You are at the sidelines of a HS football game. The star running back gets clobbered, and doesn't get up for about 30 seconds. As soon as the trainer gets out there he gets up and walks him to the sideline. The trainer states he did not lose consciousness, just had the wind knocked out of him. Coach comes over and asks you to check him out so they can get him back in the game ASAP.

What do you do?
Can you return him to play?

You are seeing a 14 Y/O gymnast who slipped and hit her head last week at a meet. She was dazed for about 15 seconds but had no loss of consciousness. She was seen in the local ED, told she had a grade 1 concussion and would be able to return to active competition after 1 week of rest. She is following up with you to get a note saying she can return to practice.

What do you do?
Would you call this a grade 1 concussion?

You are helping with a summer youth soccer league for kids age 8-12. One of the parents has requested that the rules be changed so that “heading” the ball is not allowed due to the risk of head injury, both acutely and in the long term. They ask you to write a letter of support for their request.

What do you do?
Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. May be caused by a direct blow to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head.

Typically results in the rapid onset of short lived impairment of neurologic function that resolves spontaneously. May result in neuropathological changes but the acute symptoms largely reflect a functional disturbance rather than a structural injury.

Concussion results in a graded set of clinical syndromes that may or may not involve loss of consciousness. Concussion is typically associated with grossly normal structural neuroimaging studies.

For the practicing clinician, perhaps a more useful working definition is a trauma-induced alteration in mental status that may or may not involve LOC.

Twenty percent of traumatic brain injury resulting in loss of consciousness (LOC) occurs during sports activity. Concussions are 6 times more likely to occur in organized sports than in leisure physical activity.

Reported incidence of concussion in high school and college football players is between 4% and 5%. Studies in which players have directly and confidentially reported their symptoms after a blow to the head have revealed much higher rates of concussion, ranging from 15% to 45%.
**Concussion**
- May be associated with a blow to the skull; however, direct impact to the head is not required. In fact, in the laboratory setting, concussion can be achieved more effectively by nonimpact rotation of the head than by a blow to the head.

**Signs and Symptoms**
- LOC
- Amnesia
- Disorientation
- Dazed
- Confused
- Emotionality
- Poor coordination
- Seizure
- Slow verbal response
- Personality changes
- Headache
- Dizziness
- Nausea or vomiting
- Balance difficulties
- Vision changes
- Photophobia
- Phonophobia
- Concentration difficulties
- Drowsiness
- Depression

**Molecular effects**
- On a molecular level, there is a disruption of neuronal membranes, resulting in a massive efflux of potassium into the extracellular space.

**Molecular effects**
- This results in the calcium dependent release of excitatory amino acids, particularly glutamate, which stimulates further potassium efflux.
- As the concentration of extracellular potassium increases, it triggers neuronal depolarization, which is followed by neuronal suppression.

**Molecular effects**
- Sodium-potassium pumps work to restore homeostasis.
- Given the degree of the induced ion fluxes, a large amount of energy is expended, which increases glycolysis. This results in lactic acid accumulation.

**Molecular effects**
- To meet these increased metabolic demands and remove accumulated lactate, an increase in cerebral blood flow might be expected. However, a decrease in cerebral blood flow has been observed.
Old Classification systems

- Several different systems based on duration of symptoms or loss of consciousness (LOC)
  - Examples: Cantu, American Neurological Society, Colorado, etc
- Return to play guidelines time based, depending on grading of initial concussion

Concussion in Youth

- Lovell 2004*
  - High School athletes ages 13 to 18
  - Preseason Neuropsychological testing
  - 43 with concussion during season had repeat evaluations at average of 36 hours and Day 6 post injury

Memory performance scores

- Baseline: 76
- 36 hours: 79
- Day 6: 83
- P<0.003, P<0.004

Reported symptoms

- Baseline: 0
- 36 hours: 15
- Day 6: 8
- P<0.0001, P<0.000001
**Concussion in Youth**

- By old guidelines, these youth could be returned to play during the game as they were asymptomatic at 15 minutes.
- Study shows concussion effects will continue to progress over at least the next 36 hours.

**Field – 2003**

- 371 college athletes and 183 high school athletes.
- Baseline neuropsychological evaluation.
- 54 sustained concussions and had serial neuropsychological evaluations.

**Concussion in youth**

- 90% of HS and 96% of college injuries were in Football.
- High School mean age was 15.9.
- College mean age was 19.9.
- Matched ages for control group.

**Baseline scores similar in Neuropsych tests**

- At 24 hours, significant differences between concussed and control groups at both levels.
- At day 3, collegiate athletes same as control group, but High School athletes remained significantly delayed.
- Persisted but improving through Day 7.

**Post concussion symptoms**

- Significantly more in High School athletes at Days 1, 3 and 5, but not Day 7.
- Significantly more in college athletes at Days 1 and 3 only.

**Lovell '98**

- 64 HS athletes with concussions (24 controls).
- Baseline, 36 hours, day 4, day 7.
- Significant memory deficits noted at 3 time points on testing compared to baseline.
- Reported symptoms only at 36 hours, no symptoms noted at Day 4 or 7.
- Memory deficits present even without noted symptoms.
Pre-season Neuropsych testing

- At college and professional level, pre-season neuropsychological testing is done on all athletes.
- If they sustain a concussion during the season, they are retested and only when they return to baseline can they be returned to play.

Pre-season Neuropsych testing

- Often computer based, but still need a trained person to administer test.
- Not practical for most high school or recreational sports.

New Classification System

- At the second International Conference on Concussion in Sport, the use of grading systems was abandoned explicitly in favor of classifying concussions as simple or complex.

Classification system

- A simple concussion is one in which the injury resolves without complication in 7 to 10 days.
- A complex concussion is one in which there are persistent symptoms, complications, or prolonged cognitive impairment. Repeated concussions that occur with progressively less force may also fit into this category.

Management

- Each concussion should be managed individually by using multiple means of assessment.
- No player should be returned to play until the symptoms of concussion have resolved completely, both at rest and during exercise.
- Because younger athletes require longer recovery times, more conservative return-to-play decisions should be considered for younger athletes.

Recommendations from 2nd International Conference on Concussion in Sports

- The player should not be allowed to return to play in the current game or practice.
- The player should not be left alone, and frequent assessments should be done.
- Player should be medically evaluated.
- Return to play must follow a medically supervised stepwise process.
Return-to-Play Protocol
Recommended by the 2nd International Conference on Concussion In Sport

- Stepwise level of activity
- Several steps of progressively increasing exertion
- Advance only if asymptomatic
- If symptoms develop, stop activity, go back to previous step for 24 hours

1. No activity / complete rest. When asymptomatic progress to:
2. Light aerobic exercise such as walking or stationary bike, NO resistance training
3. Sport specific exercise (skating in hockey, running in soccer) progressive addition of resistance training
4. Noncontact training drills; progressively increased resistance training
   - Follow-up with provider
5. Full-contact training after medical clearance
6. Game play

www.thinkfirst.ca

- Canadian initiative to educate and improve care
- Great website with evaluation tools and return to play protocol handout
During recovery, an athlete’s academic performance may suffer, and intellectual activity may increase their symptoms. Thus, “cognitive rest” has been recommended for school-aged athletes.

Second Impact Syndrome

- Second-impact syndrome occurs after athletes have sustained a concussion from which they are still symptomatic and receive a second injury to the head.
- This second injury may be minor. Even a blow to the chest or trunk that transmits accelerative forces to the brain can result in second-impact syndrome.
**Second Impact Syndrome**

- Patient rapidly decompensates
- Autoregulatory control over cerebral blood flow is disrupted, causing rapid increase in intracranial pressure
- Widespread anoxic changes and hemiation
- Death

**Second Impact Syndrome**

- Controversial diagnosis
- Even those that question if it exists still agree that patients should not return to play until all symptoms and deficits have resolved
- Only reported under age 21

**Repeat Concussions**

- After a first concussion, a player is at increased risk for additional concussions.
- Those who experience a LOC are 6 times more likely to sustain another concussion
- The risk of recurrent concussion greatest within 7 to 10 days

**Repeat Concussions**

- One study* of High School athletes demonstrated those with a history of two or more previous concussions (more than 6 months prior to study) performed similar on neuropsychological testing as those with an acute injury

* *Mosser / Neurosurgery

**Repeat Concussions – why?**

1. Certain athletes’ styles of play may predispose them to concussion
2. Certain athletes are more susceptible to concussion
3. The age and level of play may expose certain athletes to greater forces than those who do not sustain concussions
4. Players who sustain multiple concussions may simply receive more play time
5. It may be that once an athlete’s brain has sustained a single concussion it becomes more susceptible to injury.
Concussion and Soccer

- Although concussion is a common injury in soccer, it does not seem to occur as a result of purposeful heading of the ball.

Concussion and Soccer

- Although the potential value of headgear in soccer should not be overlooked, it is unclear how much benefit headgear provides, what negative impact it will have on ball control, and whether players will accept it.

Concussion and Soccer

- Perhaps the most effective ways of decreasing the risk of concussion and other head injuries in soccer is to decrease the mass and air pressure of the ball used by smaller, younger players, strictly enforce the rules, and secure and pad goal posts properly.

Case #1

- You are at the sidelines of a HS football game. The star running back gets clobbered, and doesn't get up for about 30 seconds. As soon as the trainer gets out there he gets up and walks him to the sideline. The trainer states he did not lose consciousness, just had the wind knocked out of him. Coach comes over and asks you to check him out so they can get him back in the game ASAP.

  - What do you do?
  - Can you return him to play?

Case #3

- You are helping with a summer youth soccer league for kids age 8-12. One of the parents has requested that the rules be changed so that “heading” the ball is not allowed due to the risk of head injury, both acutely and in the long term. They ask you to write a letter of support for their request.

  - What do you do?
### Summary

- New classification scheme:
  - **Simple** - all symptoms resolve in 7 to 10 days
  - **Complex** - prolonged symptoms / prolonged recovery / repeat concussions

- New Return to Play guidelines
  - Stepwise approach, proceed when asymptomatic
  - Not time based

### Main References