



# Sports Concussions: When is it Safe to Go Back in the Pool?

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# Disclosures

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- **The speaker has no financial interests in any product or device discussed.**
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# Sports Concussions: When is it Safe to Go Back in the Pool?

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- Tracy's Story



# Sports Concussion

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- Definitions and diagnostic criteria
- Epidemiology and pathophysiology
- Sideline Evaluation
- Treatment and management
- Post-concussion symptoms
- Return to school and play
- Role of neuropsychological testing
- Summary



# What is a concussion?

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- Concussion = Mild traumatic brain injury
  - But not the mild head injury we are talking about when we say GCS 13 – 15
- A disruption in normal brain function due to a blow or jolt to the head

*Centers for Disease Control*

- A trauma induced alteration in mental status that may or may not involve loss of consciousness

*American Academy of Neurology*



# What is a concussion?

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- May be caused by a direct blow to the head or elsewhere on the body. You do not have to hit your head!
- Rotational component important
- Rapid onset/short lived impairment in neurologic function.
- Largely a functional, *not* a structural injury!
- Graded set of syndromes (+/- LOC); symptom resolution follows course.
- Neuroimaging studies grossly normal.



# Sports Concussions Epidemiology

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- 1.5 million brain injuries per year in the US ranging from mild to severe
- More than 1 million seek care in ED's
- 75% of all injuries are mild (MTBI)
- 650,000 children each year with MTBI
  - 90% with seemingly mild injuries
  - 325,000 will have a CT scan
  - 90% of these will have a negative CT

# Sports Concussions Epidemiology

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- 20% (300,000) are sports injuries (most 10 – 18 yo)
- 10% of these injuries will require hospitalization
- Up to 1 million injuries occur and are not reported
- 30 million children, 5 – 17 yo participate in organized sports annually in the U.S.

# Sports Concussions Epidemiology



- In the U.S., football, soccer, equestrian events, skiing and baseball are most commonly associated sports
- Injuries (MTBI) are common!

# Sports Concussions Epidemiology



- **Football - Single season:**
  - 20% high school football players
  - 10% college football players
- **Football - Career**
  - 20% high school football players
  - 40% college football players
- **Ice Hockey**
  - 7% of all hockey players will sustain a concussion in a single season of play
  - Ice hockey is the leading cause of sports – related MTBI in Canada

# Sports Concussions Epidemiology



- Recreational sports are also associated with head injuries
- Athletes who sustain concussions in other activities
- Economic, academic and societal costs of all of these injuries not well documented



# Sports Concussions: Common Myths

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- 60% agree . . . *How quickly a person recovers from head injury depends mainly on how hard they work at recovering.*
- 40% agree . . . *Sometimes a second blow to the head can help a person remember things that were forgotten.*
  - **Guilmette & Paglia (2004)**
- Athletes do not report symptoms because, “It is nothing serious.”



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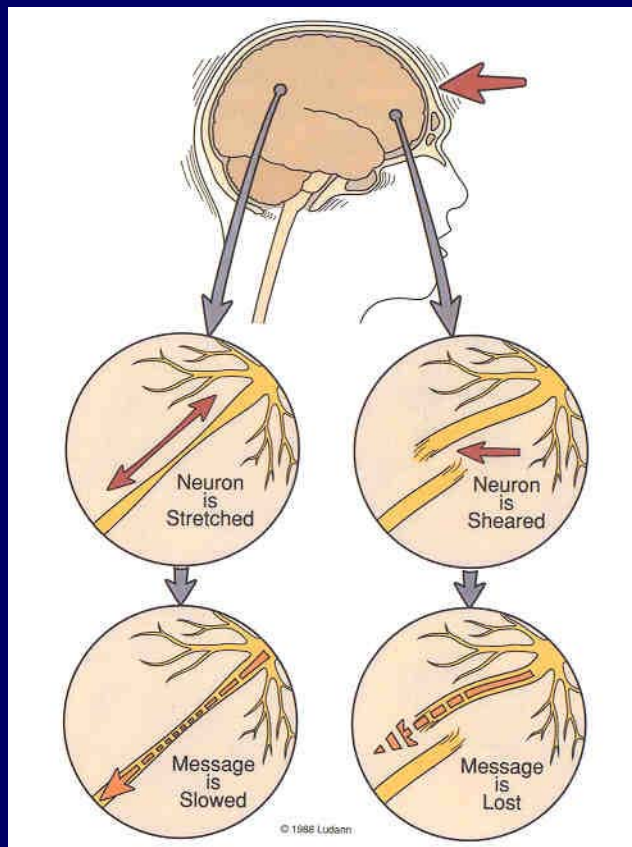
## **Concussion**

*Allan H. Ropper, M.D., and Kenneth C. Gorson, M.D.*

**“Concussion” refers to an immediate and transient loss of consciousness accompanied by a brief period of amnesia after a blow to the head.**

**Considerable confusion persists among physicians and the public regarding concussion and the post-concussion syndrome.**

# Pathophysiology of Injury



- A complex physiological process induced by traumatic biomechanical forces
  - sudden chemical changes
  - stretching and tearing of brain cells
- Structural brain imaging (CT or MRI) is almost always normal
- Still many unanswered questions . . .



# Neurometabolic Cascade

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- Abrupt neuronal depolarization
- Potassium efflux
- Release of excitatory neurotransmitters
- Changes in glucose metabolism
- Altered cerebral blood flow
- The brain goes into an ***ENERGY CRISIS*** that can last up to 7 – 10 days
  - *Giza and Hovda, 2001 (based on animal models of concussion)*



# Sideline Evaluation: Recognizing Concussion

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- Blow or jolt to the head **AND**
- Loss of consciousness **OR**
- Post-traumatic amnesia **OR**
- Dazed or confused **OR**
- Focal neurologic finding **OR**
- Signs and symptoms . . .



# Sideline Evaluation: Signs and Symptoms

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- LOC or amnesia
- Confusion
- Poor coordination
- Slowed responses
- Memory problems
  - Same questions
  - Forget play; opponent
- Emotional; irritable
- Headache
- Feeling 'foggy'
- Dizziness or lightheadedness
- Nausea
- Bothered by light or noise
- Feeling tired or sleepy

*athletes may not report symptoms*



# Sideline Evaluation: Memory

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- Which period is it?
- What team are we playing?
- What's the score?
- How did you get hurt?
  
- Focus on recent memory

# Sideline Evaluation: Cognitive Assessment

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- 3 Word Recall
- Months in Reverse
- 3,4 & 5 Digits in Reverse

*when in doubt – sit 'em out*



# Evaluation of Sports Concussions Seeking Medical Attention

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- *No return to play that day!!!*
- *All athletes who have had a concussion must see a physician and have a neurologic examination before they are allowed to return to play.*
- *Any athlete with a loss of consciousness should be seen that day.*

# Evaluation of Sports Concussions Seeking Medical Attention



- Athletes with an altered LOC or focal exam should be transported with full spinal immobilization.
- Athletes who have had a seizure should be transported by ambulance.
- Athletes with more than a brief LOC should be transported by ambulance.

# Evaluation of Sports Concussions Seeking Medical Attention

- Athletes with a brief LOC but now alert, oriented and a normal exam may go in private vehicle. Will they go?
- Other indications for immediate evaluation:
  - Vomiting
  - Headache – not relieved by acetaminophen or worsening
  - Visual changes, decreasing LOC or confusion



# AAN Criteria for Sports-related Concussion

## *Outdated*

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**Grade 1 Transient Confusion**  
Symptoms resolve in <15 min  
No LOC

**Grade 2 Transient Confusion**  
Symptoms last >15 min  
No LOC

**Grade 3 LOC:** a) brief  
b) prolonged





# Current Prague 2004 Guidelines

(McCrorry et al. 2004)

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- **Simple concussion**

- ✓ LOC < 1 minute
- ✓ resolves in 7-10 days
- ✓ first concussion

- **Complex concussion**

- LOC > 1 minute
- ✓ symptoms last longer than 7 – 10 days
- ✓ history of multiple concussions
- ✓ increasing “concussability”

- **Can't make determination at time of injury**

**No athlete  
returns in the  
current game  
or practice**

# Evaluation of Sports Concussions in the ED or Office



- Detailed H & P, thorough neurologic exam; GCS.
- Other indicators of mental status.
- The goal is to be sure that there is not an intracranial lesion that will need intervention.
- If no imaging is to be done, patient and family need to be given instructions:
  - When to seek care emergently
  - Follow – up
  - *Start* the “return to play” discussion

# Evaluation of Sports Concussions: Who Needs a CT?

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- CT scans are quicker and more available than MRI's
- *Not everyone with a concussion needs imaging; absence of an intracranial injury can be accurately excluded in some patients*
- For the acute evaluation of an injured athlete, CT scans are indicated; MRI may be indicated for follow – up, especially if there are persistent symptoms.



# Evaluation of Sports Concussions: Who Needs a CT? Pediatric Data

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- Risk of CT scans (estimated):
  - 1 lethal malignancy induced per 2,000 CT scans in 1 y.o.
  - 1 lethal malignancy induced per 5,000 CT scans in 10 y.o.
  - Up to 3 times as many nonlethal malignancies

# Evaluation of Sports Concussions: Who Needs a CT?

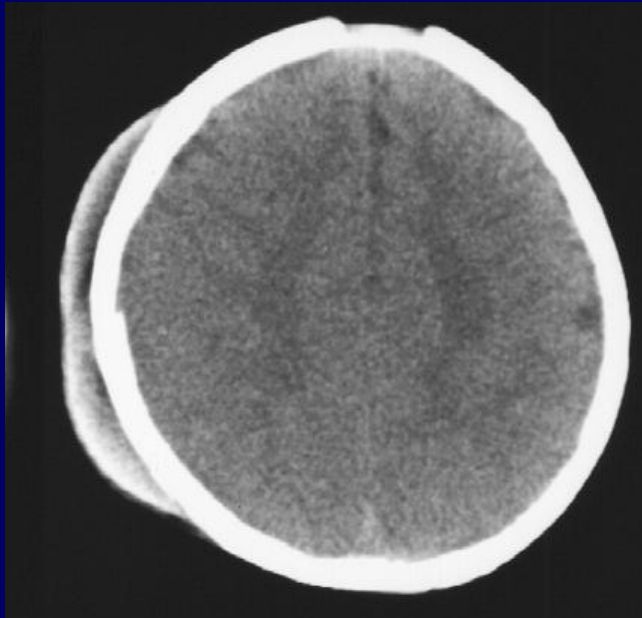
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- CT scan is positive:
  - This is *not* a concussion
  - Intracranial injuries (epidural and subdural hematomas, contusions, cerebral edema, etc.) require *immediate* neurosurgical consultation and hospitalization

# Evaluation of Sports Concussions: Who Needs a CT?

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- CT scan is negative:
  - *This is a concussion!*
  - Diagnosis is based on history and physical examination findings.
  - CT scans not sensitive enough to detect abnormalities in patients with concussions.
- Still may have poor outcome or prolonged symptoms

# Prague Guidelines

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- No one returns to play on the day that they suffered a concussion
- Simple Concussion
  - Symptoms resolve within 7 – 10 days.
- Complex Concussion

# Sports Concussions: Acute Treatment

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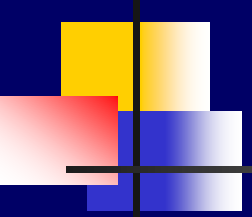


- **Symptom Relief**
- **Return to Play**

# Sports Concussions: Treatment



- **Symptom Relief**
  - Rest
  - Fluids
  - Time
  - Analgesia
    - Acetaminophen
    - Ibuprofen
    - Opioids
  - Nausea and Vomiting
    - Insure hydration
    - Ondansetron
    - Avoid sedating antiemetics



# Common Physical Problems after Concussion

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- Headache
- Dizziness and lightheadedness
- Clumsiness and poor balance
- Fatigue and lack of energy
- Sleep disturbance
- Blurred vision and light sensitivity
- Ringing in the ears

# Common Emotional-Behavioral Problems after Concussion

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- Irritability
- Anxiety
- More extreme moods
- Easily overwhelmed
- Emotional and behavioral outbursts
- Lack of motivation





# Common Cognitive Problems after Concussion

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- Feeling 'dazed' or 'foggy' or 'fuzzy'
- Easily distracted and easily losing track of things
- Trouble doing more than one thing at a time
- Poor learning and memory
- Poor reading comprehension

# Common Cognitive Problems after Concussion

- Word-finding problems, and trouble putting thoughts into words
- Stuttering, slurred or scrambled speech
- Slowed processing
- Poor organization
- Easily confused
- *Poor mental stamina*





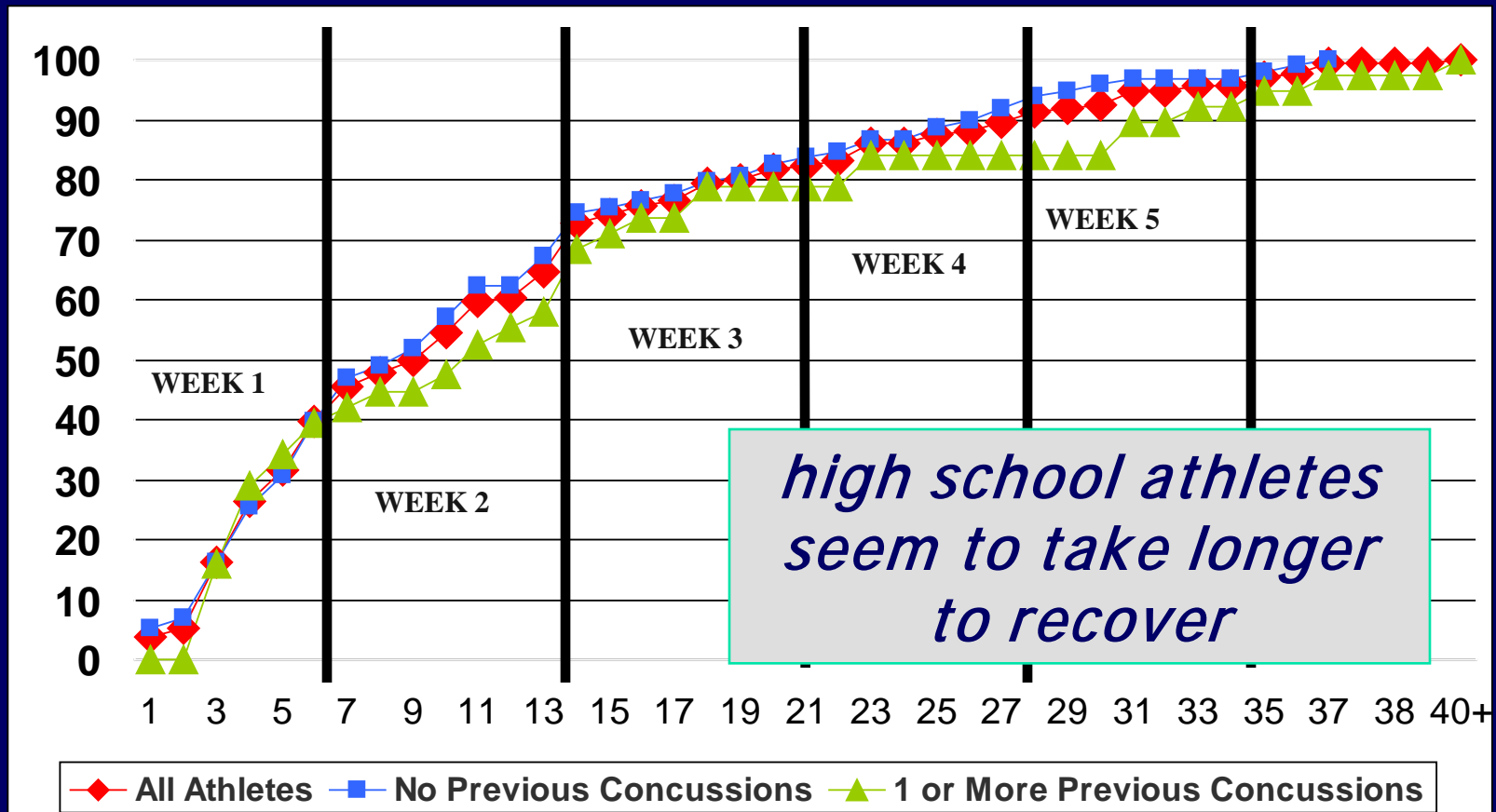
# Recovery from Concussion

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- Full recovery in 7-10 days. . .in most cases
- Risk factors for slow or incomplete recovery
  - prior concussion
  - other brain illness or injury
  - learning disability
  - psychiatric disorder
- Psychological complications
  - depression or anxiety
  - loss of self-confidence

# Recovery From Sports Concussion

## How Long Does it Take on ImPACT?



N=134 High School athletes

Collins et al., 2006, Neurosurgery



## While symptomatic. . .

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- Avoid re-injury (organized sports, gym class, recess, recreational activities)
- Avoid physical and mental overexertion
- Early education improves outcome—just knowing what to expect can reduce anxiety
- Prolonged symptoms – refer to a multidisciplinary concussion management team.

*resist pressure to return to play too soon*

# Case

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- 16 y.o. player runs into line and is tackled.
- Gets up, wobbly, returns to huddle; lines up and collapses.
- Attempts to stand but can't.
- Trainer and coach reach him; he is unresponsive.
- In retrospect, tackled with helmet to helmet hit one week earlier.
- Returned to play the same day when he reassured the trainer and coaches that he was fine.



# Case 2 – Second Impact Syndrome

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- This is a real case from Colorado.
- Athlete developed severe brain swelling; never woke up (declared brain dead two days later).
- Several cases per year in the U.S.
- Seems to be limited to young males (?) from early teens to early twenties.
- Loss of cerebral autoregulation of vascular control.
- Happens when person suffers a second, often seemingly mild blow to the head.
- Prevention is the only treatment!

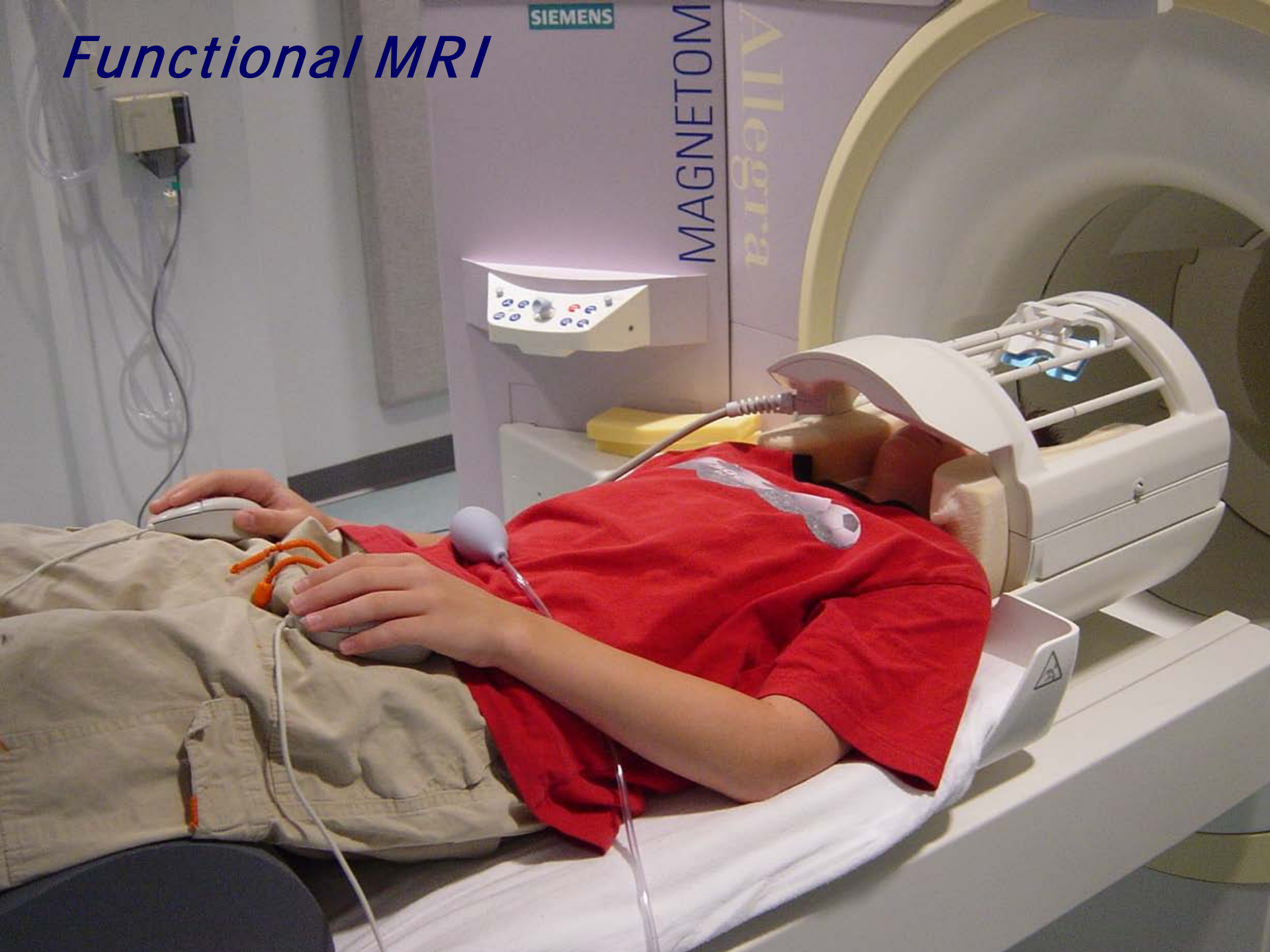


# Post-concussion syndrome (PCS)

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- Symptoms of concussion that can persist for days, weeks, months, or longer
- Symptoms are worsened by . . .
  - ✓ mental effort
  - ✓ environmental stimulation
  - ✓ physical activity
  - ✓ emotional stress
- What do we know about what is going on in the brain during this time?

# *Functional MRI*

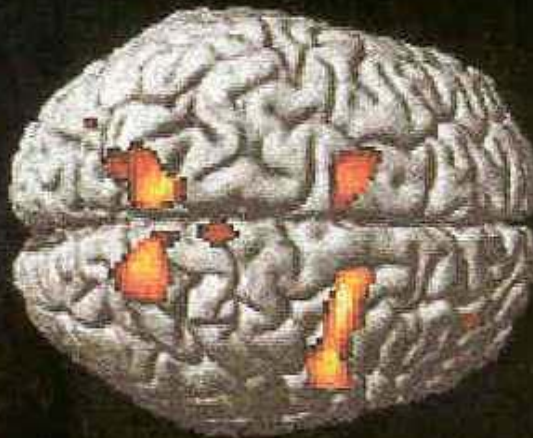
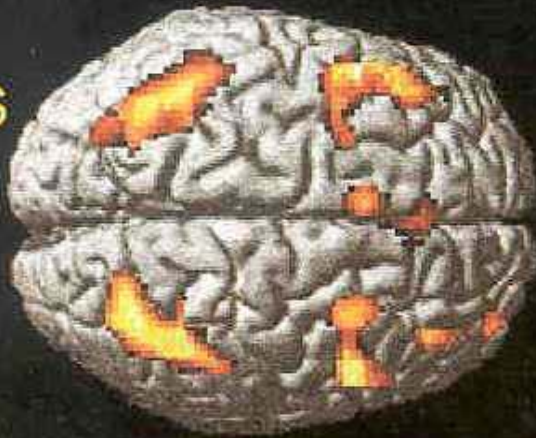


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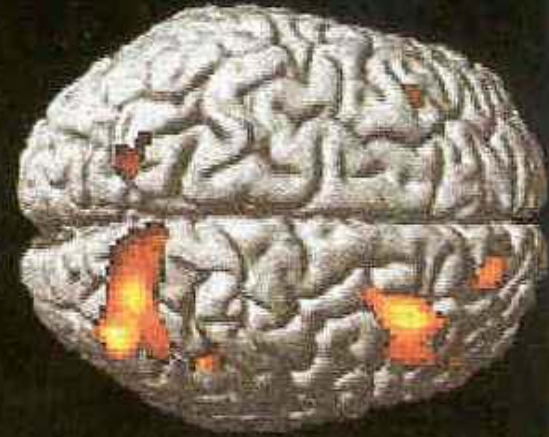
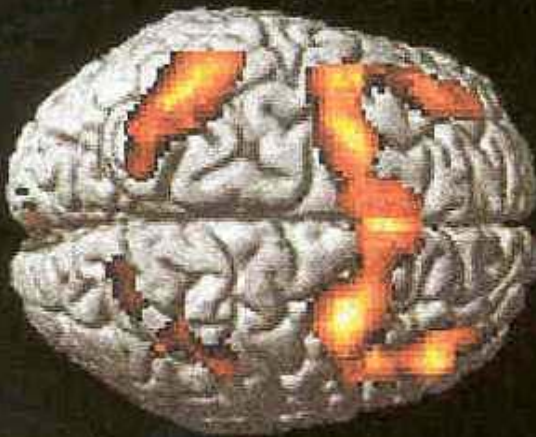
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Controls



MTBI





# Secondary Problems in PCS

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- **Invisible Injury – person looks the same and no medical evidence of injury**
- **Female athletes may be more at risk; more severely affected**
- **Poorly understood by doctors, employers, teachers, coaches, family and friends**
- **Expectation from self and others to 'get over it' and 'get back in the game'**

*Most people think the symptoms of a concussion will only last a few days.*



# Secondary Problems in PCS

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- Symptoms can disrupt academic, social, vocational and recreational activities
- Changes in functioning can lead to changes in self-confidence and identity
- Risk of depression and withdrawal

*many patients think they are just lazy or crazy*



# Concussion in the Classroom

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- **Fatigue - tires easily in class and over the course of the day**
- **Headache and other symptoms worsen with reading or concentration**
- **Trouble doing more than one thing at a time (e.g., listening to the teacher and taking notes)**
- **Frequent visits to the nurse's office**

# Concussion in the Classroom

- Late or incomplete homework
- Easily overloaded and 'shuts down'
- Takes longer to read and learn
- Bothered by bright light in the classroom or noise in the cafeteria
- Emotional outbursts
- Lack of motivation



# Post – Concussion Symptoms



"Mr. Osborne, may I be excused? My brain is full."

- Don't all kids have these problems?



# Principles of Concussion Treatment

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- No cure for concussion, but treatment can help the person feel better and function better while symptomatic; cognitive rest is important
- Early diagnosis and education is critical
- Rest early (7-10 days?) and then gradually increase activity
- Regular follow-up until recovered



# Treatment Strategies—PCS

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- Education and counseling to promote effective coping and adjustment
- Medication
  - Sleep disturbance
  - Headache
  - Irritability or mood swings
  - Fatigue and poor concentration
  - Amantadine – for prolonged symptoms
- Physical and Occupational Therapy for balance, vision and cognitive problems

# Treatment Strategies—PCS

- **Neuropsychological Testing**
  - Clarify cognitive and emotional status
  - Monitor recovery and guide re-entry
  - Screen for tendency to minimize or maximize symptoms
- **Refer for adjunctive treatments**
  - Vision (dry eye, photophobia)
  - Pain
  - Depression





# Prague 2004

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## Cognitive Rest

The concept of 'cognitive rest' was introduced with special reference to a child's need to limit exertion with activities of daily living and to *limit scholastic activities while symptomatic*



# Guidelines for Return to School after Concussion

- Out of school at first if necessary, and then gradual re-entry as tolerated
- Avoid re-injury especially in physical education class and in crowded hallways or stairwells
- Provide academic accommodations
- Communicate and Educate





# Academic Accommodations

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- Rest breaks during school in a quiet location (not always the nurse's office)
- Extra time and quiet location for tests
- Provide student with class notes
- Reduced course and work load
  - Drop unnecessary classes
  - Decrease homework
  - Home tutoring
- Avoid over-stimulation, (e.g., cafeteria or noisy hallways)

*MTBI, not laziness or adolescence, is the problem*



# Return to Play (RTP)

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- Athlete must be symptom free at rest and after physical or mental exertion
- Return to play should follow a medically supervised step-wise progression
  - State of Washington: Lystedt Law, May 2009
- Athlete's history, duration of symptoms, and other factors must be considered



# Return to Play Protocol

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1. Physical/mental rest until asymptomatic
2. Light aerobic exercise (i.e., stationary bike)
3. Sport specific exercise
4. Non-contact training drills (i.e., light resistance training)
5. Full contact training after physician clearance
6. Return to play

- *Guided by healthcare professional*
- *Recurrence of symptoms: return to previous level for at least 24 hours.*



# Multiple Concussions

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- Increasing concussability
- Longer recovery
- Accumulating damage
- Problems can be subtle and hard to detect
- Possible lifelong symptoms and problems

*3 strikes and you're out ? Not necessarily . . .*



# Neuropsychological Testing In Sports Concussion

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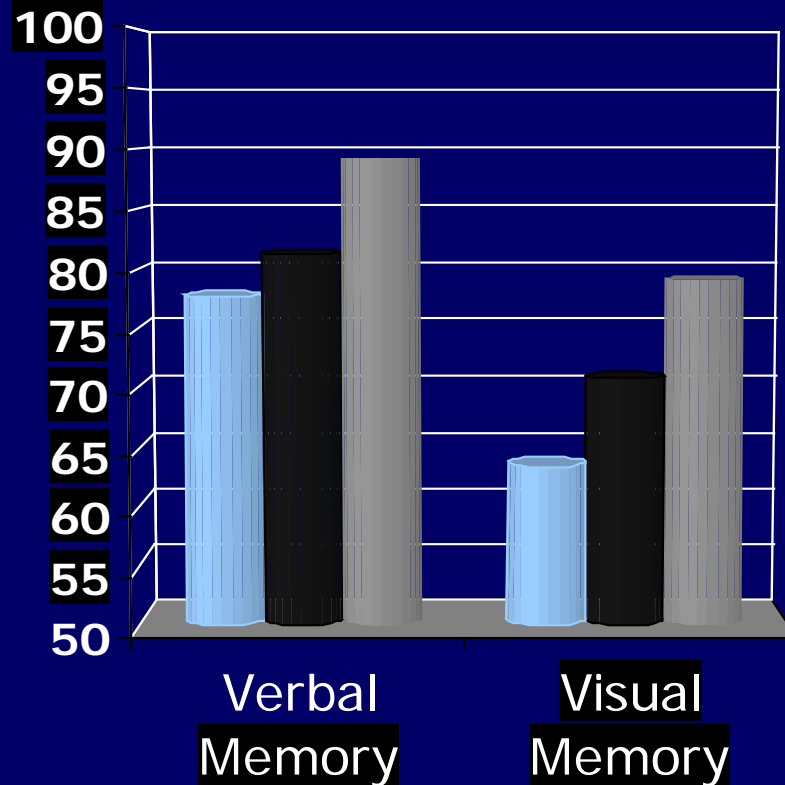
- Computerized tests that measure attention, memory, and processing speed (reaction time)
- Sensitive to effects of concussion
- Tests can be repeated multiple times to monitor recovery
- Ideally, pre-injury baseline testing done for all athletes
- ImPACT, CogSport, HeadMinder

# Unique Contribution of Neurocognitive Testing to Concussion Management

■ Symptomatic ■ Asymptomatic ■ Control

Testing reveals cognitive deficits in asymptomatic athletes at 4 days post-concussion

N=215, MANOVA  
p<.000000  
(Lovell et al., 2004)





# Neuropsychological Testing

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- IS useful for concussion screening and management.
  - IS validated with multiple published studies (individual products and studies vary some).
  - IS NOT a substitute for medical evaluation and treatment.
  - IS NOT a substitute for comprehensive neuropsychological testing when needed.
- *Athletes with complex concussions should be referred to a concussion management specialist*



# Sports Concussions: Summary

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- **MTBI is common in sports, especially in the young.**
- **A direct blow to the head is not necessary**
- **Recognition of concussion and who is at risk is important.**
- **Imaging studies may be used to rule out more severe injuries as needed; they will be normal in patients with MTBI.**
- **Rest is an important part of therapy.**
- **No one is allowed to return to play on the day of an injury – no matter how mild it seems.**



# Sports Concussion: Summary

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- Six step progression for return to play.
- Return to school, work, driving, etc. also must be discussed.
- Patients with symptoms for greater than 7 – 10 days – consider referral to multidisciplinary team
- It is a real injury even if it is *invisible!*
- Prevention is important!



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*Thank you!*