Concussion: From Athlete To Weekend Warrior

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Objectives

I. Recognize Signs of Concussion
II. Explain Pathophysiology of Concussion
III. Organize Management Plan For Concussion
IV. Explain Risks of Returning To Play Too Early
V. Develop Return To Play Guidelines

Question 1

- 16 year old H.S. LB misses a tackle and receives a knee to his helmet. Positive L.O.C. for less than 30 seconds and then able to get up on his own and walk towards the sideline. After initial medical evaluation he sits on the bench for the 1st half. There is no appreciable neuro deficits on the sideline. What is the minimum timeframe that has to pass before he can return to the game?

a) 7 days with RTP on 8th day if asymptomatic
b) 5 days with RTP on 6th day if asymptomatic
c) 3 days with RTP on 4th day if asymptomatic
d) Next day
e) 2nd day

Question 2

- A high profile patient who is a professional B-ball player comes into the office to discuss his past medical history. He has had 5 documented previous concussions over the course of his 7 year career. He had one concussion with LOC and always returned to competition within 7-10 days. Which of the following would be an accurate statement to consider when advising him to retire from his sport?

a) Assessment of each prior concussion particularly severity should not influence decision
b) There is higher risk after sustaining > 2 concussions in 7 year period
c) Subsequent concussions can resolve faster than previous
d) Normal MRI brain would lessen concerns
e) There is a potential risk for long-term neurocognitive deficits

Epidemiology And Prevalence

- NCAA
  - 0.43 per 1000 athletic exposures
- High School
  - 0.23 per 1000 athletic exposures
- Largest Number
  - Men's Football
- Highest Rate
  - Women's Ice Hockey
- Men Vs. Women
  - Basketball overall rate is 0.07 per 1000 exposures in men vs. 0.21 per 1000 exposures in women

Signs and Symptoms of Concussion

Physical	Emotional	Cognitive	Sleep-Related
• Headache	• Irritability	• Feeling mentally "foggy"	• Drowsiness
• Nausea	• Sadness	• Feeling slowed down	• Sleeping more than usual
• Vomiting	• More emotional	• Difficulty concentrating	• Sleeping less than usual
• Balance problems	• Nervousness	• Difficulty remembering	• Difficulty falling asleep
• Visual problems		• Forgetful of recent information	
• Fatigue		• Confused about recent events	
• Sensitivity to light		• Answers questions slowly	
• Sensitivity to noise		• Repeats questions	
• Dazed			
• Stunned			

Most Commonly Reported Symptoms Within 3 Days

Signs and Symptoms of Concussion			
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Table 1 – Five major features of a concussion

1. Concussion 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.
2. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously.
3. Concussion may result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.
4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course; however, it is important to note that in a small percentage of cases, postconcussion symptoms may be prolonged.
5. No abnormality on standard structural neuroimaging studies is seen in concussion.

Content from McCrory P et al. *J Athl Train.* 2009.[6]

School of hard knocks

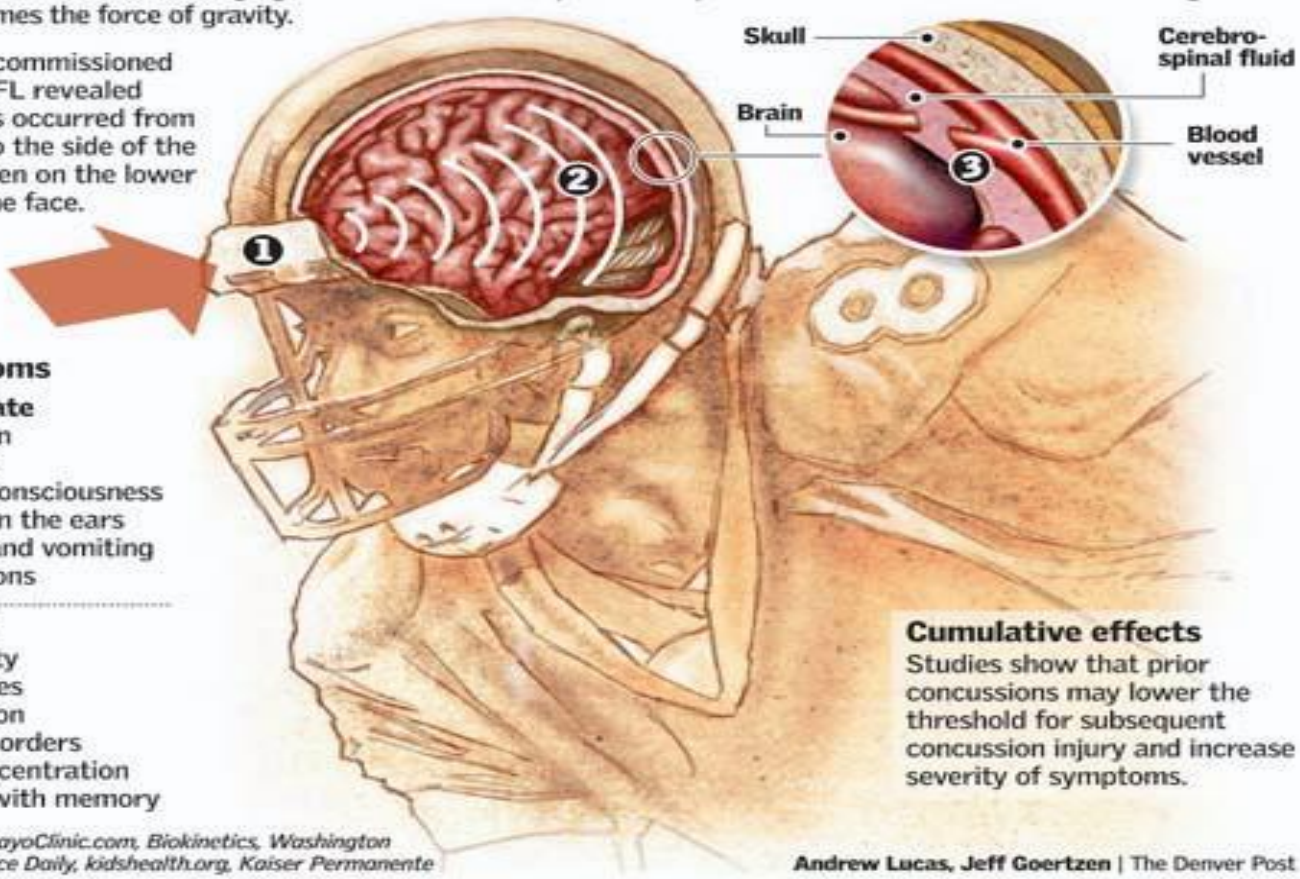
A concussion occurs when a violent blow to the head causes the brain to slam against the skull beyond the ability of the cerebrospinal fluid to cushion the impact. Between 1996 and 2001, NFL teams reported nearly 900 concussions.

1 When a football player takes a hit to the head, speeds range from 17 to 25 miles per hour with a force averaging 98 times the force of gravity.

2 The shock wave passes through the brain and bounces back off the skull. The concussion usually occurs at the opposite side from the point of impact.

3 The impact can cause bruising of the brain, tearing of blood vessels and nerve damage.

A study commissioned by the NFL revealed most hits occurred from a blow to the side of the head, often on the lower half of the face.



Symptoms

Immediate
Confusion
Amnesia
Loss of consciousness
Ringing in the ears
Nausea and vomiting
Convulsions

Delayed
Irritability
Headaches
Depression
Sleep disorders
Poor concentration
Trouble with memory

Cumulative effects

Studies show that prior concussions may lower the threshold for subsequent concussion injury and increase severity of symptoms.

Sources: MayoClinic.com, Biokinetics, Washington Post, Science Daily, kidshealth.org, Kaiser Permanente

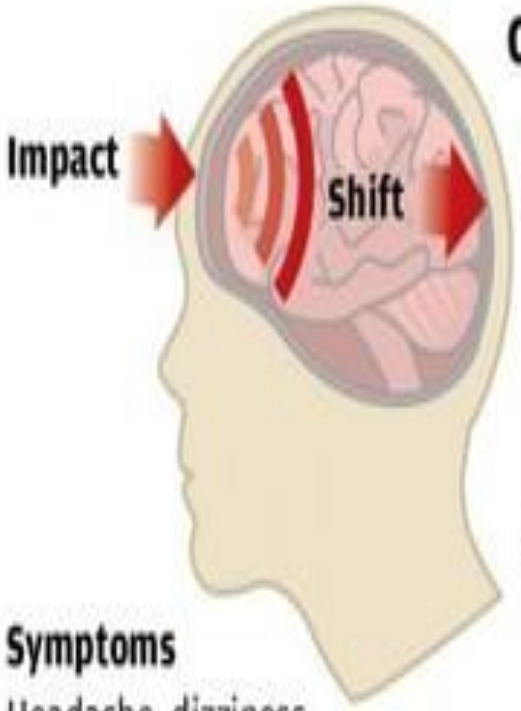
Andrew Lucas, Jeff Goertzen | The Denver Post

Concussive Pathophysiology

1) Influx of neurotransmitters(Glut./NMDA)
2) Sodium/Potassium Pump Works Overtime
3) Increase In Glucose Metabolism
4) Diminished Cerebral Blood Flow
5) Energy Crisis
6) Persistent Calcium-Mitochondrial Oxidation
7) Alternate Fuel-Lactate Induces Acidosis

Traumatic head injuries

A concussion occurs when a blow to the head results in the brain slamming against the skull.



Concussion

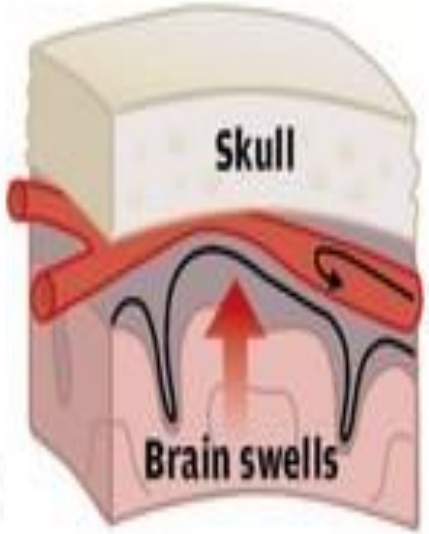
Brain collides with skull, which can cause bruising, torn tissues and swelling.

Symptoms

Headache, dizziness, confusion, nausea, difficulty hearing and seeing, lack of concentration

Second impact syndrome

When a player who is not fully recovered from a concussion suffers a second blow to the head, it can be fatal.



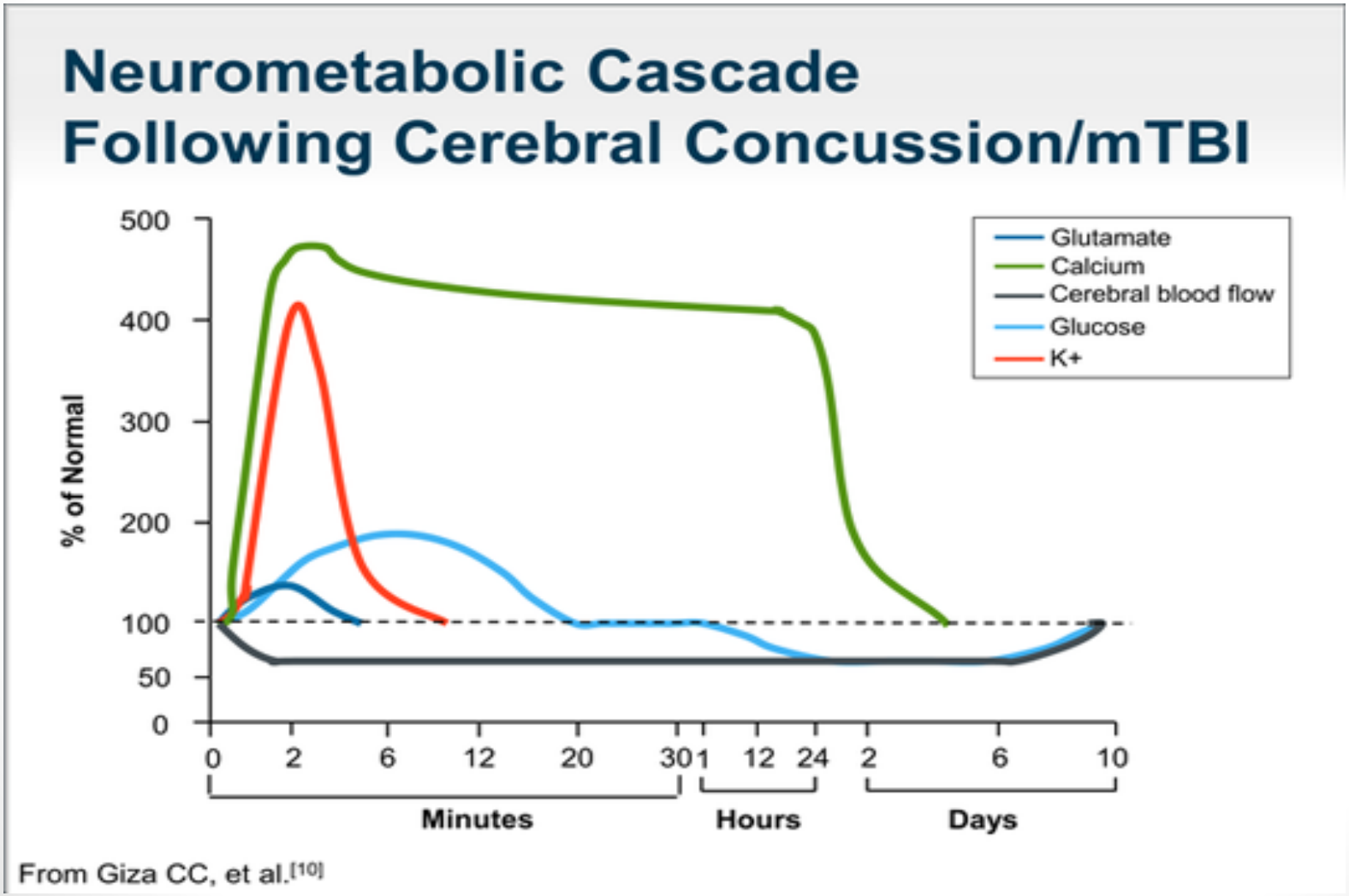
Massive swelling of brain

Cuts off flow of fresh blood to brain

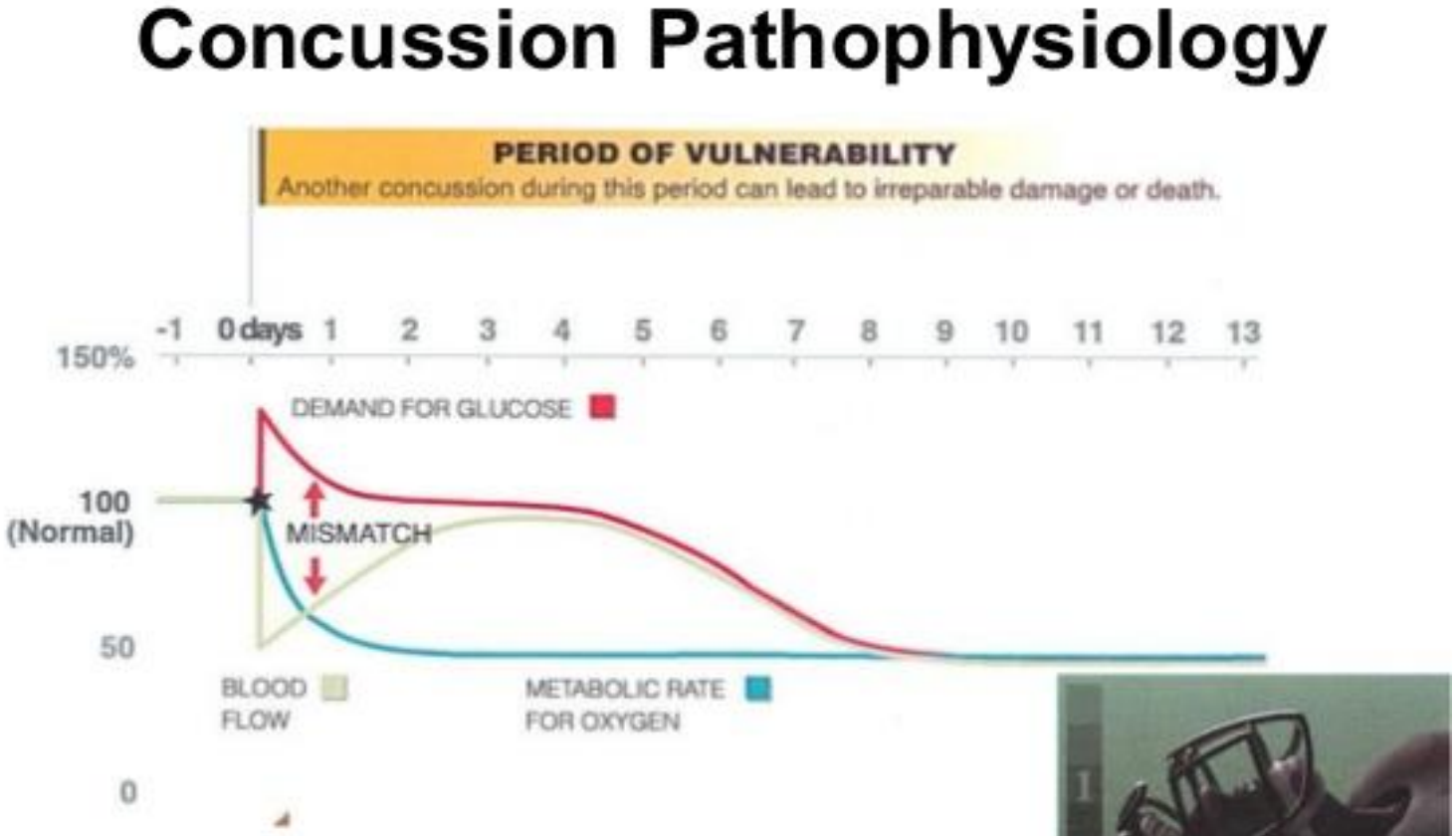
SOURCE: American Academy of Neurology, U.S. Centers for Disease Control and Prevention, KRT

State Journal

1)Avoid Impact to the Head Again
2)Avoiding Worsening The Starvation Crisis



Auto-Regulatory Malfunction



Athletic Concussion In Developing Brain

- The younger the brain the more resilient the brain is after injury?
  - Moderate fluid percussion in rats vs. weight drop model
- 1st Week After Injury
  - NMDA alterations
  - Increased cognitive impairment
  - Stagnant lesion size in rats with immobilization
- Repeated Injury > Two Isolated Events
  - Cognitive defect could present later without initial signs

Predisposing Factors

- Personal History of Headaches
- Family History of Headaches
- History of Concussion
- Underlying ADD/ADHD
- History of Depression/Anxiety
- Dyslexia

Score According to Severity	None			Moderate		Severe	
	0	1	2	3	4	5	6

Symptom	Preseason Baseline	Time of Injury	24 Hours Post-Injury	Day 3 Post-Injury	Day 4 Post-Injury	Day 5 Post-Injury
Blurred Vision						
Dizziness						
Drowsiness						
Sleeping More than Usual						
Easily Distracted						
Fatigue						
Feeling "In a Fog"						
Feeling "Slowed Down"						
Headache						
Unusually Emotional						
Irritability						
Loss of Consciousness						
Loss of Orientation						
Memory Problems						
Nauseous						
Nervousness						
Personality Changes						
Poor Balance/Coordination						
Ringing in the Ears						
Sadness						
Seeing Stars						
Sensitivity to Light						
Sensitivity to Noise						
Sleep Disturbances						
Vacant Stares/Glassy Eyes						
Vomiting						
TOTAL SYMPTOM SCORE:						

Child-SCAT3™

Sport Concussion Assessment Tool for children ages 5 to 12 years

For use by medical professionals only

What is the Child-SCAT3?[1]

The Child-SCAT3 is a standardized tool for evaluating injured children for concussion and can be used in children aged from 5 to 12 years. It supersedes the original SCAT and the SCAT2 published in 2005 and 2009, respectively. For older persons, ages 13 years and over, please use the SCAT3. The Child-SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion recognition Tool[1]. Preseason baseline testing with the Child-SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the Child-SCAT3 are provided on page 3. If you are not familiar with the Child-SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, groups and organizations. Any revision or any reproduction in a digital form requires approval by the Concussion in Sport Group.

NOTE: The diagnosis of a concussion is a clinical judgment, ideally made by a medical professional. The Child-SCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgement. An athlete may have a concussion even if their Child-SCAT3 is "normal".

What is a concussion?

A concussion is a 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 (some examples listed below) and most often does not involve loss of consciousness. Concussion should be suspected in the presence of any one or more of the following:

- Symptoms (e.g., headache), or
- Physical signs (e.g., unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour (e.g., change in personality).

SIDELINE ASSESSMENT

Indications for Emergency Management

NOTE: A hit to the head can sometimes be associated with a more serious brain injury. If the concussed child displays any of the following, then do not proceed with the Child-SCAT3; instead activate emergency procedures and urgent transportation to the nearest hospital:

- Glasgow Coma score less than 15
- Deteriorating mental status
- Potential spinal injury
- Progressive, worsening symptoms or new neurologic signs
- Persistent vomiting
- Evidence of skull fracture
- Post traumatic seizures
- Coagulopathy
- History of neurosurgery (e.g. Shunt)
- Multiple injuries

1 Glasgow Coma Scale (GCS)

Best eye response (E)	
No eye opening	1
Eye opening in response to pain	2
Eye opening to speech	3
Eyes opening spontaneously	4
Best verbal response (V)	
No verbal response	1
Incomprehensible sounds	2
Inappropriate words	3
Confused	4
Oriented	5
Best motor response (M)	
No motor response	1
Extension to pain	2
Abnormal flexion to pain	3
Flexion / Withdrawal to pain	4
Localizes to pain	5
Obeys commands	6
Glasgow Coma score (E + V + M)	of 15

GCS should be recorded for all athletes in case of subsequent deterioration.

Potential signs of concussion?

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop participation, be evaluated by a medical professional and **should not be permitted to return to sport the same day** if a concussion is suspected.

Any loss of consciousness?	☐ Y ☐ N
"If so, how long?"	
Balance or motor incoordination (stumbles, slow / laboured movements, etc.)?	☐ Y ☐ N
Disorientation or confusion (inability to respond appropriately to questions)?	☐ Y ☐ N
Loss of memory:	☐ Y ☐ N
"If so, how long?"	
"Before or after the injury?"	
Blank or vacant look:	☐ Y ☐ N
Visible facial injury in combination with any of the above:	☐ Y ☐ N

2 Sideline Assessment – Child-Maddocks Score[3]

"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)

Where are we at now?	0 1
Is it before or after lunch?	0 1
What did you have last lesson / class?	0 1
What is your teacher's name?	0 1
Child-Maddocks score	of 4

Child-Maddocks score is for sideline diagnosis of concussion only and is not used for serial testing.

Any child with a suspected concussion should be REMOVED FROM PLAY, medically assessed and monitored for deterioration (i.e., should not be left alone). No child diagnosed with concussion should be returned to sports participation on the day of injury.

BACKGROUND

Name:	Date / time of injury:
Examiner:	Date of assessment:
Sport / team / school:	
Age:	Gender: ☐ M ☐ F
Current school year / grade:	
Dominant hand: ☐ right ☐ left ☐ neither	
Mechanism of injury ("tell me what happened"):	

For parent / carer to complete:

How many concussions has the child had in the past?	
When was the most recent concussion?	
How long was the recovery from the most recent concussion?	
Has the child ever been hospitalized or had medical imaging done (CT or MRI) for a head injury?	☐ Y ☐ N
Has the child ever been diagnosed with headaches or migraines?	☐ Y ☐ N
Does the child have a learning disability, dyslexia, ADD/ADHD, seizure disorder?	☐ Y ☐ N
Has the child ever been diagnosed with depression, anxiety or other psychiatric disorder?	☐ Y ☐ N
Has anyone in the family ever been diagnosed with any of these problems?	☐ Y ☐ N
Is the child on any medications? If yes, please list:	☐ Y ☐ N

SCAT 3

- > 13 year old athletes
  - Child SCAT 3
- Glasgow Coma Scale
- Maddock Score
  - Questions related to current related events
- Cognitive Score
- Symptom Evaluation
- Neck Score
- Balance Error Score System
  - Gait Examination

Concussion Management: Areas of Focus

Acute management

- Rule out more serious intracranial pathology
  - CT, MRI, neurologic examination primary diagnostic tests

Post-injury management

- Prevent against cumulative effects of injury
  - Less biomechanical force causing extension of injury
- Prevent presence of post-concussion syndrome

Determination of asymptomatic status essential for reducing repetitive and chronic morbidity of injury

Harmon KG, et al.[3]

TABLE 6 6-STEP RETURN-TO-PLAY PROTOCOL

PHASE	REHABILITATION	OBJECTIVE
Phase 1	Baseline	Patient must be on physical and cognitive rest with no symptoms for at least 24 hr.
Phase 2	Increase heart rate	The goal is to increase heart rate for 5-10 min through mild activity such as walking, light jogging, or an exercise bike.
Phase 3	Moderate exercise	In this phase the goal is limited body and head movement through more moderate intensity activities such as brief running or moderate weight lifting.
Phase 4	Noncontact exercise	The goal is to increase intensity but avoid contact. Activities could include more intense running, stationary biking, or noncontact sport-specific drills.
Phase 5	Practice	Reintegrate into full contact practice.
Phase 6	Play	Return to competition.

From May KH, et al.[11]

When To Refer To Specialist?

1) The symptoms have not gone away after 10-14 days, or
2) The symptoms worsen at any time,
3) Patient has a history of multiple concussions or risk factors for prolonged recovery. This may include a history of migraines, depression, mood disorders, or anxiety, as well as developmental disorders such as learning disabilities and ADHD.

Concussion Treatment

- REST
- REST
- REST
- REST

Concussion Treatment

- Rest
- Monitor Concussion Symptoms
- Vestibular Oculomotor Therapy
- Neuro-ophthalmology program
- Speech Therapy
- Pharmacologic Management
- Graded Exercise Program

Pharmacologic Management

Yes

- Tylenol
- Fish Oil
- Gabapentin
- SSRIs-antidepressants
- Melatonin
- Topamax

No

- NSAIDs
- Vitamin E
- Multi-vitamins
- Ambien-sleep agents
- Narcotics
- Sumatriptan?

Diet In Concussion Management

- Lean protein and low fat diets

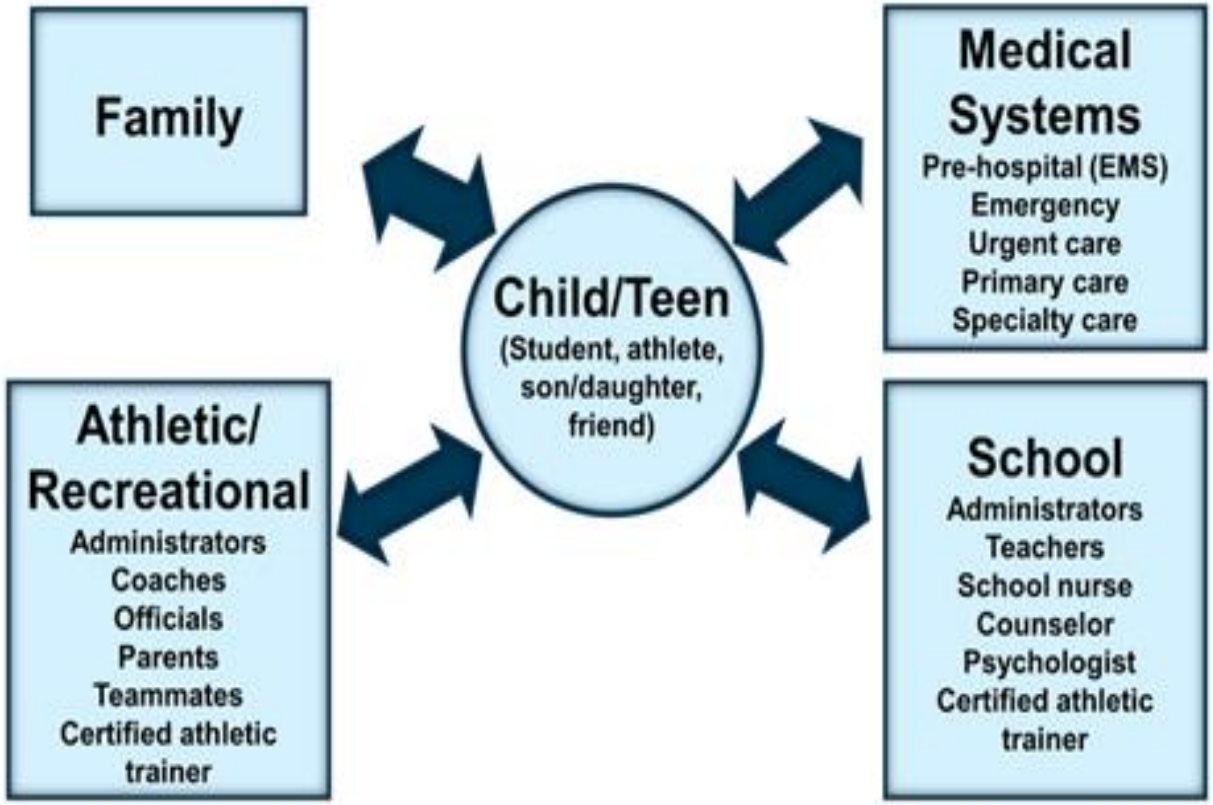
OMT in Concussion

- Goal-Reduce Pain
- Cervical Myofascial Strain/Whiplash
  - HVLA?
  - Caution with oculomotor deficits

Post-Concussion Syndrome Treatment

- University of Buffalo Study
  - Eli et al
  - Graded Exercise Program

Four Corners Approach to Concussion Care



CDC.[2]

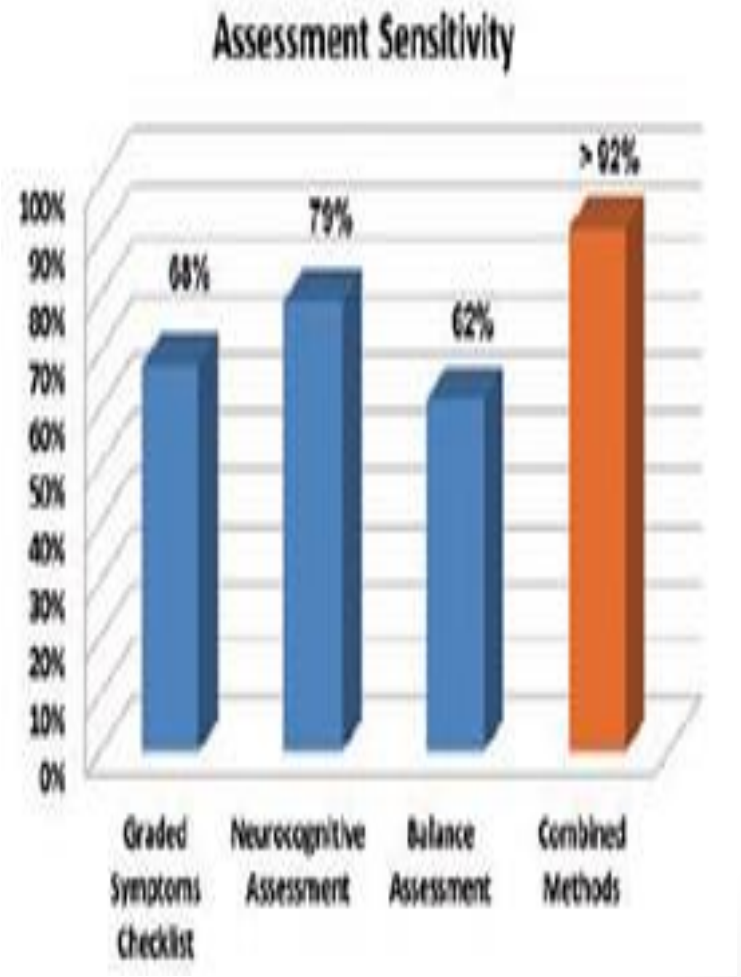
IMPACT TESTING

- Review Data
  - 30% False Positive
  - 30% False Negative
- Sand-Bagging
  - Poor Baseline Testing

- Testing Options

Alternative Baseline Testing

- Dynamic Baseline Testing
- Value of Balance Testing
- Value of Cognitive Testing
- Monitoring Heart Rate



Concussion Prevention

- Rugby Style Tackling
  - 2014 New Hampshire Football Study
  - Serevi Seattle Based Company
  - Goal-Decrease Head Impact

USA FOOTBALL

HEADS UP FOOTBALL

Long-Term Sequelae of Multiple Concussions

- Cognitive impairment and executive function impairment
  - NP testing with multiple concussions vs. control
- Headache disorders
- Decreased perceived health related quality of life measures
- Psychiatric disorders including depression is increased with multiple concussions
- Dementia pugilistica: dementia associated with retired boxers

Chronic Traumatic Encephalopathy

- Diagnosed at autopsy
  - Increase in donation of brain tissue by professional athletes
- True incidence unknown
- Pathologic Findings
  - Superficial cortical layers
  - Atrophy-temporal, hemispheres, brainstem, thalamus
  - Tau-immunoreactive neurofibrillary tangles & astrocyte tangles

CTE Clinical Presentation

- Insidious cognitive decline
- Confusion
- Disorientation
- Behavioral changes
- Parkinsonian features
- Psychotic features

Second Impact Syndrome

- Catastrophic Brain Swelling
  - Symptomatic upon second impact
  - 2^{nd} impact < 1^{st} impact
- Pathophysiology
  - Cerebral dysautoregulation
- Extraordinarily rare
  - True incidence unknown
- Rapid deterioration

Ohio Legislation

- House Bill 143
  i. If coach or referee removes participant from sport then participant is not cleared to return to play in the same day
  ii. In order to return to competition a licensed physician must provide written documentation

- Coaches-online concussion course

- Is Baseline Testing Mandatory?

Equipment Changes

- Flex Helmet
  - Absorbs Impact
- Mouthguard
  - Prevention of concussion?
- Weight of the Soccer Ball
- There is no convincing evidence that new helmet technology, mouthpieces or protective head gear prevents concussion

Updated Zurich Guidelines

Question 1

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Conclusion

- Understanding pathophysiology of concussion will help determine best time course in returning athlete to practice and game
- Dynamic Testing improves baseline testing accuracy while assisting the clinician with return to play of the athlete
- In treating concussion there must be a team approach

References