

# Concussions: Identification and Management Protocol

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<https://youtu.be/JlbgVdDES1A>



# Disclosures

- I, Douglas Comeau, nor any family members, have any relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation

# Learning Objectives

- recognize the activities that can result in concussion
- Identify the warning signs of concussion
- Know appropriate return to play progression
- Attempts at prevention
- Future research

# Concussion can happen at any moment



**BOSTON**  
**UNIVERSITY**

Chronicle / Lacy Atkins

# With the Game on the Line



Chronicle / Lacy Atkins

And it can be on the road



Chronicle / Lacy Atkins

# Would you be ready as Team Physician?



Chronicle / Lacy Atkins



The After Effects can change your outlook on life...



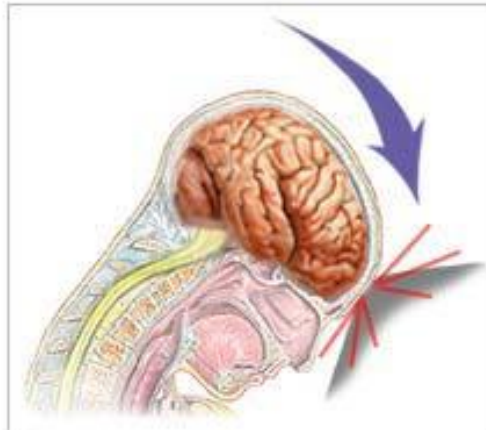
# Statistics

- >300,000 mild traumatic brain injuries occur annually
- Can happen in any sport
- Much higher risk in game situation than in practice

# History of concussion

- 40 years ago concussion first defined by Committee on Head Injury Nomenclature of the Congress of Neurological Surgeons
- “immediate and transient impairment of neural functions, such as an alteration of consciousness, disturbance of vision and equilibrium due to brain stem involvement”
- Over the next thirty years, over sixteen theories and return-to-play guidelines were published

A concussion is a violent jarring or shaking that results in a disturbance of brain function



ADAM.

# Prior Grading Scales

	<b>Grade 1</b>	<b>Grade 2</b>	<b>Grade 3</b>
<b>Cantu</b>	<b>No LOC PTA &lt; 30 “</b>	<b>LOC &lt; 5 “ PTA 30” to 24’</b>	<b>LOC &gt; 5 “ PTA &gt; 24 ‘</b>
<b>Colorado Medical Society</b>	<b>Transient confusion No PTA, no LOC</b>	<b>Transient confusion + PTA , no LOC</b>	<b>LOC</b>
<b>American Academy of Neurologists</b>	<b>Transient confusion No LOC, sx &lt; 15”</b>	<b>Transient confusion No LOC, sx &gt; 15”</b>	<b>LOC</b>

# Prior Grading Scale Return

	<b>Grade 1</b>	<b>Grade 2</b>	<b>Grade 3</b>
<b>Cantu</b>	<b>No sx for 1 week</b>	<b>No sx for 2 weeks</b>	<b>Out 1 mos, No sx for 1 week</b>
<b>Colorado Medical Society</b>	<b>Sx &lt; 20"</b> Same day	<b>No sx for 1 week</b>	<b>Out 1 mos, no sx for 2 weeks</b>
<b>American Academy of Neurologist</b>	<b>Sx &lt; 15"</b> Same day	<b>No sx for 1 week</b>	<b>Brief LOC: 1 week Long LOC: 2 week</b>

# Why didn't it work

- Too many opinions
- Too many controversies
- Need for standard of care

# Concussion Grading Scales

- Abandoned with 2001 Vienna Conference
- Now combined measures of recovery
  - Injury severity
  - Injury prognosis
  - Individual-specific return to play
- Severity graded once all symptoms resolved and athlete has returned to baseline
- Number of concussion signs does not correlate with severity of concussion

# Vienna Conference: 2001

- First international symposium on concussion
- Redefined “sports” concussion
  - traumatically induced transient disturbance of brain function caused by a complex pathophysiologic process.
  - subset of mild traumatic brain injury which is generally self-limited and at the less severe end of the brain injury spectrum.

## CONCUSSION





# Defining the Nature of Concussion

- Direct blow to the head, face, neck with an “impulsive” force transmitted to the head
- Rapid onset of short-lived impairment of neurological function that resolves spontaneously
- Neuro-pathologic changes
  - Acute symptoms are functional instead of structural
- Graded set of clinical syndromes
  - May or may not involve loss of consciousness
  - Resolution typically follows sequelae
- Typically associated with grossly normal structural neuroimaging studies

# Pathophysiology, subtypes

- Clinical Manifestations
  - Confusion, Memory Problems, LOC
- Anatomic Localization
  - Cerebral versus brainstem
- Biomechanical Impact
  - Rotational versus linear force
- Genetic Phenotype
  - Apo-lipoprotein epsilon 4 (ApoE4) positive
- Neuropathological change
  - Structural injury versus none

# Risk Factors

## Concussion

- Good Evidence
  - Previous history
- Fair Evidence
  - Sport
  - Position
  - Playing Style
  - Gender
- Weak Evidence
  - Migraines
  - Genetics

## Prolonged Recovery

- Good Evidence
  - Young age
  - Greater number, severity, duration of symptoms
- Fair Evidence
  - Pre-injury learning disabilities, mood disorders, ADD
  - Migraine

# Second International Conference on Concussion: Prague 2005

- Second International Conference on Concussion and Sport
  - IHF, FIFA, IOC
- Need to update grading system and management
- Definition unchanged
- Nature of Concussion unchanged except for the following
  - Post-concussive symptoms may be prolonged or persistent

# Prague Concussion Classification

- New classification system recommended with Prague Conference
- Simple versus complex
- Did not work
- Updated in Zurich



# 3<sup>rd</sup> International Conference on Concussion: Zurich 2008

- Simple vs. Complex does not work for all
- Treat each concussion individually
- Neuropsychiatric testing for all concussions could be ideal
- Developed SCAT2
- New Research on Exercise Testing for PCS

# Concussion

- Zurich 2013:
  - 4<sup>th</sup> international conference on concussion in sport
  - Held in November 2012
  - Multi-specialty meeting
  - PCSM, Neurosurgery, Neurology, Family Medicine, Pediatrics, Orthopedic Surgery all represented
  - Multiple professional organizations worldwide
  - Evaluate concussion diagnosis, management, and make any necessary changes
  - Developed SCAT3, including a child SCAT3
  - Neuropsychologist recommended but not mandated
  - Vestibular rehab for chronic symptoms
  - Added exercise from chronic symptoms

# Questions on History and Pathology?



# Concussion Defined

- From Sport Concussion Assessment Tool 3<sup>rd</sup> Edition
- Disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific signs and/or symptoms and most often does not involve loss of consciousness. Concussion should be expected in any one or more of the following:
  - Symptoms (eg. Headache)
  - Physical signs (eg. unsteadiness)
  - Impaired brain function (eg. Confusion)
  - Abnormal behavior (eg. change in personality)

# Indications for Emergency Management

- Glasgow Coma Scale < 15
- Deteriorating mental status
- Potential spinal injury
- Progressive, worsening symptoms or new neurologic signs

# Sideline/Workside Assessment

- The unconscious athlete
  - CAB
  - Cervical spine
  - Immediate referral?



# Sideline/Workside Assessment

- History
  - Mechanism of Injury
  - Assess level of alertness, speech
  - Amnesia
  - Graded Symptom Evaluation



# Graded Symptom Evaluation

- Warrior athlete scores themselves at the time of evaluation as how they currently feel (initial evaluation only)
- Scoring 0→6
  - None
  - Mild
  - Moderate
  - Severe
- For follow-up visits, same scoring system over a period of time
  - Never
  - Sometimes
  - Always

# Graded Symptom Evaluation

- Headache
- “pressure in head”
- neck pain
- nausea or vomiting
- Dizziness
- Blurred vision
- Balance problems
- Sensitivity to light
- Sensitivity to noise
- Feeling slowed down
- Feeling like “in a fog”
- “Don’t feel right”
- Difficulty concentrating
- Difficulty remembering
- Fatigue or low energy
- Confusion
- Drowsiness
- trouble falling asleep
- more emotional
- irritability
- Sadness
- nervous or Anxious

# Graded Symptom Evaluation

- Total number of symptoms (Maximum possible 22)
- Symptom severity score (Maximum possible 132)
- Do the symptoms get worse with physical activity?
- Do the symptoms get worse with mental activity?
- if you know the warrior athlete well prior to the injury, how different is the athlete acting compared to his / her usual self?

# Sideline/Workside Assessment

- Physical Exam
  - Vital signs
  - Cervical spine
  - Neurological exam





# Assessment Tools

- Standardized Assessment of Concussion (SAC)
- Balance Error Scoring System (BESS)
- Sport Concussion Assessment Tool 3 (SCAT3)
  - Available online for free
  - Smartphone app for free

## Sideline Assessment – Maddocks Score

*"I am going to ask you a few questions, please listen carefully and give your best effort."*

**Modified Maddocks questions** (1 point for each correct answer)

At what venue are we at today?

0

1

Which half is it now?

0

1

Who scored last in this match?

0

1

What team did you play last week/game?

0

1

Did your team win the last game?

0

1

**Maddocks score**

of 5

Maddocks score is validated for sideline diagnosis of concussion only and is not included in SCAT 2 summary score for serial testing.

## 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

## Cognitive assessment

### Standardized Assessment of Concussion (SAC)

#### Immediate memory

*"I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order."*

**Trials 2 & 3:**

*"I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before."*

Complete all 3 trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. Score 1 pt. for each correct response. Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

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
<b>Total</b>									

**Immediate memory score**

of 15

## Cognitive assessment

### Standardized Assessment of Concussion (SAC)

#### Concentration

##### Digits Backward:

*"I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7."*

If correct, go to next string length. If incorrect, read trial 2. One point possible for each string length. Stop after incorrect on both trials. The digits should be read at the rate of one per second.

##### Alternative digit lists

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

##### Months in Reverse Order:

*"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November ... Go ahead"*

1 pt. for entire sequence correct

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan

0 1

Concentration score

of 5



## Balance examination

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)<sup>6</sup>. A stopwatch or watch with a second hand is required for this testing.

### Balance testing

*"I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances."*

### Balance testing – types of errors

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec



(a) Double leg stance:

*"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."*



(b) Single leg stance:

*"If you were to kick a ball, which foot would you use? [This will be the dominant foot] Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*



(c) Tandem stance:

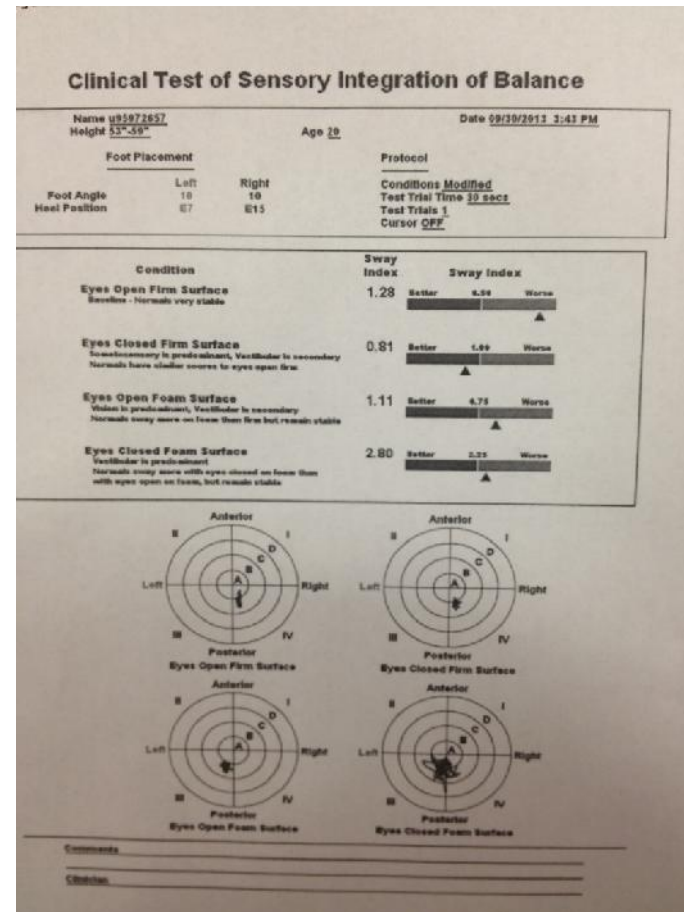
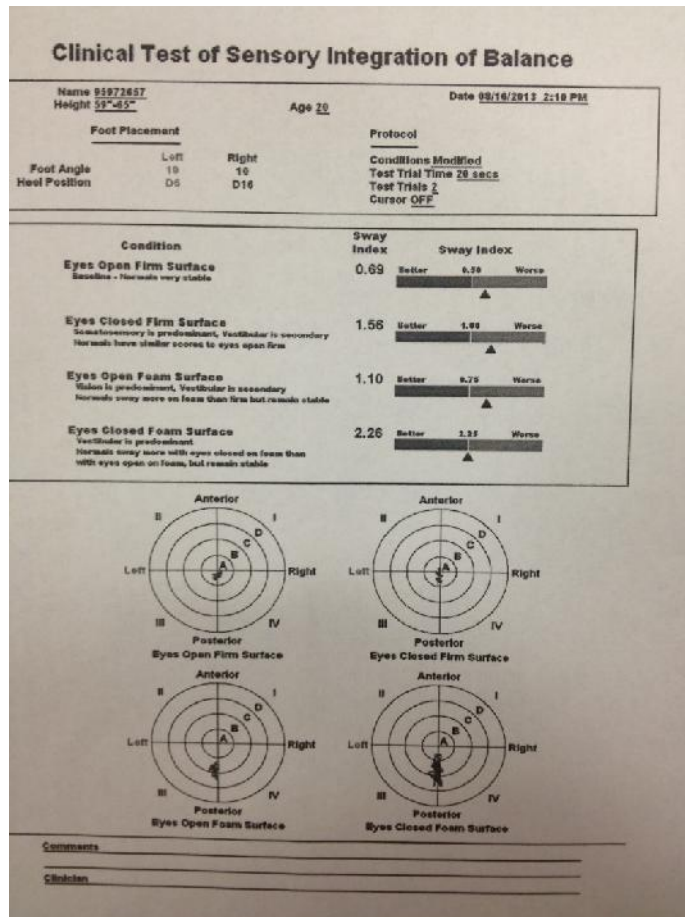
*"Now stand heel-to-toe with your non-dominant foot in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*

# Biodex Balance Machine





# Biodex Report Comparison



## Coordination examination

### Upper limb coordination

Finger-to-nose (FTN) task: *"I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended). When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of the nose as quickly and as accurately as possible."*

Which arm was tested: ☐ Left ☐ Right

Scoring: 5 correct repetitions in < 4 seconds = 1

Note for testers: Athletes fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions. Failure should be scored as 0.

Coordination score

of 1

## Cognitive assessment

### Standardized Assessment of Concussion (SAC)

#### Delayed recall

*"Do you remember that list of words I read a few times earlier?  
Tell me as many words from the list as you can remember in any  
order."*

Circle each word correctly recalled. Total score equals number of words recalled.

List	Alternative word list		
elbow	candle	baby	finger
apple	paper	monkey	penny
carpet	sugar	perfume	blanket
saddle	sandwich	sunset	lemon
bubble	wagon	iron	insect

Delayed recall score

of 5

# Return to Play/Work Decision

- If a concussion is diagnosed the warrior athlete should not return to work during that day
- Still unsure? Functional testing



# Monitoring and Instructions

- Frequent assessments for changes in status
- Instructions for athletes/parents



# Symptomatic Treatment

- Early symptoms are generally best managed by cognitive and physical rest
- OTC analgesics are commonly used for headache symptoms
- Other commonly used medications/supplements have an unclear role in symptom management
  - ADHD medications
  - Migraine Medication
  - Fish Oil
  - Others
- Care should be taken not to cloud the return to play/work decision by masking post-concussive symptoms

# Physical and Cognitive Rest





Dear Professor,

This letter is to inform you that (student-athlete's name) sustained a head injury on (date). As with all injuries, head injuries require a period of rest and rehabilitation to heal properly. The function of the brain requires that this rest be from both physical and cognitive exertion. While we have the capability to monitor the physical rest of this student-athlete, the academic, social, and environmental cognitive stressors are beyond our control. Therefore, we ask that you please consider these stressors and the overall well-being of (student-athlete's first name) if (he/she) should contact you regarding rescheduling academic requirements that may occur during this period of cognitive rest.

Please be aware that our recommendation is for complete physical and cognitive rest until the student-athlete is asymptomatic at rest. That being said, at no time will the student-athlete be instructed to disregard any academic requirement, merely to work with each professor to identify a possible accommodation. The student-athlete has also been advised that cognitive rest entails avoiding unnecessary; talking on the phone, text messaging, sitting in front of a computer, watching television, reading, etc.

We appreciate your understanding in this matter. If you have any further questions about the nature of this letter or the importance of cognitive rest in the rehabilitation from head injuries, please feel free to contact me

Sincerely,



# Second Impact Syndrome

- A second concussion prior to the first symptoms dissipating
- Physical paralysis
- Seizures
- Mental Disabilities
- Death in 50% of athletes
  - F.H.: 9/98 California, HS MLB, brain hemorrhage
  - A.B.: 9/98 Kansas City, HS FB, Subdural hematoma
  - D.B.: 2/97, San Antonio, 19 YO boxer, concussion


# Return to Play/Work

- Rest until asymptomatic (physical and mental)
- Light aerobic exercise (stationary cycle)
- Sport/Work-specific training (drills, no head impact)
- Non-contact work drills (start light resistance training or more complex drills)
  - Repeat NP and balance testing after this step, if applicable
- Full contact work/training after medical clearance
- Return to competition (game play or work)
- No less than 24 hours before each stage

# Neuropsychological testing

- Pre-injury/Post-injury comparison
- Old school pencil to paper modality
- New school computerized testing
  - Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)
  - Concussion Resolution Index
  - CogSport
- Well established, mixed support
- Data does not support one test over the other; however, research is ongoing
- ImPACT frequently used at high school, colleges, professional levels

# ImPACT Example



## ImPACT® Clinical Report

Exam Type	Baseline			
Date Tested	08/16/2013			
Last Concussion				
Exam Language	English			
Test Version	2.1			


Composite Scores	Percentile scores if available are listed in small type.			
Memory composite (verbal)	99			
Memory composite (visual)	89			
Vis. motor speed composite	35.08			
Reaction time composite	0.53			
Impulse control composite	11			
Total Symptom Score	2			

**Cognitive Efficiency Index: 0.49**

The Cognitive efficiency Index measures the interaction between accuracy (percent correct) and reaction time (seconds) on the Symbol Match test. This score was not developed to be helpful in determining the extent to which the athlete tried to win by taking a slow approach (jeopardizing speed) or attempted to improve their accuracy by taking a fast approach (jeopardizing accuracy). The range of scores is from approximately zero to 1.0. A higher score indicates that the athlete did well in both the speed and accuracy domains on the symbol match test. A low score (below .20) means that they performed poorly on both the speed and accuracy component. If this score is a negative number, the test taker performed poorly on the reaction time component.

Hours slept last night	9.5			
Medication	-			

\* June 1 bcp zyrtec



## ImPACT® Clinical Report

Exam Type	Post-Injury 1			
Date Tested	09/30/2013			
Last Concussion	09/24/2013			
Exam Language	English			
Test Version	2.1			

Composite Scores	Percentile scores if available are listed in small type.			
Memory composite (verbal)	96			
Memory composite (visual)	77			
Vis. motor speed composite	39.85			
Reaction time composite	0.53			
Impulse control composite	6			
Total Symptom Score	0			

**Cognitive Efficiency Index: 0.6**

The Cognitive efficiency Index measures the interaction between accuracy (percent correct) and reaction time (seconds) on the Symbol Match test. This score was not developed to be helpful in determining the extent to which the athlete tried to win by taking a slow approach (jeopardizing speed) or attempted to improve their accuracy by taking a fast approach (jeopardizing accuracy). The range of scores is from approximately zero to 1.0. A higher score indicates that the athlete did well in both the speed and accuracy domains on the symbol match test. A low score (below .20) means that they performed poorly on both the speed and accuracy component. If this score is a negative number, the test taker performed poorly on the reaction time component.

Hours slept last night	8			
Medication	*			

\* June 1 Neurontin

# Neuropsychological Testing

- Concussions can be managed appropriately without the use of neuropsychological testing
- In some cases, properly administered and interpreted NP testing may provide added value to assess cognitive function and recovery in the management of sports concussions.



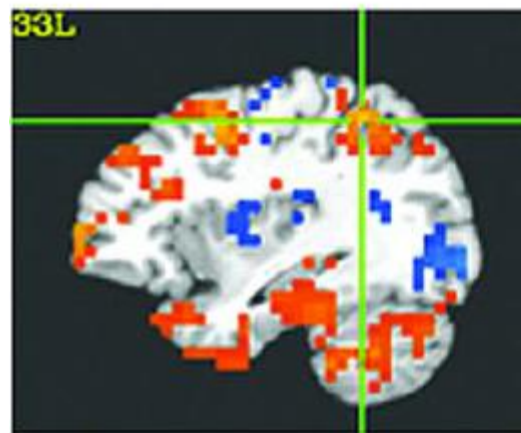
# Neuropsychological Testing

- Computerized neuropsychological testing should be interpreted by healthcare professionals trained and familiar with the type of test and the individual test limitations
- Neuropsychological testing should be used only as part of a comprehensive concussion management strategy and should not be used in isolation
- It is unknown if use of neuropsychological testing in the management of sports concussion helps prevent recurrent concussion, catastrophic injury, or long-term complications.

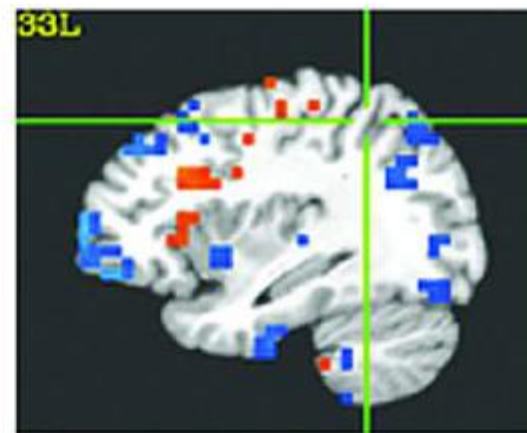
# Neuroimaging Testing

- Imaging is used to rule out structural brain or cranial injury
  - Generally in the acute or sub-acute setting
- Newer imaging techniques are being studied but clinical significance is not clear
  - functional MRI
  - Diffusion tensor imaging
  - Magnetic Resonance Spectroscopy

***Pre-Season***

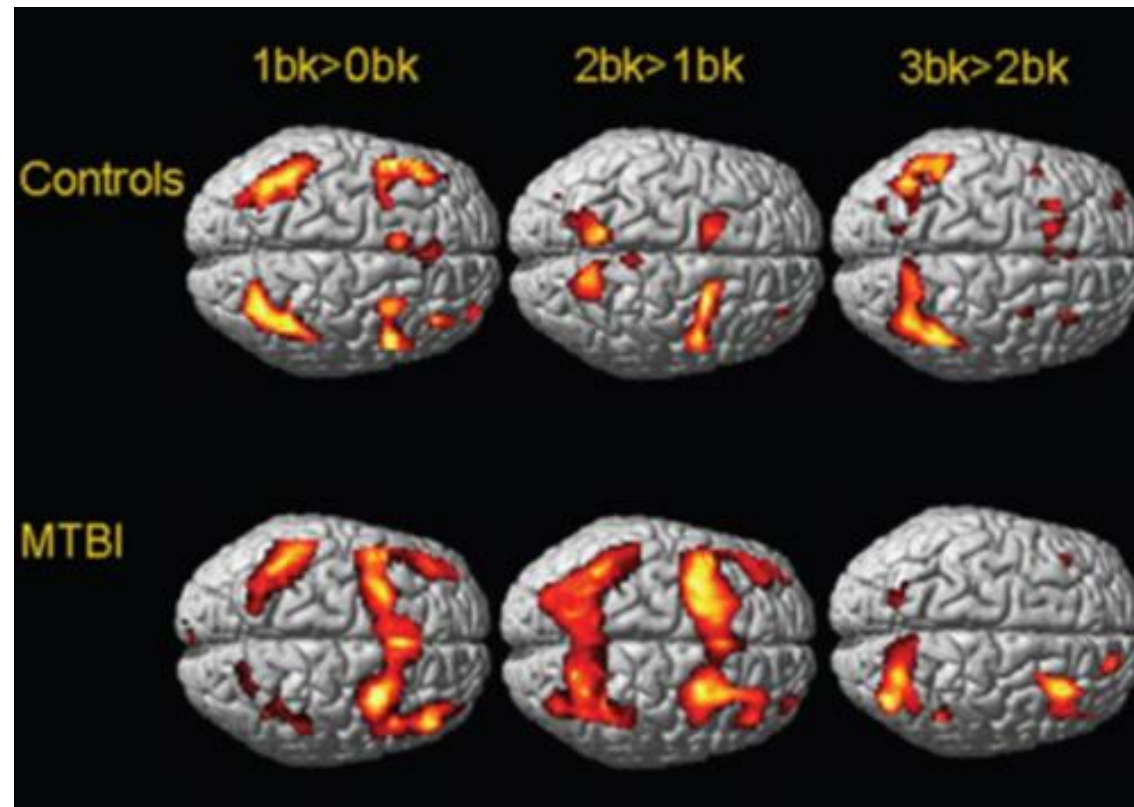


***In-Season***





# Functional MRI



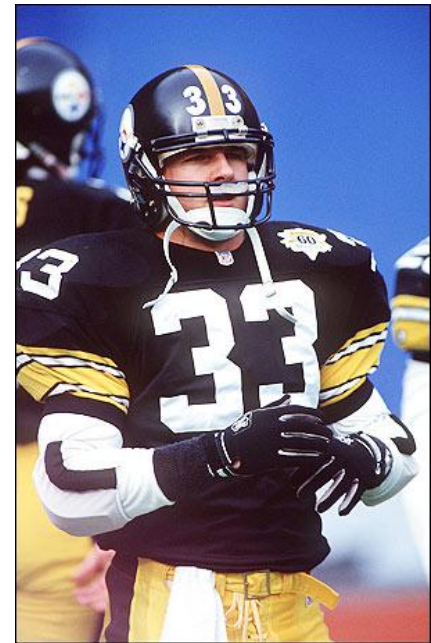
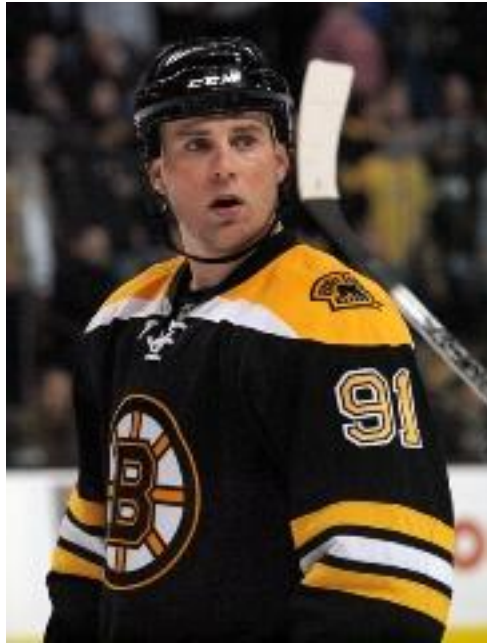
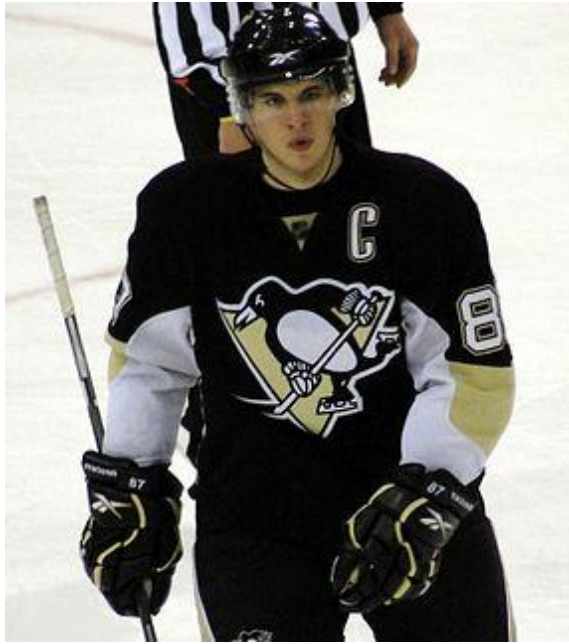


# Newer Techniques for Return

- Vestibular rehabilitation
- Cervical rehabilitation
- Speech and language Pathology
- Ocular rehabilitation
- ? Need for standardized cognitive return

# Post-Concussive Syndrome

- No universal definition of post-concussive syndrome
- Persistent symptoms and signs of concussion for weeks to months after the incident
- Symptoms of post-concussion syndrome can be subjective or objective and are often vague and non-specific making the diagnosis difficult.



# Post-Concussion Syndrome

- Risk factors not clear
- No correlation between severity of injury on presentation and development of post concussive syndrome
- Rehabilitation
  - Cognitive therapy may be useful in some circumstances
  - Progressive exercise programs may improve recovery times
    - Graded exercise testing to determine symptoms threshold
  - Vestibular rehabilitation

# Insomnia and Depression in PCS

- Effective
  - Nortriptyline
  - Amitriptyline
  - Trazodone
  - Melatonin 3-5 mg PO qhs
- Mixed
  - Gabapentin
  - SSRIs
- Ineffective
  - Ambien

# Cognitive Function

- Fish Oil/Omega 3 Fatty Acid
  - 1000 mg tablets (600 mg EPA/DHA)
    - 5 tabs PO TID x10d
    - 5 tabs PO BID x10d
    - 5 tabs PO daily x10d

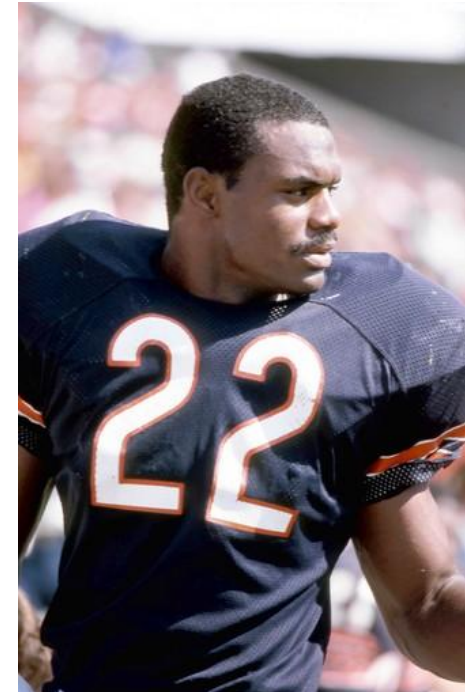
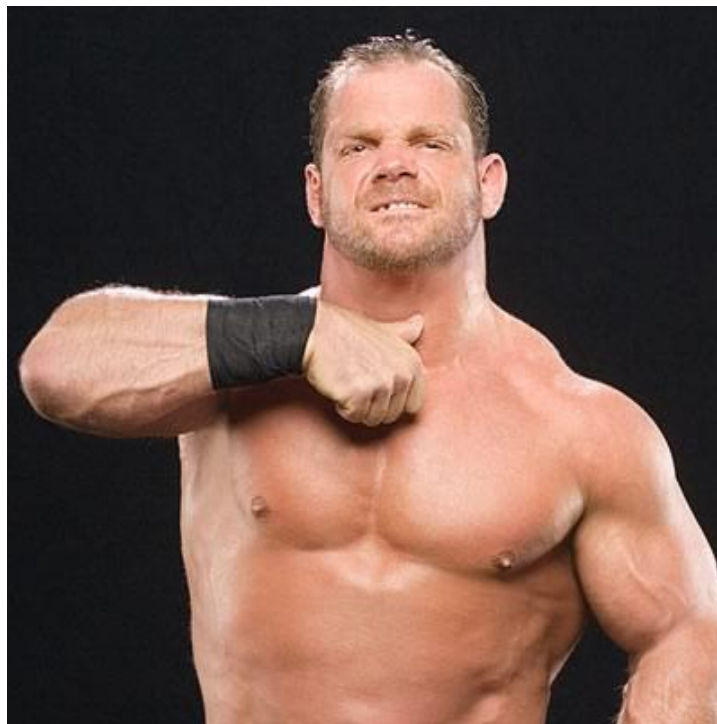
# Headache

- Coenzyme Q10
  - 160 mg PO daily
- Riboflavin/Vitamin B2
  - 400 mg PO daily
- Magnesium Oxide
  - 400 mg PO daily
- D-Ribose
  - 4 grams PO daily

# Long-Term Effects

- Research suggests that recurrent concussion may be associated with depression and progressive neurodegenerative conditions such as mild cognitive impairment and Alzheimer's disease.
- Small case series have led to the hypothesis that repetitive brain trauma is associated with a progressive neurodegenerative disease known as chronic traumatic encephalopathy(CTE).
- However, no prospective longitudinal studies are available, and more research is needed to understand any link between recurrent concussion or sub-concussive impacts and this neurodegenerative condition





# CTE Center

- Founded in 1996
- BU School of Medicine and Boston Medical Center
- Studied over 100 brains post-mortem
- Deposit of tau protein
- 18 of 19 NFL players with CTE
- In coordination with NFL

# Prevention

- Rule Changes

- Spearing
- No head checking in hockey
- Delay contact

- Protective equipment has not been shown to decrease the risk or severity of concussions

- Risk compensation of equipment change

# Recent Rule Changes

- Pop Warner
  - Contact
- NFL
  - Practices
  - Penalties
  - Eye in the Sky
- NCAA Division 1, 1A football
  - Practice
- MLB
  - 7 day DL

# Medicolegal Considerations



- Concussion Management uses clinical judgment on an individual basis
- Science of concussion at an early stage
- State Legislation
- Riddell Lawsuit

# Education

- Coaches, parents, players, physicians, ATC
- Classroom instruction
- Video
- Combined effort
- International effort

# Take Home Points

- Very few concussions present with loss of consciousness – Be vigilant!
- Follow a standard assessment algorithm including history, physical, special testing
- No same day return to play/work

# Future

- Research ongoing, with difficulty in obtaining double-blinded prospective studies
- Validate current assessment tools
- Delineate role of neuropsychological testing
- Improve identification of those at-risk of PCS, prolonged symptoms
- Enhanced imaging, biomarkers
- Minimum time out for concussion?



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# Ryan Center for Sports Medicine

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Boston Medical Center's sports medicine clinic

Boston's first full spectrum, multi-disciplinary sports medicine center

Team Physicians for:

BU, BC, Emerson, Boston Public Schools, USA Gymnastics



# What does the Ryan Center Offer?

- Concussion Clinic
  - Trained sports medicine physicians
  - Biodex Balance Machine
  - ImPACT neuropsychological testing
  - Vestibular rehab
  - Cervical Rehabilitation
- OMT
- MSK Ultrasound
- Physical Therapy
- X-Ray
- Treadmill Testing
- Fracture Care
- PRP

# Thank You!

