neurological and neurocognitive examination when considered necessary by the team physician following multiple concussions. Any significant neurologic symptoms should trigger such an evaluation.

Improvised Explosive Device Blast Injuries

- **Primary Blast Injury:** Wave induced changes in atmospheric pressure [hollow organs most effected].
- **Secondary Blast Injury:** Objects placed in motion by the blast and hitting soldiers.
- **Tertiary Blast Injury:** Soldiers being put in motion by the blast and hitting other objects.
- **Quaternary Blast Injury:** Burns, toxic fumes, crush injuries, hypertension.

Blast Injuries: Comparison to Sports Concussions

- Blast injuries are more complicated than sports concussions, yet have some similarities, particularly in the tertiary phase of acceleration-deceleration.
- Complications include:
 - **Primary over pressure dynamics**
 - **Secondary blunt injury**
 - **PTSD**

RECOMMENDATIONS FOR ASSESSMENT AND TREATMENT OF CONCUSSION BLAST INJURY IN THE FIELD OF OPERATION

LEVEL I [Line Medic Care]:

- Rest, observation (establishment of “Battle Buddy”), information, and positive expectations, (up to 2 days).

LEVEL I or II [FOB or BAMF Care]:

- Continue rest, observation, and positive expectations up to 14 days if improvement is noted. Referral to Level III if symptoms persist or deteriorate.

LEVEL III [Combat Support Hospital (CSH) Care]:

- Repeat ANAM or RBANS, or Comprehensive Neuropsychological Assessment. Possible referral to Level IV or V hospital care.

LEVEL IV or V [Military Hospital or in CONUS Care]:

- Comprehensive Neuropsychological Assessment.

Concussion Controversies

- We are uncomfortable with our lack of knowledge and the complexity of the concussion issue.
- When faced with this lack of comfort and complexity, we tend to become reductionists in order to increase our comfort by reducing our uncertainty.
- Reductionism leads us to simple extremes (all concussions are devastating or they are inconsequential).
- These simple extremes breed scientism or charlatanism.

Concussion Controversies

- Get comfortable with ambiguity
- Recognize and embrace the complexity of the concussion issue and treat it as a challenge to your scientific and clinical/medical skills.
- Take individual vulnerability into account when treating/managing your patient/athlete.

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BISC
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