HAI Group.

TRAUMATIC BRAIN INJURY

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1. Which best describes a Traumatic Brain Injury:

a. Getting KO'd by Conor McGregor
b. Skull Fracture
c. Slipping on ice and smacking your head
d. Concussion

2. Which best describes your occupation:

a. Defense Counsel
b. General Counsel
c. Claims Professional
d. Other

Why Concussion?

CDC TBI Surveillance Report 2016/17

- TBI diagnosed in 2.9 million emergency department visits, hospitalizations, and deaths in 2014.
- 225,000 people are hospitalized and survive.
- 60,000 people die.
- Adults aged ≥75 years accounted for the highest proportion of all TBI-related hospitalizations and deaths.
- Unintentional falls account for most TBI hospitalizations.

Martland - 1928

PUNCH DRUNK*

HARRISON S. MARTLAND, M.D.
NEWARK, N. J.

For some time fight fans and promoters have recognized a peculiar condition occurring among prize fighters which, in ring parlance, they speak of as "punch drunk." Fighters in whom the early symptoms are well recognized are said by the fans to be "cuckoo," "goofy," "cutting paper dolls," or "slug nutty."

opinion that in punch drunk there is a very definite brain injury due to single or repeated blows on the head or jaw which cause multiple concussion hemorrhages in the deeper portions of the cerebrum. Such hemorrhages are very apt to occur in or near the corpora striata, in the corona radiata but almost never in the cerebral cortex or below the tentorium cerebelli. These hemorrhages are later replaced by a gliosis or a degenerative progressive lesion in the areas involved. Therefore, in late stages the symptoms often mimic those seen in diseases characterized by the parkinsonian syndrome. I realize that this theory, while alluring, is

- First discovered in 1928 in NJ boxers published in JAMA
- Found in 17% of living professional boxers in England, named CTE in 1969

Mike Webster

- Mike Webster (March 18, 1952 – September 24, 2002) played center in the NFL from1974 to 1990 w ith the Pittsburgh Steelers and Kansas City Chiefs. Webster anchored the Steelers' offensive line from 1974 to 1979 and is considered by some as the best center in NFL history.

Omalu et al 2005:

Neurosurgery. 2005 Jul;57(1):128-34; discussion 128-34.

Chronic traumatic encephalopathy in a National Football League player.

Omalu BI[1], DeKosky ST, Minster RL, Kamboh MI, Hamilton RL, Wecht CH.

CONCLUSION:
This case highlights potential long-term neurodegenerative outcomes in retired professional National Football League players subjected to repeated mild traumatic brain injury. The prevalence and pathoetiological mechanisms of these possible adverse long-term outcomes and their relation to duration of years of playing football have not been sufficiently studied. We recommend comprehensive clinical and forensic approaches to understand and further elucidate this emergent professional sport hazard.

Zackery Lystedt

- In 2006, 13 year old Zackery Lystedt collapsed from a traumatic brain injury when he was allowed back in a game just 15 minutes after suffering a concussion.
- He spent the next 3 months in a coma. It took 3 years before he could stand with assistance.

What is Concussion?

What is a concussion?

- "A traumatic brain injury induced by biomechanical forces"
- Subset of mild TBI

Common features

1. Caused by direct or indirect blow to head or body with force transmitted to the head
2. Short-lived impairment of neurologic function that resolves spontaneously
3. Symptoms may appear immediately, or develop over hours to days after the impact.
4. Signs and symptoms are from functional disturbance, not structural injury (no changes on standard neuroimaging)
5. Resolution typically follows a sequential course. However, in some cases, symptoms may be prolonged.
6. Symptoms can't be explained by something else
7. **All concussions are serious**

Myths about concussions

- **If you don't "black out" it's not a concussion**
  - LOC occurs in fewer than 10% of all concussions

- **Only football players get concussions**
  - Anyone can get a concussion, in any sport or activity

- **If your CT scan is normal, it's not a concussion**
  - Concussions DO NOT show up on CT or MRI

Question 1: True or false?

Most concussions occur during sports

1. True
2. False

Image via: https://www.dublinschool.org/boys-lacrosse

False

- >50% NOT related to organized sports
- In contact sports, rates of overall injury and concussion increase with age and pubertal maturation status

Image via: https://www.aboutkidshealth.ca/concussion

Epidemiology

- 1.1-1.9 million reported concussions per year in kids ≤ 18 yo
- In last 10 years ED visits for concussion increased >200%!
- 2.2 x higher incidence in girls than boys in comparable sports
- Repeat concussion rates have decreased in the past 4 years

Image via www.pediatricsassociates.com

How do we diagnose a concussion?

- ***Concussion is still a clinical diagnosis***
  - *Diagnosed by history and physical examination*
    - History of a hit to the head
    - Followed by typical signs/symptoms
    - Other causes of symptoms have been ruled out
      - By physical examination +/- CT or MRI

Signs and symptoms

PHYSICAL
Headache
Dizziness
Nausea
Vomiting
Balance problems
Visual problems
Fatigue
Sensitive to light
Sensitive to noise
Dazed, stunned
LOC
Tonic posturing
Convulsive movements

COGNITIVE
Feeling "foggy"
Feeling slow
Poor concentration
Poor memory
Repeats questions
Answers questions slowly
Confused about recent events

EMOTIONAL
Irritable
Sad
Emotional
Nervous

SLEEP
Drowsy
Sleeping more
Sleeping less
Can't fall asleep

Signs and symptoms

- May not be noticed until days or weeks after the injury

- **Headache**
  - Most frequently reported symptom
  - Occurs in 75% of concussions

- **Loss of Consciousness**
- Occurs in <10% of concussions
- Does not predict injury severity OR length of recovery

Clinical evaluation

- **History**
  - Mechanism of injury
  - Current symptoms (**PCSS – post-concussion symptom scale**)

  - Past medical history:
    - Prior head injuries
      - how long ago ?
      - length of recovery ?
    - Migraines
    - Learning disorders
    - Neuro/psych disorders (esp. anxiety)

PCSS:
Post Concussion Symptom Scale

- Likert scale for list of 13-22 symptoms
- Converts “yes/no” to multiple choice
- Assesses symptom severity
- Allows for following progress over time

Please rate your symptoms based on how much you have felt in the last 24 hours.

	None			Moderate			Severe
Headache	0	1	2	3	4	5	6
Nausea	0	1	2	3	4	5	6
Vomiting	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Numbness or tingling	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sleeping more than usual	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling as if “in a fog”	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
More emotional than usual	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervousness	0	1	2	3	4	5	6
Fatigue	0	1	2	3	4	5	6
Sleeping less than usual	0	1	2	3	4	5	6
Visual problems	0	1	2	3	4	5	6

Pathophysiology

Disruptive stretching of neuronal cell membranes and axons

Complex cascade of ionic, metabolic and pathophysiological events

Glutamate, Ca^{2+}, K^{+}, Na^{+} dysregulation

Low metabolic state
↓ conduction velocity through neurons

↓ intracellular ATP
↓ cerebral blood flow

Clinical evaluation

- **Cognitive exam**
  - Mini-mental status exam
    - Orientation
    - Memory
      - Immediate and delayed for 3 words
        - Remote (recent news events)
    - Concentration/attention
      - Digits, months, days in reverse
  - SCAT-5 (from Berlin guidelines)

COGNITIVE & PHYSICAL EVALUATION

4 **Cognitive assessment**
Standardized Assessment of Concussion (SAC)*

Orientation (1 point for each correct answer)

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1
Orientation score		of 5

Immediate memory

List	Trial 1		Trial 2		Trial 3		Alternative word list		
elbow	0	1	0	1	0	1	candle	baby	finger
apple	0	1	0	1	0	1	paper	monkey	penny
carpet	0	1	0	1	0	1	sugar	perfume	blanket
saddle	0	1	0	1	0	1	sandwich	sunset	lemon
bubble	0	1	0	1	0	1	wagon	iron	insect
Total									
Immediate memory score total									of 15

Concentration: Digits Backward

List	Trial 1		Alternative digit list		
4-9-3	0	1	6-2-9	5-2-6	4-1-5
3-8-1-4	0	1	3-2-7-9	1-7-9-5	4-9-6-8
6-2-9-7-1	0	1	1-5-2-8-6	3-8-5-2-7	6-1-8-4-3
7-1-8-4-6-2	0	1	5-3-9-1-4-8	8-3-1-9-6-4	7-2-4-8-5-6
Total of 4					

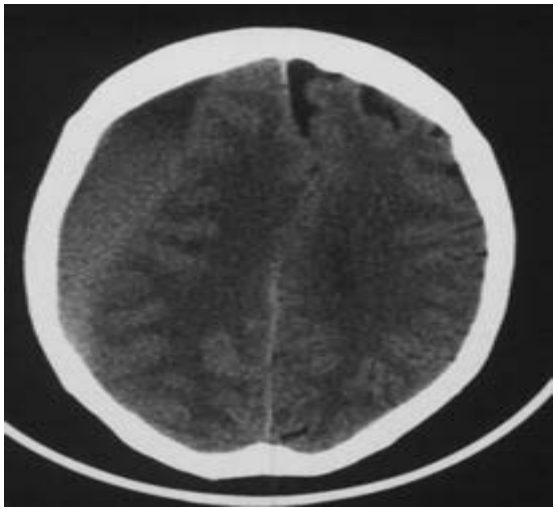
Concentration: Month in Reverse Order (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
Concentration score		of 5

Neuroimaging

- Imaging studies (CT, MRI) are almost always normal
  - Concussions do not show up on clinical MRI or CT scans

- **Imaging is indicated if structural injury is suspected:**
  - Loss of consciousness >30 seconds
  - severe headache
  - seizures
  - focal neurologic findings on exam
  - repeated emesis (more than 2x)
  - significant drowsiness or difficulty awakening
  - slurred speech
  - poor orientation to person, place, or time
  - neck pain (cervical spine XRs +/- CT)
  - significant irritability
  - worsening symptoms



Neuropsychological (NP) testing

- Provides semi-objective measure of brain function
- ***Not necessary for all concussions***
- Consider NP testing:
  - To identify deficits that may interfere w/ school or sport
  - If there is concern that patient is not being truthful about symptoms
- Most helpful when there is a baseline for comparison

Management

- **Physical rest**
  - *During acute period (24-48 hrs)*
    - Physical exertion may worsen symptoms and prolong recovery
    - No sports, PE, recess
    - No weight training or cardiovascular training
  - *After the acute period*, *aerobic exercise can facilitate recovery*
    - Sub-symptom threshold exercise training
    - Can gradually progress activity as long as it does not worsen symptoms
  - *Until complete recovery*
    - Avoid high risk for additional head trauma (e.g. contact sports)

Management

- **Cognitive rest**
  - Symptoms often worsen with cognitive activities
  - ***Many patients will need school/academic accommodations***
    - Frequent rest breaks during school day or partial days
    - Reduced workloads
    - Extra time for assignments and tests
  - ***Screens: Only need to avoid screen time if it exacerbates symptoms***
    - Typically reading on a screen and games will exacerbate
    - But watching videos, photos usually well-tolerated

Typical concussion recovery times

- There is no way to predict how long symptoms will last.
- Most concussions resolve within 4 weeks
- ***10-25% of concussions*** *result in prolonged recovery (>4 wks)*

Post-concussion syndrome (PCS)

- ***PCS is a term that is being phased out.***

- New terminology:
  - "Prolonged recovery after concussion"
  - "Persisting symptoms after concussion"

- Persisting symptoms occur in about 10-25% of concussions

- Predictors of slower recovery:
  - Higher symptom load in first few days after injury
  - History of anxiety
  - Adolescent females

Treatment of persisting symptoms

- **Treatment is symptom-focused**
  - Vestibular/visual therapy
    - For persistent dizziness, balance deficits, visual dysfunction
  - Physical therapy
    - For neck muscle strain (massage, stretching)
  - Sub-symptom threshold exercise training
    - For fatigue, headaches, dizziness
  - Academic accommodations
    - For cognitive difficulties
  - Clinical psychologist (cognitive-behavioral therapy (CBT))
    - For situational stress, anxiety, depression

Interventions for cognitive symptoms

- Cognitive remediation
  - Tutoring or “coaching” for executive skill development, study skills, organizational strategies, and metacognition
  - Be wary of programs or games claiming to “improve” cognitive abilities
- Psychostimulants for inattention
- Patience
  - Recovery can be slow but gradual
  - Multidisciplinary approach to managing complicating factors
  - Reassure when there’s trend toward improvement

Adapted from Ladish, 2015

Second-Impact Syndrome

1st concussion (ongoing symptoms)

Cerebral Edema

Possible herniation and death

Second impact syndrome

- Extremely rare
  - Fewer than 25 cases reported
- Children and adolescents at highest risk
  - All reported cases are in athletes under age 20

3. Concussion is diagnosed by:

a. Loss of consciousness
b. Nausea
c. Vestibular examination
d. Verbal response

4. Most concussions resolve:

a. 24 hours
b. 72 hours
c. 7-14 days
d. Never

5. Chronic Traumatic Encephalopathy:

a. Is transmitted by mosquitos
b. Only affects football players
c. Causes cognitive decline
d. Can be diagnosed with a blood test