## Sports Concussions: From Dings to Dementia

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## University of Virginia TBI Study

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

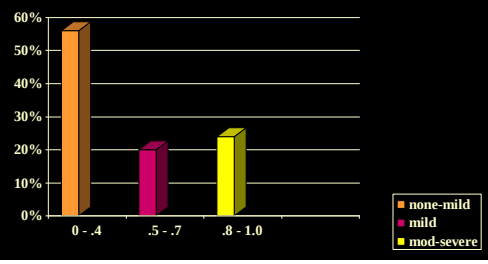
| Glasgow Coma Scale Population | No. Patients | % of |
|---|---|---|
| 3 - 8 | 260 | 21% |
| 9 - 12 | 304 | 24% |
| 13 - 15 | 684 | 55% |

## 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

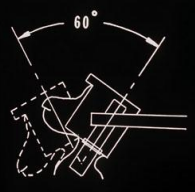
## Mild Acceleration-Deceleration Brain Injury

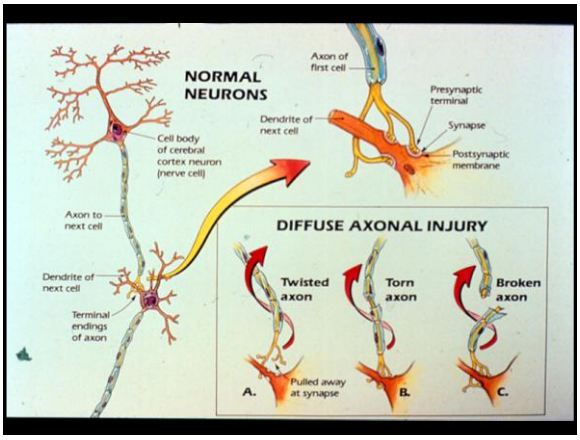
"Acceleration induced head injury in the monkey: I. The model, its mechanical and physiological correlates."

(Gennarelli et al, 1981)

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

John A. Jane, M.D., Ph.D., F.R.C.S.(C), Osward 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

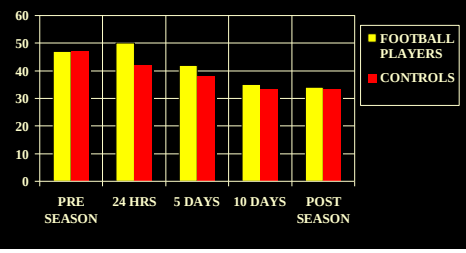
## SLAM

*Sports as a Laboratory Assessment Model*

## University of Virginia Football Study

| | |
|---|---|
| **TOTAL** (10 Universities) | 2350 Players |
| Post-injury Protocol: | |
| Concussions | 195 |
| Orthopedic Injuries | 59 |
| Student Controls | 48 |

## TRAIL MAKING B
## Pre-Season and Post-Injury Performances
(Timed in Seconds)



## 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

Standardized Assessment of Concussions (SAC)

(McCrea, Kelly, Kluge, Ackley, and Randolph, 1997)

## 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)

## *CRI Sample Report*

The light is "red"

Followup
Report Date: 11/28/1999 18:10:37
Baseline Test Date: 11/03/1999 00:22:49
Trauma Test Date: 11/25/1999 13:23:32

**Protocol Validity**

This is a valid protocol.

**Findings**

The light is "RED"

On one test, John Doe's current score was significantly lower than his baseline score stored in our files. These findings are consistent with lowered cognitive functioning due to the concussion of 11/23/1999 00:00:00.

Experts guidelines recommend that players not be allowed to return to competition until all post-concussive symptoms have resolved.

## Critical Issues in Sports Mild Head Injury

- 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

- Scientific evidence based conclusions are limited.
- 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
    - Acute and Chronic Cognitive Deficits
    - Severe Emotional Problems
    - Chronic Traumatic Encephalopathy
- Carry out the mission/goal
  - Return to game and play well
  - Avoid being lost for future games

## 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.

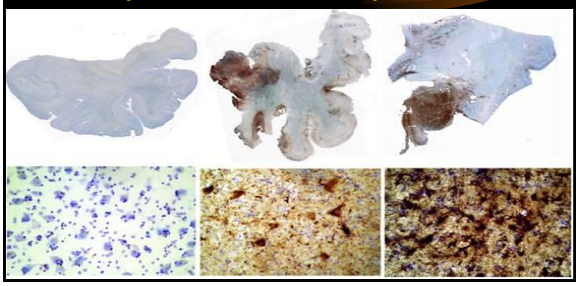
LOW-MOD INCIDENCE – HIGH POTENTIAL CHRONIC IMPACT

McKee /Cantu, 2009; Omalu,/DeKosky 2005. Evidence Level 3 & 4

## CHRONIC TRAUMATIC ENCEPHALOPATHY

Tau Protein: Amygdala (McKee et al. 2009)

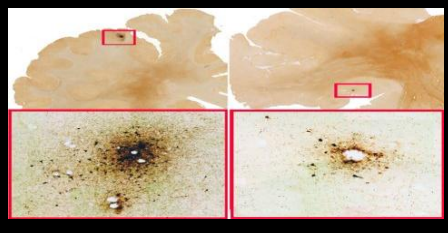
Healthy Brain Football Player Boxer



## CHRONIC TRAUMATIC ENCEPHALOPATHY

Tau Protein (McKee et al. 2009)

**Early evidence of CTE in a recently deceased 18-year-old boy who suffered multiple concussions in high school football.**



## 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 (being revised)

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

- 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.

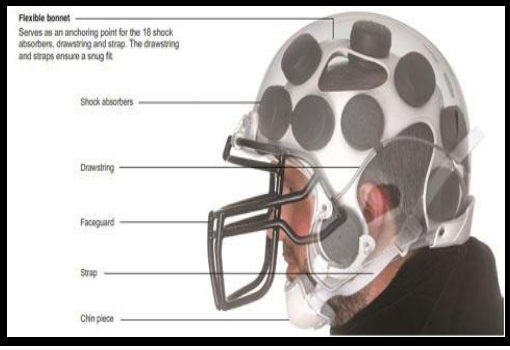
## Conservative Approach to Return to Play and Practice

- 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.
- Recommend full neurological and neurocognitive examination when considered necessary by the team physician following multiple concussions. Trigger is significant neurologic symptoms.

## PREVENTION AND REDUCTION OF RISK IN SPORTS

- Education of the athlete and public
- Rules to protect the brain
- Equipment to protect the brain
- Reduction of contact in practice

## *Xenith Sports Helmet*

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