Disclosures

- None
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2.8 Million Traumatic Brain Injuries a Year
in the United States

- 56,000 Die
- 282,000 Hospitalized
- 2.5 million Treated and released from ER

Up to 15% of those diagnosed with a mild TBI may have long-term problems.

Visit www.brainline.org for more information on preventing, treating, and living with traumatic brain injury.
Leading Causes of Traumatic Brain Injury in the United States

- 47% Falls
- 15% Struck by or Against
- 14% Traffic Incidents
- 9% Assault
- 8% Unknown
- 7% Other


Annals of Internal Medicine

In the Clinic

Concussion

sidered a form of mTBI. Although these injuries are often sports- and recreation-related, many also occur with common, everyday activities, such as falls and motor vehicle accidents (4). The importance of the primary care physician in the timely diagnosis and optimal management of concussions cannot be overstated.

Take-home points: Active recovery for concussion

- Majority of adults recover in 2 weeks; kids 4 weeks
- 1-2 days of symptom-limited physical and cognitive rest then gradually increase activity, avoiding symptom exacerbation
- Gradual return to learn / work with accommodations
- Gradual return to noncontact physical activity as tolerated
- Return to full (contact) play once asymptomatic
- PPCS: Identify and treat concussion based on profile
Concussion definition

- mTBI: mild traumatic brain injury
- Blow to head, neck, body → neurological symptoms within 48 hours
- May or may not include loss of consciousness
- Cannot be explained by drug, alcohol, medication use, or other injuries or comorbidities


Concussion recovery

- Typical time to resolve
  - Adults: 10-14 days
  - Kids: Up to 4 weeks
- CDC recommendation:
  - Counsel patients and families that most patients with concussion do not have significant difficulties that last more than 1-3 months post injury.

Case #1

- 27 y/o software engineer presenting with concussion.
- 5 days ago fell while skiing, helmeted. No LOC but immediate headache.
- Friends took her to local ED, no head CT needed. Advised to rest and to follow up the following week in primary care.
- Has not returned to work or exercise.
- Mild-moderate headache is worse with bright light and screens. Feels foggy and tired.
- Medications: none
- PMHx: none (incl no h/o concussion, HA, ADHD, psych)
- SHx: work is understanding of her injury. No drug use. 1-2 alcoholic beverages/week.

Office evaluation of concussion should routinely include all of the following except

A. Symptom assessment
B. Memory
C. Gait / balance
D. Neurological exam
E. Cervical spine exam
F. MRI brain

Purpose of concussion evaluation

1. Rule out red flags
   1. Intracranial hemorrhage
   2. Cervical injury
2. Determine
   1. Is this a concussion?
   2. Risk factors for prolonged recovery

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Self-reported symptom assessment

Symptom severity score = 46  
Clusters: headache, emotional

Cervical spine and Neurological exam with balance: Balance Error Scoring System (BESS)

Utility of brain MRI in concussion

- 3T MRI more sensitive to micro hemorrhage than CT
- In research setting, mTBI patients with normal head CT but abnormal acute brain MRI had poorer 3-month outcomes compared to those with normal imaging.
- Despite this data, further investigation needed prior to recommending brain MRI for routine clinical care.
- Routine brain MRI *not* recommended by American Academy of Neurology nor the American Medical Society for Sports Medicine

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Case #1
27 y/o woman 5 days s/p fall while skiing with concussion. Software engineer. Has been off work since injury.

- Symptom severity score moderately high (46)
- Clustering in headache, light sensitivity, mood
- Vital signs normal
- Neck exam normal
- Neurological exam non-focal
- Headache and head pressure increased with horizontal and vertical saccades
- Near point convergence < 10 cm
How would you treat this patient?

A. Order urgent head CT to rule out subtle post traumatic bleed, return to clinic after CT.
B. Order brain MRI to evaluate for post traumatic microhemorrhage, return to clinic after MRI.
C. Give advice on gradual return to cognitive and physical activity now (no contact sports), follow up 1 week.
D. Rest from cognitive and physical activity until symptom free, follow up 1 week.

Concussion treatment

- Reassurance
- Cognitive rest
- Physical rest
- Medication: acetaminophen or NSAIDs* prn headache
- Sleep
- Nutrition
- Mood

*Avoid NSAIDs acutely due to theoretical risk of intracranial hemorrhage.
Why cognitive rest?

- Concussion = energy crisis in the brain that needs rest to recover
- Animal studies: starting physical activity immediately post TBI delays cognitive recovery (Griesbach GS et al. Brain Res 2004.)
- Kids who returned to school early post concussion have been shown to have prolonged recovery (Brown NJ et al. Pediatrics. 2014.)
- Cognitive rest post injury → faster recovery times (Taubman B et al. Child Neurol. 2016.)

History of rest until symptom-free

- Derived from sports literature
- 2nd head injury prior to resolution of 1st could lead to catastrophic brain injury (evidence: animal models and second impact syndrome)
- Return to physical activity within 7-10 days associated with high risk of repeat concussion in NCAA football players (Guskiewicz KM et al. JAMA 2003.)
But too much rest may be harmful

- Concussion patients age 11-22 who rested 2 days vs 5 days: those with longer rest period had more symptoms and slower resolution of symptoms (Thomas DG et al. Pediatrics. 2015.)
- Removing a child from school for extended time may cause anxiety about returning to school (Ponsford J et al. Neuropsychology. 2012.)
- In concussion patients age 13-18 randomized to stretching vs progressive subsymptom threshold aerobic exercise 5 days post injury, those who did aerobic exercise recovered 4 days faster (13 days vs 17 days, p=0.009) (Leddy JJ et al. Jama Pediatrics. 2019.)

Berlin consensus 2017 on rest

- “There is currently insufficient evidence that prescribing complete rest achieves these objectives.” (those of mitigating symptoms and/or promoting recovery by minimizing brain energy demands post concussion)
- “After a brief period of rest …24-48 hours after injury, patients can be encouraged to become gradually and progressively more active while staying below their cognitive and physical symptom-exacerbation thresholds…”
- “The exact amount and duration of rest is not yet well defined in the literature and requires further study.”

How much rest after concussion?

1-2 days


Concussion care 2019: Active recovery

- Gradual progression back to regular activity as tolerated
- 2-point rule
  - Ok to gradually return back to cognitive and noncontact physical activity as long as the activity does not make symptoms worse by 2 points (on a 10-point scale)*
Return to learn / work progression

No school / work. OK to do light reading, little bit TV, drawing, cooking as long as doesn’t worsen symptoms.

15 min cognitive activity at a time.

30 min cognitive work at a time until can do 1-2 hours.

Return to ½ day of work / school.

Return to full day of school.

http://www.chop.edu/service/concussion-care-for-kids/returning-to-school.html

Return to play progression

After 24-48 hours

Daily activities that don’t provoke symptoms

Light aerobic activity

Sport specific activity

Non contact training

Full contact practice

Game play
Diet or supplements to expedite recovery?

- Diet: literature is sparse
- No strong evidence for use of supplements in concussion management at this time.
  - Promising results in animal studies and a few human studies on **traumatic brain injury** in recovery or prevention of concussion:
    - Omega-3 fatty acids
    - Curcumin
    - Resveratrol
    - Melatonin
    - Creatine
    - S. baicalensis
    - Vitamins C, D, E


Case #1: When can she return to skiing?

No concussion symptoms at rest + 100% school (work) without accommodations + No symptoms with RTP protocol = Return to sport
How would you treat this patient?

A. Order urgent head CT to rule out subtle post traumatic bleed, return to clinic after CT.
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C. Give advice on gradual return to cognitive and physical activity now (no contact sports), follow up 1 week.
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Case #2

- 44 y/o mother of 3 with history of ADHD, anxiety, depression
- Fell while roller-skating at rink 3 months prior to presentation, hit back of head. No helmet. May have had 1 second LOC. No amnesia.
- Since then: fatigue, foggy, dizzy
  - Needs to rest 90% of the time in bed
  - Overwhelmed around her kids, has to take breaks from being around them
  - Unable to drive
  - Short term memory trouble
Case #2: Symptoms 3 months post injury

Symptom severity score = 68
Clusters: headache, cognitive, mood, sleep

Persistent post concussion symptoms (PPCS)

*Emerging concept of concussion clinical profiles*

- Evaluate systems
  - Autonomic
  - Vestibulo-ocular
  - Cognitive
  - Emotional
- To develop an individualized, targeted management plan

Autonomic

- Orthostatic vital signs
- Elevated resting heart rate
- Large but reactive pupils

School / work: frequent breaks, 2-point rule, avoid or limit testing initially, allow use of sunglasses and/or ear plugs.
Allow light aerobic activity (2-point rule)
(PT for graduated exercise protocol)
(Medication)

Vestibulo-ocular

- Symptoms with:
  - Vertical saccades
  - Horizontal saccades
  - Near point convergence
- Abnormal balance

Vertical saccade deficit: avoid note-taking, use pre-printed notes
Horizontal saccade deficit: use larger font, audio books
Convergence deficit: larger font, audio lectures/ books
Vestibular + balance exercises either at home or with PT

Adapted with permission from slides by Matthew Grady, MD
Cognitive

Symptom report
Mental status evaluation (SAC, MMSE)

Rehab = gradual return to work or school
2 point rule
Accommodations based on other deficits (Medication)

Emotional

Symptoms +/- PHQ9 +/- GAD7

Clear plan for return to school / work
Empathy (CBT) (Medication)

Adapted with permission from slides by Matthew Grady, MD
Case #2 treatment plan

VOMS (+). mBESS score abnormal.

Diagnosed with PPCS, vestibulocular dysfunction, r/o anemia, hypothyroidism

1. Ordered TSH, CBC (normal)
2. Referred to neuro-ophthalmologist for vestibulocular rehab
3. Prescribed subthreshold aerobic activity on stationary bike that she ultimately started under supervision of physical therapist
4. Sleep hygiene
5. Healthy diet, hydration
6. Ongoing psychiatric care with pre-injury psychiatrist

Case #2 update: 6 months later

Symptom severity score = 22
Case #3

SJ is a 23 y/o semi pro rugby player presenting to you 6 months after her 5th concussion sustained when she was elbowed in the head during a game. Following her most recent injury she had 3 months of headache and light sensitivity. She missed one month of work but has now returned to full time work without issue. She now has no concussion symptoms with work or with non contact physical activity. She would like to know if and when she can return to rugby.

Would you clear SJ to return to rugby?

A. Yes, as she is now symptom free with work and physical activity.
B. Yes, if the benefits of her playing seem to outweigh her risks of repeat concussion and longer term consequences.
C. No, due to her increased risk for repeat concussion in the short term.
D. No, due to the risk that repeat injury might cause her to develop chronic traumatic encephalopathy in the long term.
Repeat concussion: **short term** risks

- Increased risk of
  - Repeat injury
  - More severe symptoms
  - Longer duration of symptoms
  - Interruption of school / work / physical activity

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Concussion and **long term risks**

- Traumatic brain injury (TBI) and neurodegenerative disease
  - Multiple studies have shown TBI increases one’s risk for neurodegenerative disease *(Wilson L et al. The chronic and evolving neurological consequences of traumatic brain injury. Lancet Neurol. 2017 Oct;16(10):813-825.)*
  - Sport-related TBI and relationship to neurodegenerative disease a recent focus
Chronic Traumatic Encephalopathy (CTE)

- Originally thought to be exclusive to boxers: “punch drunk”
- Now described in athletes, military personnel, survivors of intimate partner violence
- Pathologic diagnosis made at autopsy: tau protein deposition in specific pattern
- Chronic, progressive neurodegenerative syndrome
  - Behavioral changes: depression, aggression, impulsivity
  - Parkinsonism
  - Dysarthria
  - Cognitive deficits


What are the chances SJ will develop CTE?

- Difficult to draw causality between subconcussive blows + concussion and CTE
- However, no reports of CTE without preceding traumatic brain injury
- Concerning association between participation in collision sports and long term neuropsychiatric problems
- We do not know the dose-response relationship between number of concussions and/or subconcussive blows and likelihood of CTE.
- Need prospective, longitudinal data
My approach to this conversation

- **Yellow flags**
  - Multiple concussions
  - PPCS
  - Higher symptom burden with each injury
  - Decreased injury threshold
  - Younger age

- **Red flags**
  - Abnormal imaging
  - Ongoing symptoms

Elicit and validate benefits of this sport and all physical activity for this athlete.

Discuss short term risks repeat injury.

Discuss potential long term risks of TBI (modify based on h/o TBI).

Consider lower contact, lower risk sport.

If returning to same sport consider lower risk position or longer time for recovery.

Treat symptoms. Recommend non-contact, low risk sport or exercise.

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Concussion resources

- **UCSF Sports Concussion Program**: concussion@ucsf.edu
- **California Interscholastic Federation** [http://www.cifstate.org/sports-medicine/concussions/index](http://www.cifstate.org/sports-medicine/concussions/index)
- **Consensus statements on concussion in sport, 2017 + 2019.**
  [http://bjsm.bmj.com/content/early/2017/04/26/bjsports-2017-097699](http://bjsm.bmj.com/content/early/2017/04/26/bjsports-2017-097699)
  [https://bjsm.bmj.com/content/53/4/213.long](https://bjsm.bmj.com/content/53/4/213.long) (AMSSM statement)
- **CDC Pediatric mTBI Guidelines**:
  [https://www.cdc.gov/traumaticbraininjury/PediatricmTBIGuideline.html](https://www.cdc.gov/traumaticbraininjury/PediatricmTBIGuideline.html)
- **CDC concussion toolkit for physicians**
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Thank you!
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