Disclosure

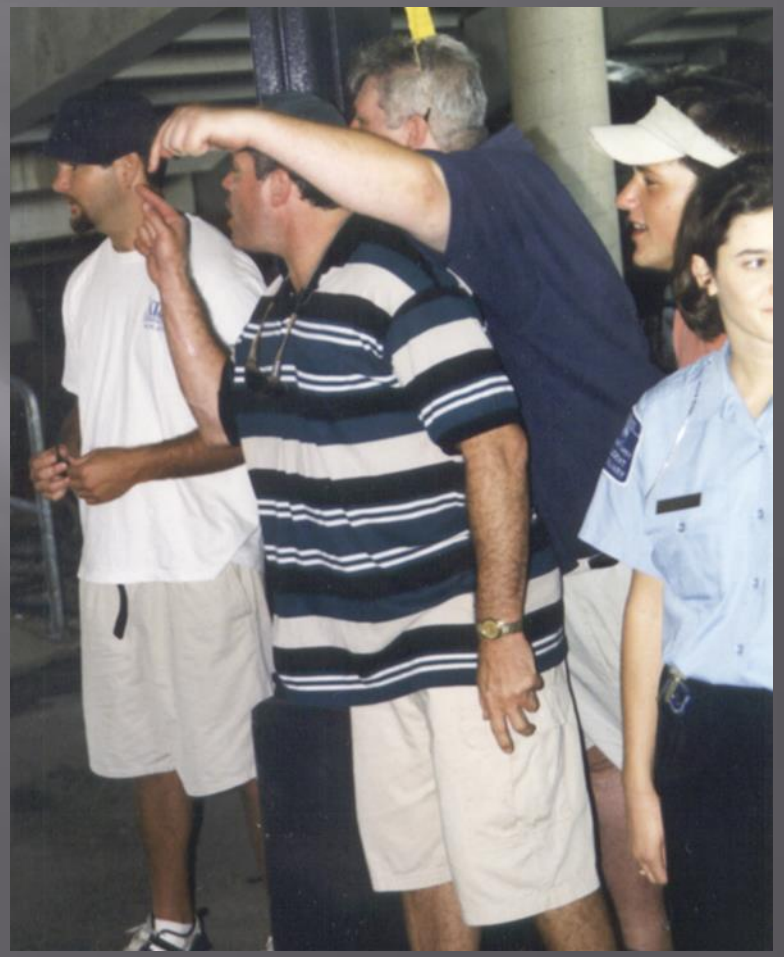
- CIC for ImPACT Applications, Inc
- Listed on ImPACT website as a “concussion management professional” in the Tucson area
- I don’t sit on the ImPACT board and receive no remuneration, financial or otherwise

Objectives

- Recognize the signs and symptoms of concussion injuries
- Be familiar with modifying factors of concussion and their role in concussion presentation and management
- Be aware of role of vestibular and ocular systems in concussion presentation
- Be aware of treatment modalities in management of concussion

Intro

- Sports concussions are complex injuries that present in a number of ways
- Long appreciated the need to exam cognitive function in concussed pt, balance assessment has been emphasized recently
- Includes vestibular and ocular motion

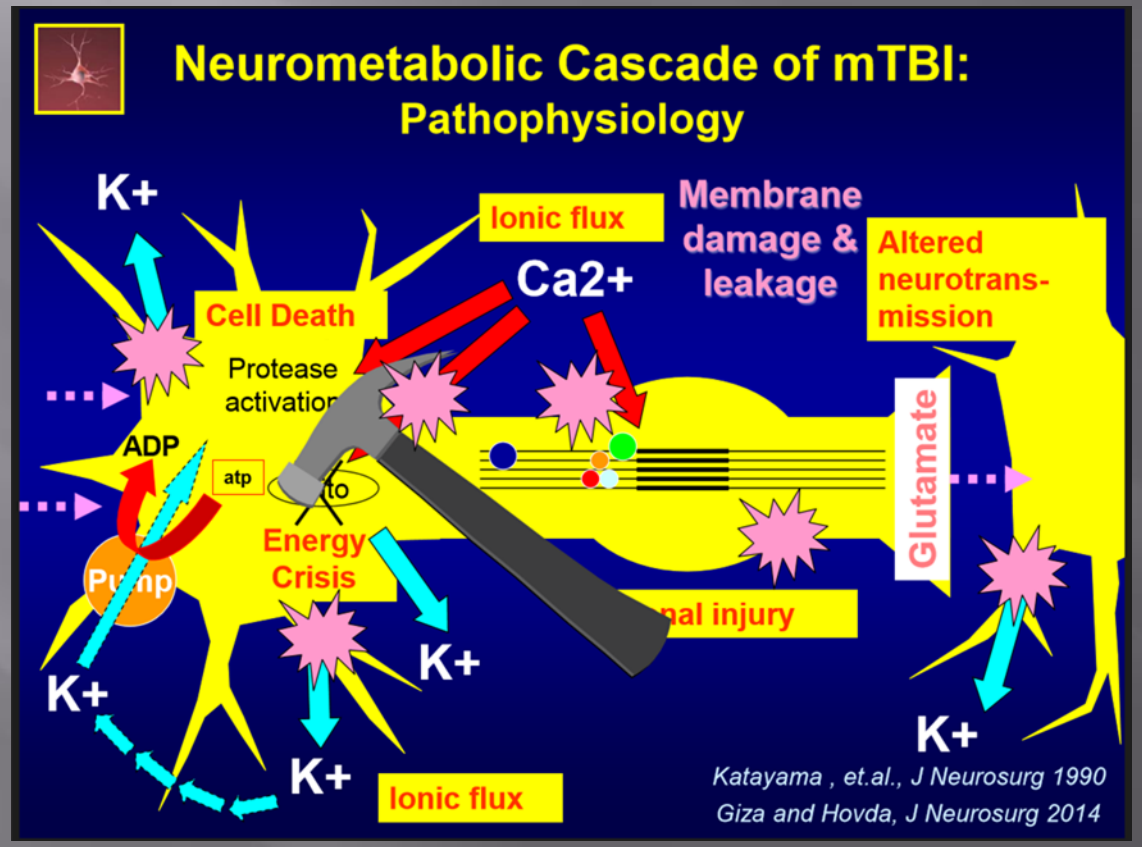


Effects of Concussive Forces on the Brain

- Typically, the "software" of the brain is affected
  - Neurometabolic/ neurochemical processes
  - Physiological
- Not the "hardware"
  - Structures appear normal with "traditional" imaging

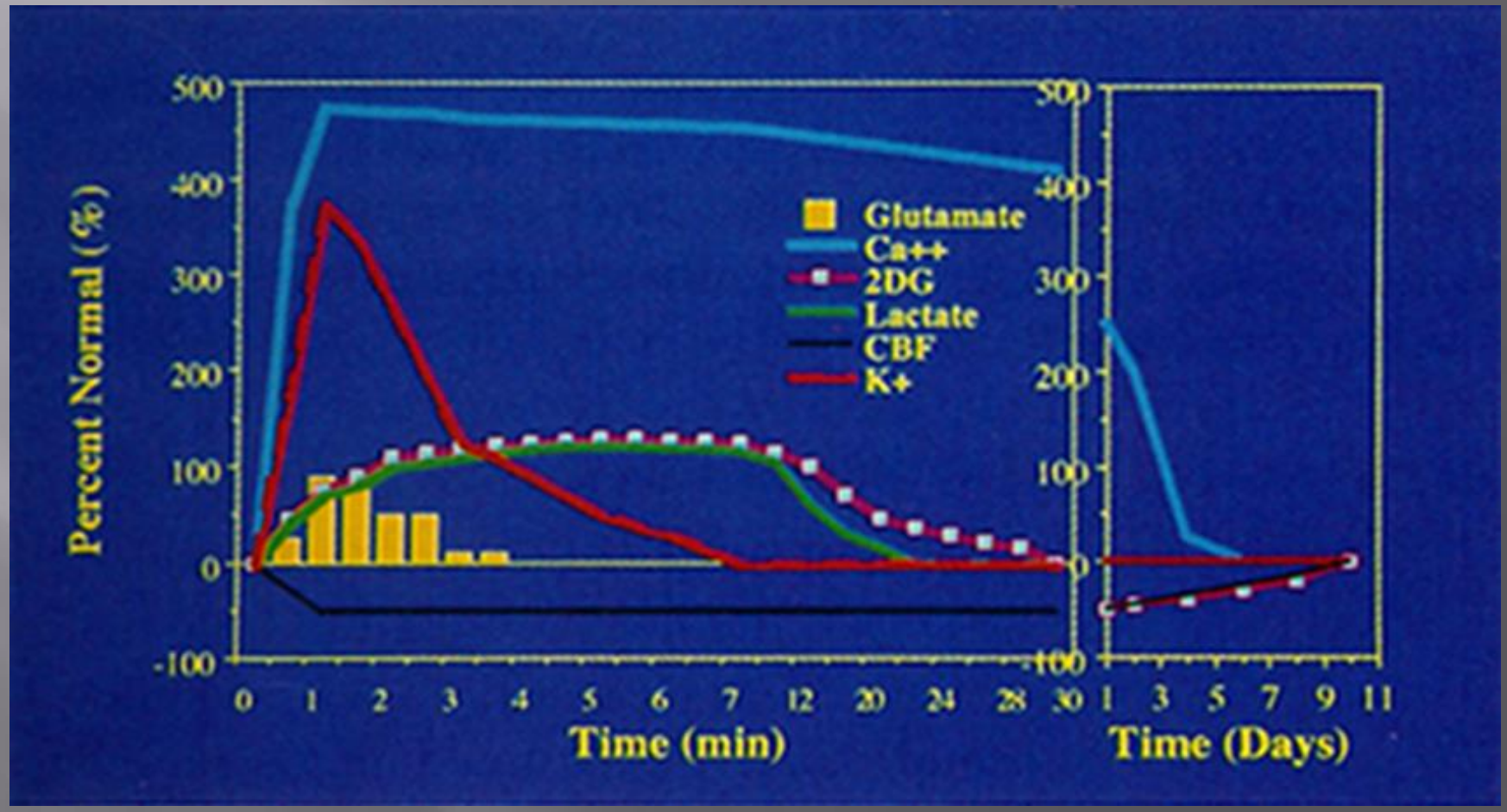
"We'll know more once we do an MRI, but, yes, this could be a career-ending injury."

Pathophysiology of Concussion



Courtesy of Chris Giza, UCLA

Pathophysiology of Concussion



Signs and Symptoms

Symptoms

- HA (71%)*
- Feeling slow (58%)*
- Concentration (57%)*
- Dizziness (55%)
- Foggy (53%)*
- Fatigue (50%) *
- Double/blurry vision (49%)
- Photophobia (47%)*
- Memory dysfunction (43%)*
- Balance (43%)*
- N/V
- Sluggish
- Change in sleep pattern
- Cognitive changes

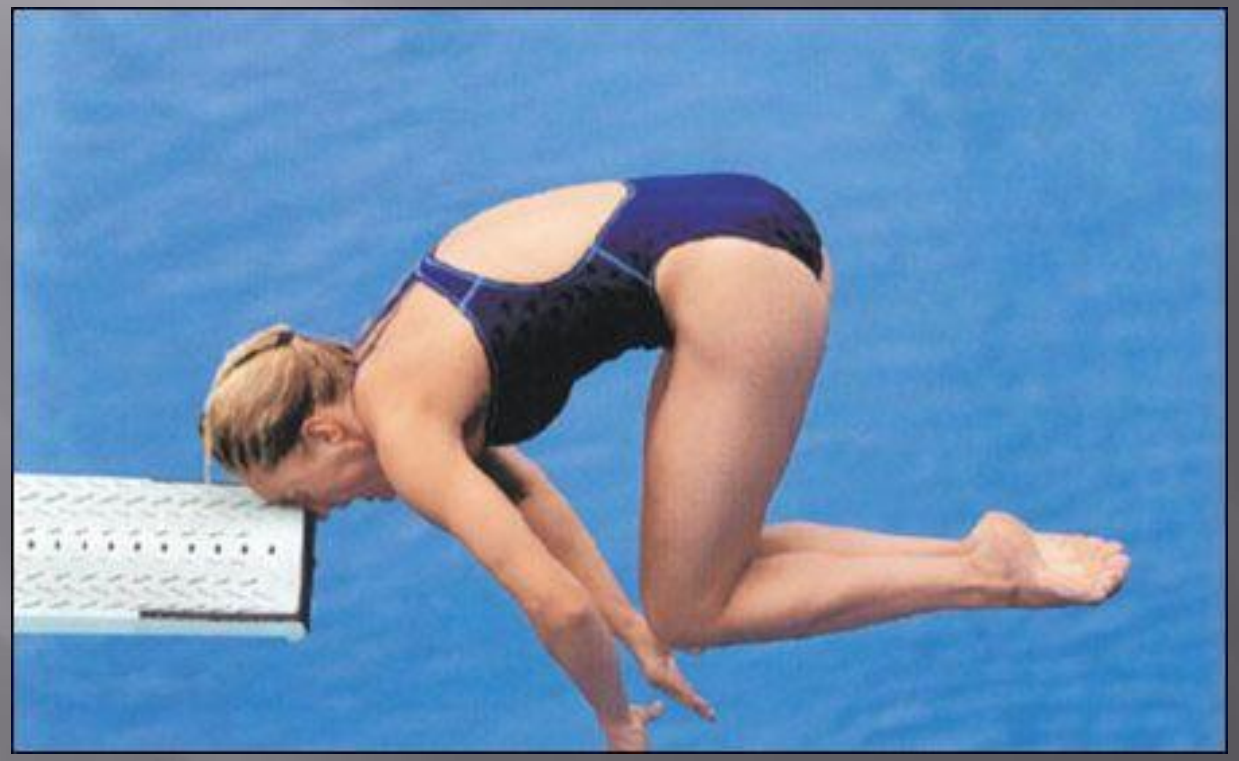
*Lovell, Collins et al, 2004

Concussion Symptoms By Category

Somatic	Cognitive	Emotional	Sleep
• Headache • Fuzzy or blurry vision • Dizziness • Fatigue • Drowsiness • Sensitivity to light • Sensitivity to noise • Balance problems • Nausea or vomiting (early on)	• Difficulty thinking clearly • Feeling slowed down • Difficulty concentrating • Difficulty remembering new information	• Irritability • Sadness • Feeling more emotional • Nervousness or anxiety	• Sleeping more than usual • Sleeping less than usual • Trouble falling asleep

SOURCE: CDC, 2013.

EVALUATION



On-field Evaluation

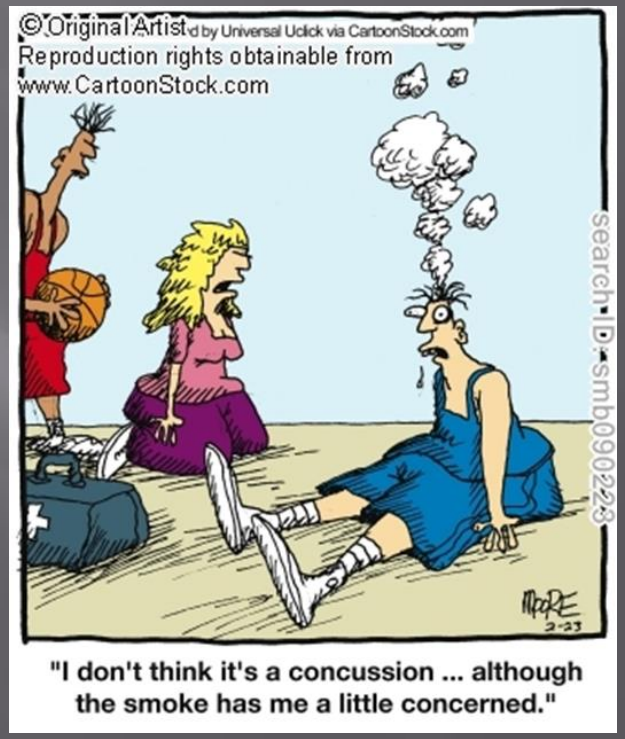
- When a player shows **ANY** symptoms or signs of a concussion:
  - All head and neck injuries assess ABC's (CABs)
    - Airway
    - Breathing
    - Circulation
  - C-spine (neck) eval (if unconscious, assume C-spine (neck) injury)

Sideline Evaluation

- Remove athlete from game/practice
- Let coach know athlete unavailable
- Primary goal is to rule out more serious injury
- Facial trauma (black eye, nasal fracture, broken or missing teeth)
  - Think possible concussion
- Ask about neck pain

Sideline evaluation of concussion

- Evaluation using SCAT-3, SAC, or other tool to assess extent of injury
- Standard orientation questions (eg, PPT) unreliable*
- Serial exams are important for the first two hours



*McCrea M et al *Neurology 1997;48:586–8*..

Sideline Evaluation

- Symptom inventory
- Memory
- Orientation
- Concentration
- Neurological examination
- Balance Coordination
- Can be done with SCAT3 or similar tool

Sideline Evaluation

Area	Evaluation Technique
Orientation	Venue, time of day and game, who scored last, opponent, city (not PPT, serial 7's/3's*)
Attention	Digits, MOY, DOW
RGA	Memory of hit, previous play, score prior to hit, plays of previous quarter, responsibilities
AGA	3 objects immediately and after 5 mins
Appearance	Dazed look, incoherent speech, balance problems, emotionality, behavior change

*McCrea M et al *Neurology 1997;48:586–8*..

SCAT3™

Sport Concussion Assessment Tool – 3rd Edition

For use by medical professionals only

Name

Date/Time of Injury:
Date of Assessment:

Examiner:

What is the SCAT3?[1]

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used in athletes aged from 13 years and older. It supersedes the original SCAT and the SCAT2 published in 2005 and 2009, respectively[2]. For younger persons, ages 12 and under, please use the Child SCAT3. The 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 SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the 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 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 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. Any of the following warrants consideration of activating 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

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

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.

2 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)

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 used for serial testing.

Notes: Mechanism of Injury ("tell me what happened"?):

Any athlete with a suspected concussion should be REMOVED FROM PLAY, medically assessed, monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle until cleared to do so by a medical professional. No athlete diagnosed with concussion should be returned to sports participation on the day of Injury.

BACKGROUND

Name: _____ Date: _____

Examiner: _____

Sport/team/school: _____ Date/time of injury: _____

Age: _____ Gender: ☐ M ☐ F

Years of education completed: _____

Dominant hand: ☐ right ☐ left ☐ neither

How many concussions do you think you have had in the past? _____

When was the most recent concussion? _____

How long was your recovery from the most recent concussion? _____

Have you ever been hospitalized or had medical imaging done for a head injury? ☐ Y ☐ N

Have you ever been diagnosed with headaches or migraines? ☐ Y ☐ N

Do you have a learning disability, dyslexia, ADD/ADHD? ☐ Y ☐ N

Have you ever been diagnosed with depression, anxiety or other psychiatric disorder? ☐ Y ☐ N

Has anyone in your family ever been diagnosed with any of these problems? ☐ Y ☐ N

Are you on any medications? If yes, please list: ☐ Y ☐ N

_____

SCAT3 to be done in resting state. Best done 10 or more minutes post excercise.

SYMPTOM EVALUATION

3 How do you feel?

"You should score yourself on the following symptoms, based on how you feel now".

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22) _____

Symptom severity score (Maximum possible 132) _____

Do the symptoms get worse with physical activity? ☐ Y ☐ N

Do the symptoms get worse with mental activity? ☐ Y ☐ N

☐ self rated ☐ self rated and clinician monitored

☐ clinician interview ☐ self rated with parent input

Overall rating: If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self?

Please circle one response:

no different | very different | unsure | N/A

Scoring on the SCAT3 should not be used as a stand-alone method to diagnose concussion, measure recovery or make decisions about an athlete's readiness to return to competition after concussion. Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.

COGNITIVE & PHYSICAL EVALUATION

4 Cognitive assessment

Standardized Assessment of Concussion (SAC)[4]

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

Immediate memory

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
Total									

Immediate memory score total of 15

Concentration: Digits Backward

List	Trial 1		Alternative digit list		
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
Total of 4					

Concentration: Month in Reverse Order (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
Concentration score		of 5

5 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength

Findings: _____

6 Balance examination

Do one or both of the following tests.

Footwear (shoes, barefoot, braces, tape, etc.) _____

Modified Balance Error Scoring System (BESS) testing[5]

Which foot was tested (i.e. which is the **non-dominant** foot) ☐ Left ☐ Right

Testing surface (hard floor, field, etc.) _____

Condition

Double leg stance:	Errors
Single leg stance (non-dominant foot):	Errors
Tandem stance (non-dominant foot at back):	Errors

And/Or

Tandem gait[6,7]

Time (best of 4 trials): _____ seconds

7 Coordination examination

Upper limb coordination

Which arm was tested: ☐ Left ☐ Right

Coordination score of 1

8 SAC Delayed Recall[4]

Delayed recall score of 5

INSTRUCTIONS

Words in *italics* throughout the SCAT3 are the instructions given to the athlete by the tester.

Symptom Scale

"You should score yourself on the following symptoms, based on how you feel now".

To be completed by the athlete. In situations where the symptom scale is being completed after exercise, it should still be done in a resting state, at least 10 minutes post exercise.

For total number of symptoms, maximum possible is 22.
For Symptom severity score, add all scores in table, maximum possible is 22 x 6 = 132.

SAC[4]

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.

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.

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

Delayed Recall

The delayed recall should be performed after completion of the Balance and Coordination Examination.

"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."

Score 1 pt. for each correct response

Balance Examination

Modified Balance Error Scoring System (BESS) testing[4]

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[4]. A stopwatch or watch with a second hand is required for this 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."

(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."

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

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. **The modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10.** If a athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of **five seconds** at the start are assigned the highest possible score, ten, for that testing condition.

OPTION: For further assessment, the same 3 stances can be performed on a surface of medium density foam (e.g., approximately 50cm x 40cm x 6cm).

Tandem Gait[4,7]

Participants are instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 meter line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. A total of 4 trials are done and the best time is retained. Athletes should complete the test in 14 seconds. Athletes fail the test if they step off the line, have a separation between their heel and toe, or if they touch or grab the examiner or an object. In this case, the time is not recorded and the trial repeated, if appropriate.

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), pointing in front of you. 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, and then return to the starting position, as quickly and as accurately as possible."

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.**

References & Footnotes

1. This tool has been developed by a group of international experts at the 4th International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2012. The full details of the conference outcomes and the authors of the tool are published in The BJSM Injury Prevention and Health Protection, 2013, Volume 47, Issue 5. The outcome paper will also be simultaneously co-published in other leading biomedical journals with the copyright held by the Concussion in Sport Group, to allow unrestricted distribution, providing no alterations are made.

2. McCrory P et al., Consensus Statement on Concussion in Sport – the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. British Journal of Sports Medicine 2009; 43: i76-89.

3. Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine. 1995; 5(1): 32–3.

4. McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sport Medicine. 2001; 11: 176–181.

5. Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24–30.

6. Schneiders, A.G., Sullivan, S.J., Gray, A., Hammond-Tooke, G. & McCrory, P. Normative values for 16-37 year old subjects for three clinical measures of motor performance used in the assessment of sports concussions. Journal of Science and Medicine in Sport. 2010; 13(2): 196–201.

7. Schneiders, A.G., Sullivan, S.J., Kvarnstrom, J.K., Olsson, M., Yden. T. & Marshall, S.W. The effect of footwear and sports-surface on dynamic neurological screening in sport-related concussion. Journal of Science and Medicine in Sport. 2010; 13(4): 382–386

ATHLETE INFORMATION

Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

Signs to watch for

Problems could arise over the first 24–48 hours. The athlete should not be left alone and must go to a hospital at once if they:

- Have a headache that gets worse
- Are very drowsy or can't be awakened
- Can't recognize people or places
- Have repeated vomiting
- Behave unusually or seem confused; are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on their feet; have slurred speech

Remember, it is better to be safe.
Consult your doctor after a suspected concussion.

Return to play

Athletes should not be returned to play the same day of injury.
When returning athletes to play, they should be **medically cleared and then follow a stepwise supervised program,** with stages of progression.

For example:

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
No activity	Physical and cognitive rest	Recovery
Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity, 70% maximum predicted heart rate. No resistance training	Increase heart rate
Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
Non-contact training drills	Progression to more complex training drills, eg passing drills in football and ice hockey. May start progressive resistance training	Exercise, coordination, and cognitive load
Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
Return to play	Normal game play	

There should be at least 24 hours (or longer) for each stage and if symptoms recur the athlete should rest until they resolve once again and then resume the program at the previous asymptomatic stage. Resistance training should only be added in the later stages.

If the athlete is symptomatic for more than 10 days, then consultation by a medical practitioner who is expert in the management of concussion, is recommended.

Medical clearance should be given before return to play.

Scoring Summary:

Test Domain	Score		
	Date: _____	Date: _____	Date: _____
Number of Symptoms of 22			
Symptom Severity Score of 132			
Orientation of 5			
Immediate Memory of 15			
Concentration of 5			
Delayed Recall of 5			
SAC Total			
BESS (total errors)			
Tandem Gait (seconds)			
Coordination of 1			

Notes:

CONCUSSION INJURY ADVICE

(To be given to the **person monitoring** the concussed athlete)

This patient has received an injury to the head. A careful medical examination has been carried out and no sign of any serious complications has been found. Recovery time is variable across individuals and the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

If you notice any change in behaviour, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please contact your doctor or the nearest hospital emergency department immediately.

Other important points:

- Rest (physically and mentally), including training or playing sports until symptoms resolve and you are medically cleared
- No alcohol
- No prescription or non-prescription drugs without medical supervision. Specifically:
  - No sleeping tablets
  - Do not use aspirin, anti-inflammatory medication or sedating pain killers
- Do not drive until medically cleared
- Do not train or play sport until medically cleared

Clinic phone number

Patient's name _____

Date/time of injury _____

Date/time of medical review _____

Treating physician _____

Contact details or stamp

SCAT-3

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.

SCAT-3

2 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)

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 used for serial testing.

SCAT-3

3 How do you feel?

"You should score yourself on the following symptoms, based on how you feel now".

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22)

Symptom severity score (Maximum possible 132)

Do the symptoms get worse with physical activity? ☐ Y ☐ N

Do the symptoms get worse with mental activity? ☐ Y ☐ N

☐ self rated ☐ self rated and clinician monitored

☐ clinician interview ☐ self rated with parent input

Overall rating: If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self?

Please circle one response:

no different	very different	unsure	N/A

SCAT 3

4 Cognitive assessment

Standardized Assessment of Concussion (SAC)[4]

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

Immediate memory

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
Total						

Immediate memory score total of 15

Concentration: Digits Backward

List	Trial 1	Alternative digit list		
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
Total of 4				

Concentration: Month in Reverse Order (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
Concentration score		of 5

SCAT

5 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength

Findings: _____

6 Balance examination

Do one or both of the following tests.

Footwear (shoes, barefoot, braces, tape, etc.) _____

Modified Balance Error Scoring System (BESS) testing[5]

Which foot was tested (i.e. which is the **non-dominant** foot) ☐ Left ☐ Right

Testing surface (hard floor, field, etc.) _____

Condition

Double leg stance:	Errors
Single leg stance (non-dominant foot):	Errors
Tandem stance (non-dominant foot at back):	Errors

And / Or

Tandem gait[6,7]

Time (best of 4 trials): _____ seconds

7 Coordination examination

Upper limb coordination

Which arm was tested: ☐ Left ☐ Right

Coordination score	of 1

8 SAC Delayed Recall[4]

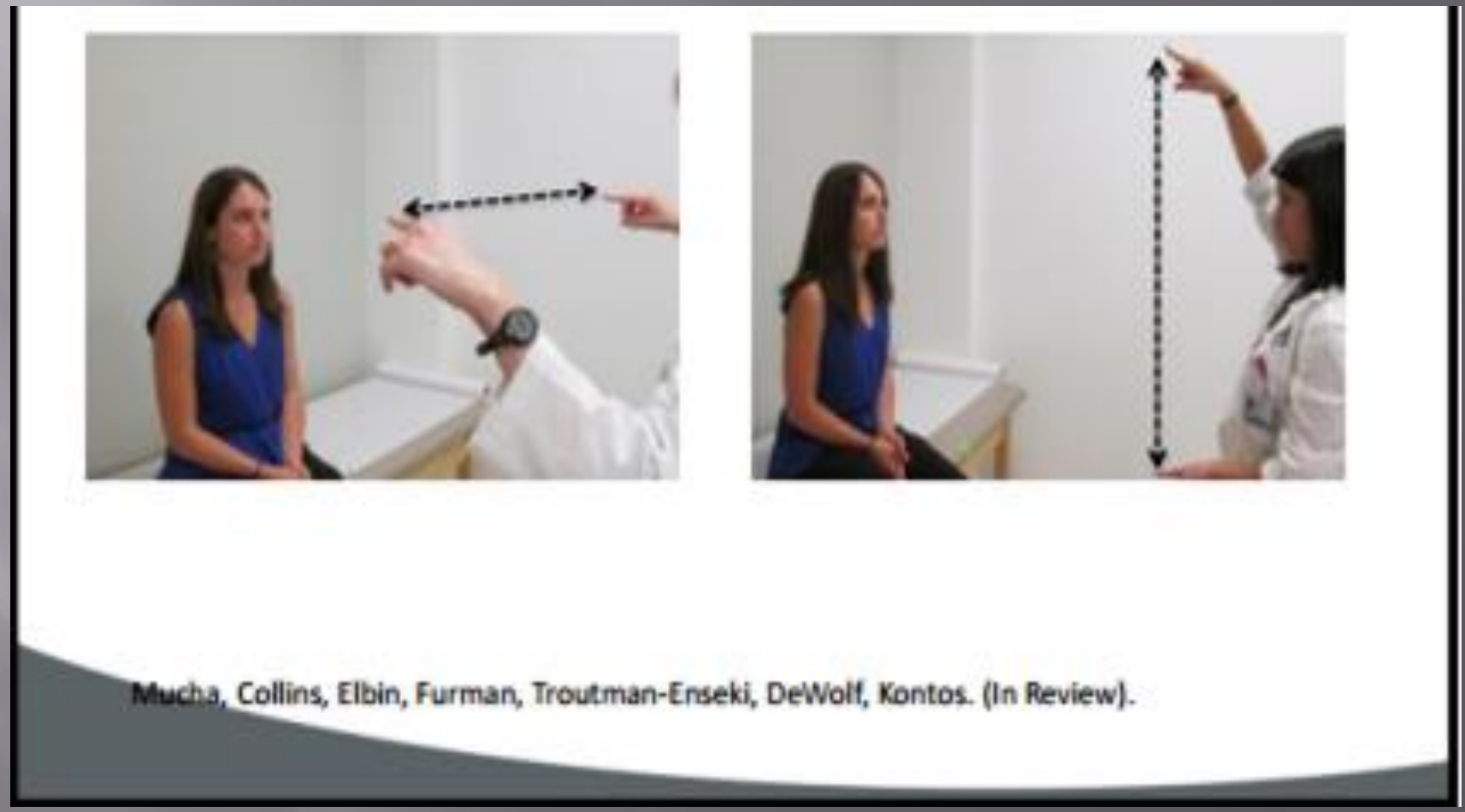
Delayed recall score	of 5

Vestibular-Ocular Screening

Smooth Pursuits

Mucha A, Collins M et al Am J Sp Med 2013;42(10)2479-86

Horizontal and Vertical Saccades



Mucha A, Collins M et al Am J Sp Med 2013;42(10)2479-86

Near Point Convergence

Mucha A, Collins M et al Am J Sp Med 2013;42(10)2479-86

Vestibular-Ocular Reflex

Mucha A, Collins M et al Am J Sp Med 2013;42(10)2479-86

Visual Motor Sensitivity (VMS)

Mucha, Collins, Elbin, Furman, Troutman-Enseki, DeWolf, Kontos. *AJSM*, 2014.

Mucha A, Collins M et al Am J Sp Med 2013;42(10)2479-86

In-Office Evaluation

Symptom Report

- Challenges
  - Injured athletes may not be honest with their sxs
  - Athletes are often addicted to their sport
- What's helpful
  - Ask others (parents, friends, SOs, teammates, roommates)

Monitor Symptoms Daily

CONCUSSION SYMPTOM SHEET

NAME: _____

I.D.#: _____

DATE:

✓	SYMPTOMS	SCORE: 0 = No Symptoms; 1 = Minor; 6 = Severe						
	Headache	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Nausea	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Vomiting	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Balance Problems	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Dizziness	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Fatigue	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Trouble falling asleep	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Sleeping more than usual	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Sleeping less than usual	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Drowsiness	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Sensitivity to Light	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Sensitivity to Noise	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Irritability	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Sadness	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Nervousness	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Feeling more emotional	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Numbness or tingling	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Feeling slowed down	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Feeling mentally foggy	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Difficulty concentrating	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Difficulty remembering	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6
	Visual problems such as double vision, blurring, etc	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5	❍ 6

COMMENTS: _____

Vestibular System

- Subjective Complaints of Vestibular Dysfunction
  - Dizziness
  - Foggy
  - “One step behind”
  - Nausea
  - Overwhelmed in high stimulus area

Ocular Symptoms

- Frontal pressure in the head /behind eyes when reading/computer work/taking notes in class
- Have blurred or fuzzy vision while reading or difficulty reading
- Difficulties with “focus” or trouble with adjusting your eyes from near to far vision
- Symptoms worse during the school week versus the weekend
- Excessively tired at the end of a school day
- Difficulty with visual-based classes

Neuropsychological Testing

- NP testing can be a very useful
- Full cognitive recovery should occur before RTP
- Symptoms usual resolve before NP testing normalizes
- Zurich guidelines NP testing is not required; however, several investigators have proposed that baseline NP testing be obtained in all athletes participating in contact sports as part of their preparticipation assessment.
- This testing may be very helpful in the case of subsequent concussions, in that it can be used to assist with the timing of RTP.
- Before an athlete becomes clinically asymptomatic, NP testing may be used to evaluate for deficits initially after injury, and may be useful in assisting with return to school issues and guidelines for teachers.

GRADING SCALES

Question

- An athlete has a 45 second episode of loss of consciousness after heading another person's head during a soccer match. No PTA, HA, dizziness or other S/S of a concussion. She now feels fine and has a normal examination. How would you grade the severity?
  - Grade 1
  - Grade 2
  - Grade 3
  - Need more information to answer the question
  - Can't answer the question as it's worded

Concussion Grading Scales

- Over 25 scales
- None based on outcome or objective data
- Most scales assign worst prognosis to those with LOC

Concussion Grading Scales

	Rugby football league (UK)	Federation Internationale de Ski (FIS)	Amateur Boxing Association	Auto Cycle Union (UK)	The Jockey Club (UK)	Rugby Union (Aust)	Rugby League (Australia)
Mild	No LOC	Transient concussion	Immediate recovery	LOC <5 mins	No LOC	No LOC, confusion and disorientation, double vision, giddiness, unsteadiness	*Grade 0* No LOC, not stunned or dazed, subsequent headache or difficulty in concentration *Grade 1* No LOC, stunned or dazed, no amnesia, sensorium clears <1 min
Mod	LOC <2 mins	LOC <60 secs	Complete recovery within 2 mins	LOC 5–60 mins	LOC <60 secs or any degree of PTA or if rider sent to hospital	LOC <4 mins, vomiting	*Grade 2* No LOC, cloudy sensorium >1 min, headache, may have amnesia, tinnitus, or dizziness
Severe	LOC >2 mins	LOC >60 secs	Complete recovery delayed for >2 mins	LOC >60 mins	LOC >60 secs	LOC >4 mins	*Grade 3* LOC <1 minute, not comatose, Grade 2 symptoms during recovery *Grade 4* LOC >1 minute, not comatose, Grade 2 symptoms during recovery

LOC, loss of consciousness; PTA, posttraumatic amnesia.


GRADING SCALES

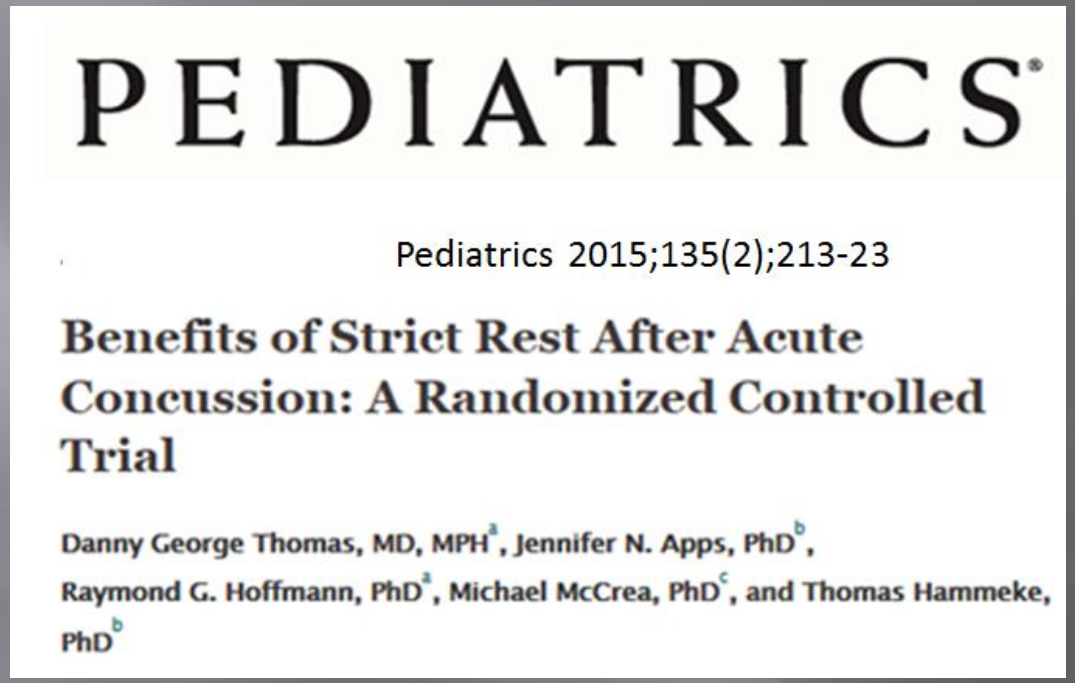
TREATMENT

Treatment

- Cognitive as well as physical rest is important
- Cognitive rest important in peds
- Many clinicians recommend "cocoon therapy" which may worsen treatment*
- 24-48 hours of cognitive rest is reasonable
  - No evidence-based data on optimal rest period^

*Thomas D, Apps J, et al 2015

^ McCrory P, et al 2013



PEDIATRICS

Pediatrics 2015;135(2);213-23

Benefits of Strict Rest After Acute Concussion: A Randomized Controlled Trial

Danny George Thomas, MD, MPH[a], Jennifer N. Apps, PhD[b], Raymond G. Hoffmann, PhD[a], Michael McCrea, PhD[c], and Thomas Hammeke, PhD[b]

- Strict rest for five days no more beneficial than up to 48 hours of rest
- No clinically significant difference in neurocognitive or balance outcomes
- Intervention group had more daily postconcussive sxs (over 10 days and slower symptom resolution)

Rest

- Advise pt in advance what to expect (they may get **BORED!!!)**
- Goal is to lessen imbalance between energy availability and energy needs
  - Restrict video games
  - Consider limiting computer use
  - Don’t restrict all social media (Facebook, texting, phone)
  - Restrict time in movies, mall, sporting events, and other high stimulation environments

Rest

- Accommodations
  - School absence when necessary
  - Also consider having the athlete **not** attend hardest classes initially
  - Initially attend ¼ day, then ½ day and then titrate up to full day
  - Breaks and extra time for homework
  - Extended time for assignments or tests
  - Work modifications if not able to completely take time off
  - Imperative to monitor physical activity

Rest- What Does Rest Mean?-

- Activities increase BP, pulse and temp (difficulty with regulation)
  - Can I go to Spring Fling/Disneyland/Magic Mountain?
  - Can I ride my bike to school and around campus?
  - Can I “celebrate” my birthday?
  - Can I “interact” with my GF/BF?
- Include ADL’s in physical exertion recommendations
  - Laundry, vacuuming, cleaning house, etc

Sleep

- Challenges
  - Circadian rhythm is disrupted after concussion
  - Sleep disturbances in 42-70% concussed athletes
  - Pain from other injuries can also impair quality/quantity of sleep

*Jaffee M et al *Brain Inj, 2015; 29(2): 221–227*

Sleep

- What is helpful
  - Sleep hygiene
    - Comfortable room temp (temp regulation often impaired)
    - Avoid stimulation immediately before bedtime
    - Go to bed/get up at same time
  - Try to avoid sleepers in acute phase
    - Re-evaluate if insomnia becomes a chronic problem
  - Remain on a schedule even if not participating in activities
  - Monitor use of all meds/supplements, MJ, herbals, kava, etc

Medical Therapies for Concussion

- Sleep (use after discussing sleep hygiene)
  - Antihistamines
  - Melatonin
  - Trazodone
  - Ambien
  - Benzos (negative effects on arousal and cognition)
- Somatic (HA)
  - OTCs- (caution- rebound HA)
  - Amitriptyline (good for tension- and migraine-type HA)
  - Topamax
  - BF, PT, trigger point injections, psychotherapy

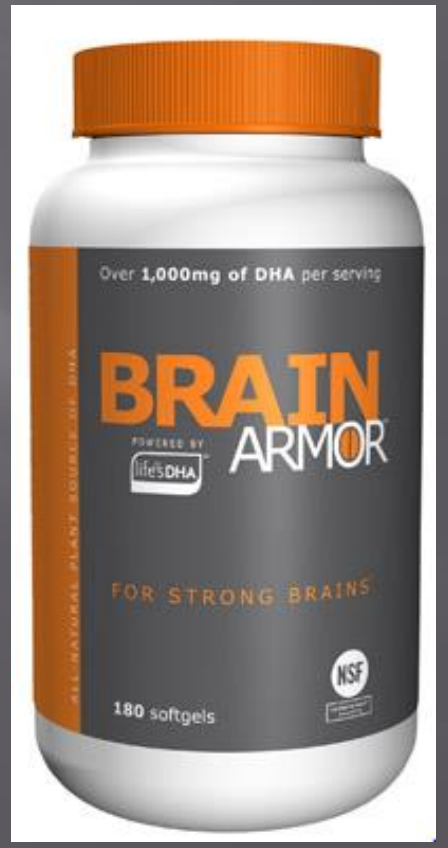
Medical Therapies for Concussion- (Con't)

- Emotional
  - Coping strategies, psychotherapy
  - Amitriptyline
  - Sertraline and other SSRIs
- Cognitive
  - Cognitive rehab for severe, prolonged sxs
  - Methylphenidate
  - Amantidine

Role of Nutrition

Question

- Omega-3 fatty acids can help recover from a concussion
  - True
  - False



Some Nutrients That Affect Cognition After Injury

Nutrient	Effects	Food sources
Omega-3 fatty acids (e.g. docosa-hexaenoic acid–DHA)	Improves cognition for expt TBI & expt Alzheimers; reduces cognitive decline in human aging	Fish, flaxseed, krill, kiwi fruit, walnuts
Ketones	Improves cognition for expt TBI; reduces seizures in human epilepsy	Ketogenic diet/supplements; Atkins diet
Lactate, pyruvate	Improves cognition for expt TBI	Intravenous infusion
Curcumin	Improves cognition for expt TBI & expt Alzheimers	Turmeric (curry spice)
Saturated fat	Worsens cognition for expt TBI & human aging	Butter, suet, lard, coconut oil, cottonseed oil, dairy, meat
Vitamin E	Improves cognition for expt TBI; reduces cognitive decline in human aging	Asparagus, avocado, nuts, peanuts, olives, spinach
Choline	Improves cognition for expt seizures; may be related to human cognitive function	Egg yolks, chicken, veal, turkey, liver, lettuce

Modified from Gomez-Pinilla F, Nature Rev Neurosci 2008

Courtesy of Chris Giza, UCLA

Omega 3 Fatty Acids

- Good rat data
  - Less membrane damage (Mills et al J Neurosurg 2010)
  - ↓oxidative stress after TBI (Wu A et al J Neurotrauma 2004)
  - ↓axonal damage after concussion (Mills JD et al N Neurosurg 2010 and Bailes and Mills J Neurotrauma 2010)
- Need good human studies

Omega 3 Fatty Acids

- Less membrane damage (Mills et al J Neurosurg 2010)
- ↓oxidative stress after TBI (Wu A et al J Neurotrauma 2004)
- ↓axonal damage after concussion (Mills JD et al N Neurosurg 2010 and Bailes and Mills J Neurotrauma 2010)
- …." The evidence is convincing that, if one had a pet rat and a book fell on its head, one should give it fish oil. The evidence is missing for humans. Therefore, although 6-3 PUFA seems safe and generally well tolerated and the potential benefit seems to be greater than the risk of taking fish oil, caution should be used in prescribing fish oil. Further work is needed to determine whether the use of 6-3 PUFA in humans, in particular DHA and EPA, produces clinically measurable benefits after concussion."
    - Trojian T, Jackson E *Curr Sp Med Rep 2011;10(4)180-185*

Vestibular

- Non-pharmacological
  - Vestibular PT
- Pharmacological
  - Tricyclics if also has migraines
  - SSRI’s if mood disorder

Ocular

- Treatment
  - Neuro-ophthalmologist
  - Prisms and other lenses rx'ed by vision therapy specialist
  - Vestibular therapist
  - Audiobooks
  - Note-taking services
  - Computer breaks (occupational and academic)

RTP

Factors That Determine the Length of Rest Period Before Progression

- How long did symptoms last?
- What were symptoms at time of injury?
- What were symptoms that persisted?
- Previous history of concussion
- Age of patient
- Confidence patient is being honest
- Risk of activity

Factors That Determine the Length of Rest Period Before Progression

- Non-medical factors
  - Season vs off-season
  - When is next competition
  - Ability to allow to practice without contact
  - “Necessity” to practice to be able to play
    - Many of these factors allow you to be more conservative
  - SAM/D^
  - SAD/M^

^ Not evidence-based!

Graduated RTP Protocol

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
1. No activity	Symptom limited physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity <70% maximum permitted heart rate No resistance training	Increase HR
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
4. Non-contact training drills	Progression to more complex training drills, eg, passing drills in football and ice hockey May start progressive resistance training	Exercise, coordination and cognitive load
5. Full-contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6. Return to play	Normal game play	

McCrory P et al Br J Sp Med 2013

Same day return to play

MODIFIERS

Concussion Modifiers

Factors	Modifier
Symptoms	Number Duration (>10 days) Severity
Signs	Prolonged loss of consciousness (LOC) (>1 min), Amnesia
Sequelae	Concussive convulsions
Temporal	Frequency—repeated concussions over time Timing—injuries close together in time 'Recency'—recent concussion or traumatic brain injury (TBI)
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion
Age	Child and adolescent (<18 years old)
Comorbidities and premorbidities	Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder (ADHD), learning disabilities (LD), sleep disorders
Medication	Psychoactive drugs, anticoagulants
Behaviour	Dangerous style of play
Sport	High-risk activity, contact and collision sport, high sporting level

McCrory P et al Br J Sp Med 2015

Modifiers*

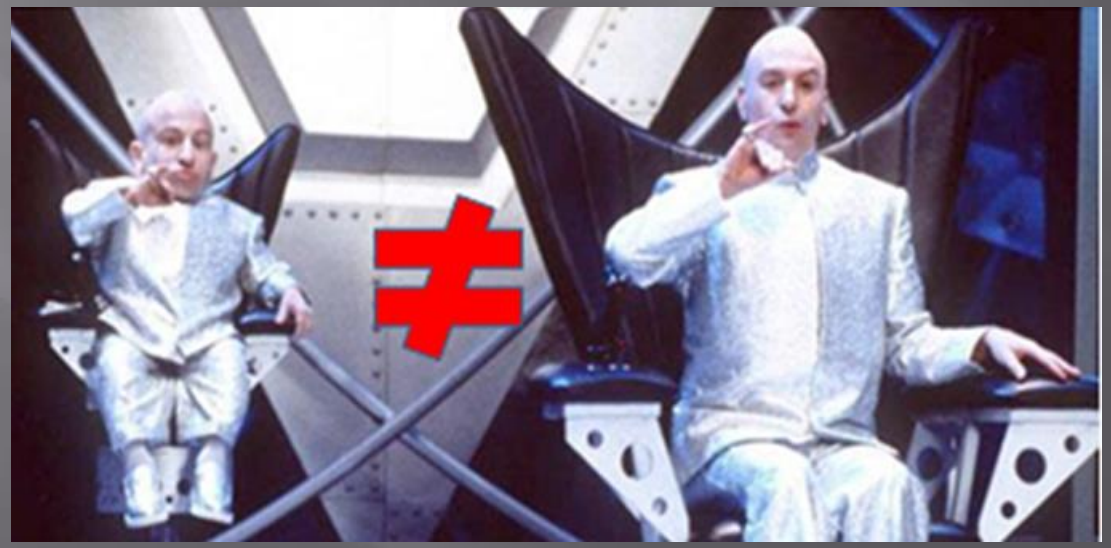
McCrory P et al Br J Sp Med 2013

- Symptoms (Prolonged LOC, dizziness)
- Signs
- Temporal
- Threshold
- Age
- Comorbidities (Migraines, Depression/anxiety, ADHD)
- Gender
- SAM/D^
- SAD/M^

^Personal Experience, not evidenced-based!

Pediatrics

- Children should be managed more conservatively
  - RTL prior to RTP
  - Slower progression back to sports
  - Kids still developing cognitively
  - Not completely myelinated neurons
  - Frontal lobes don’t mature until 20s
  - Immature brain more sensitive to effects of glutamine
  - More prolonged cerebral swelling



Prevention

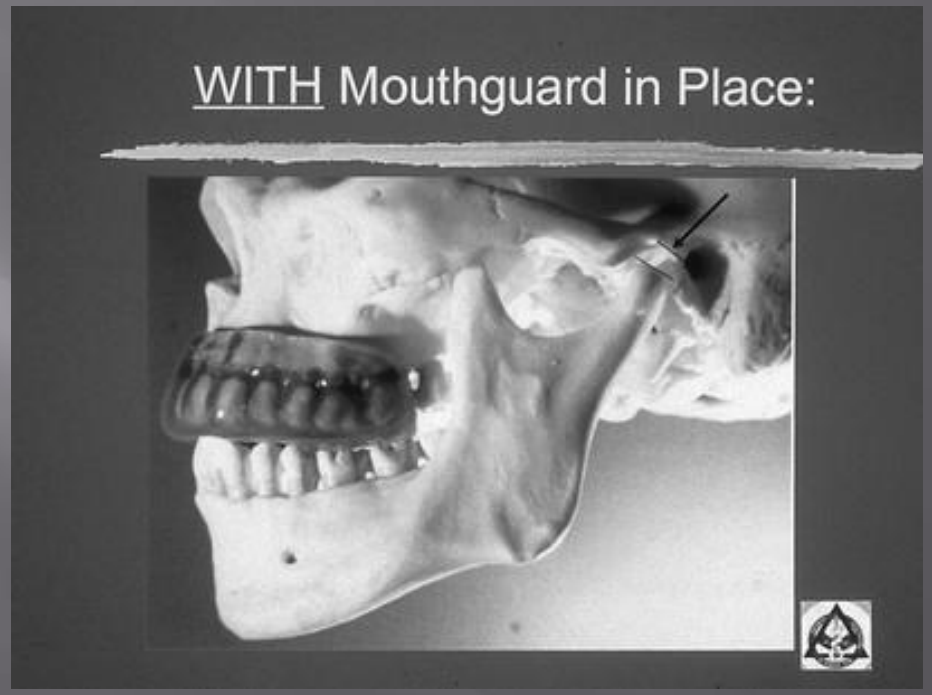
Questions

- Soccer head gear (such as Full 90) helps prevent concussions
  - True
  - False
- A custom mouth piece (as opposed to the “boil-and bite”) does not decrease one’s risk of concussions
  - True
  - False
- Improving neck strength and mass will decrease risk of a concussion
  - True
  - False

Mouthguards

- No help in concussion prevention or in reducing neurocognitive deficits
  - McCrory P *Br J Sports Med* 2001; *35*:81-82
  - Mihalik, Pardini,et al *Den Trauma 2007;* 23(1):14–20

Condylar Position with Mouthguards



Winters, JE *J Ath Train 2001 Jul–Sep; 36(3): 339–341*

Do Protective Devices Work?

SPORT	EQUIPMENT	EFFECTIVE	COMMENTS
Football	CMO	No	Facial/Dental
Rugby	Mouthguard	No	
Rugby	Headgear	Inconclusive	
Soccer	Headgear	No	
Field Hockey	Faceshield	Inconclusive	Facial/Dental
Ice Hockey	Faceshield	No	Faster RTP
Alpine Sports	Helmets	No evidence	Head injuries
Bicycle/Motor/ Equestrian	Helmets	No	Head injuries

Navarro, R *Current Sports Medicine Reports. 10(1):27-31, 2011*

McCrory P, et al. *Br J Sports Med 2013;47:250–258*

COMPLICATIONS

Complications

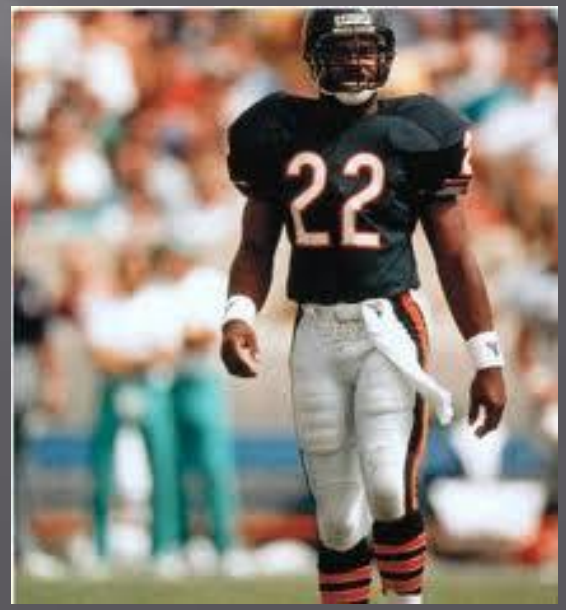
- Post concussion syndrome
  - Personality changes (irritable, aggressive)
  - Deficits in short-term memory and problem solving
  - Chronic headaches
  - Sleep difficulties
  - Anxiety and depression

Complications

- Second Impact Syndrome
  - Injury to person who is still recovering from a previous concussion
  - Get brain swelling and death
  - Only occurs in adolescents

Complications

- Chronic Traumatic Encephalopathy
  - Progressive neurodegeneration clinically associated with memory disturbances
  - Behavioral and personality changes
  - Parkinsonism
  - Speech and gait abnormalities



Collins M et al *Knee Surg Sports Traumatol Arthrosc (2014) 22:235–246*

NFL Lawsuits

- Approximately a dozen lawsuits have been filed against the NFL claiming that the league and its doctors knew the long-term risks of concussions and failed to protect the players
  - **SETTLED!** – AUGUST, 2013
    - ***$765 Million***
      - ***REJECTED BY JUDGE!!!***
        - ***NOT ENOUGH $…***

Courtesy of Randy Cohen, ATC

NCAA LAWSUITS

- Two cases currently consolidated in the Northern District of Illinois seeking class action status
- *Arrington v. National Collegiate Athletic Association*
- NCAA has rejected these claims
- NCAA has a greater exposure than the NFL
- NCAA's history with concussions is being questioned…

In Closing

- Concussions can be frustrating
- Present in different ways
- Have a good plan for sideline evaluation
- More active treatment than traditional
- Be conservative with any RTP decisions in an adolescent

In Closing

- See concussion patients on a weekly basis
  - How doing in school, assess needs for accommodations, meds, etc
  - See concussion patients later in the day
  - Know and utilize your athletic trainer
  - Be specific in recommendations for progression back to activities

In Summary

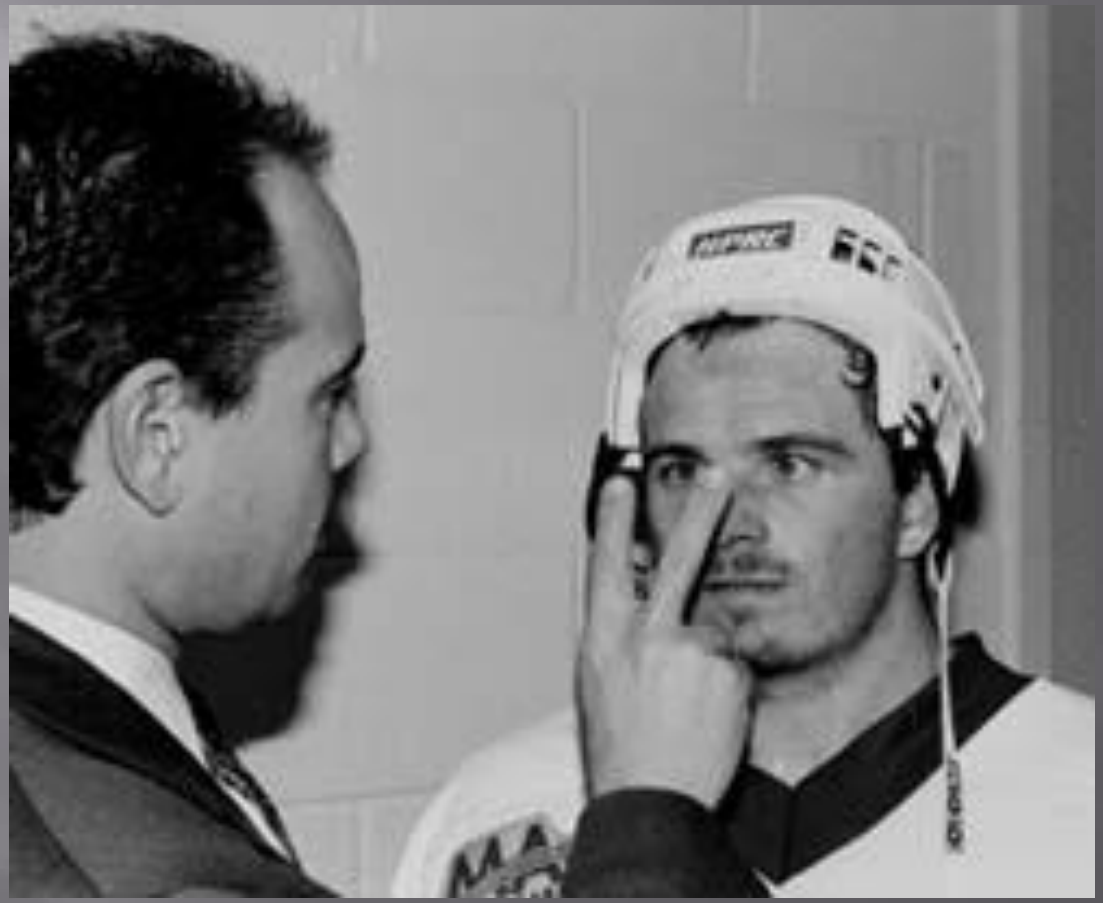
- Interdisciplinary approach to the management of concussion:
  - Physician
  - ATC
  - Neurologist
  - Neuropsychologist
  - PT
  - Audiologist
  - Coach/AD/Teacher
  - Neuro-optometrist/ophthalmologist
  - Other specialists as needed

WHEN IN DOUBT, SIT THEM OUT!

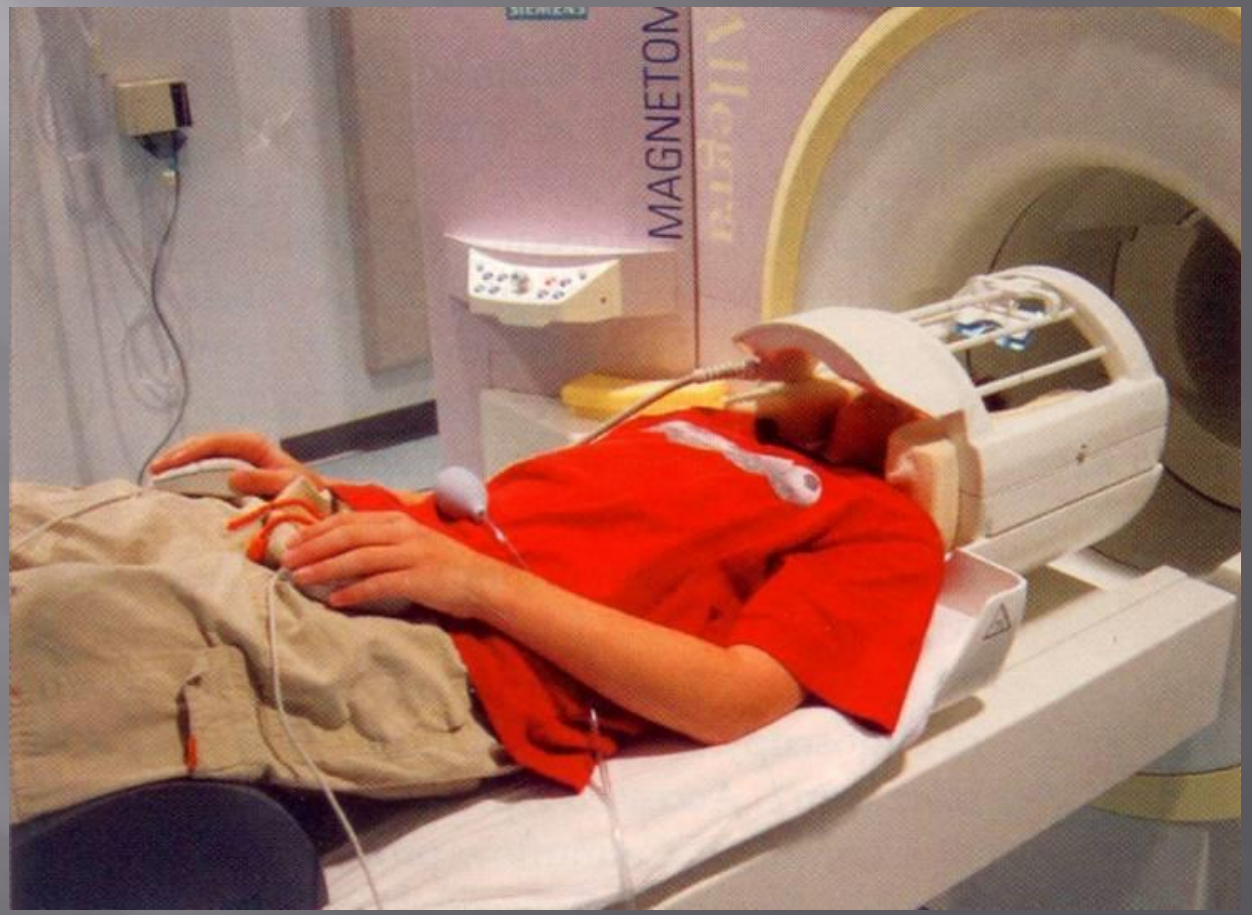
(Even if they and the coaches/parents pout!)

If They Sway, They Do Not Play!

Where we've been.....

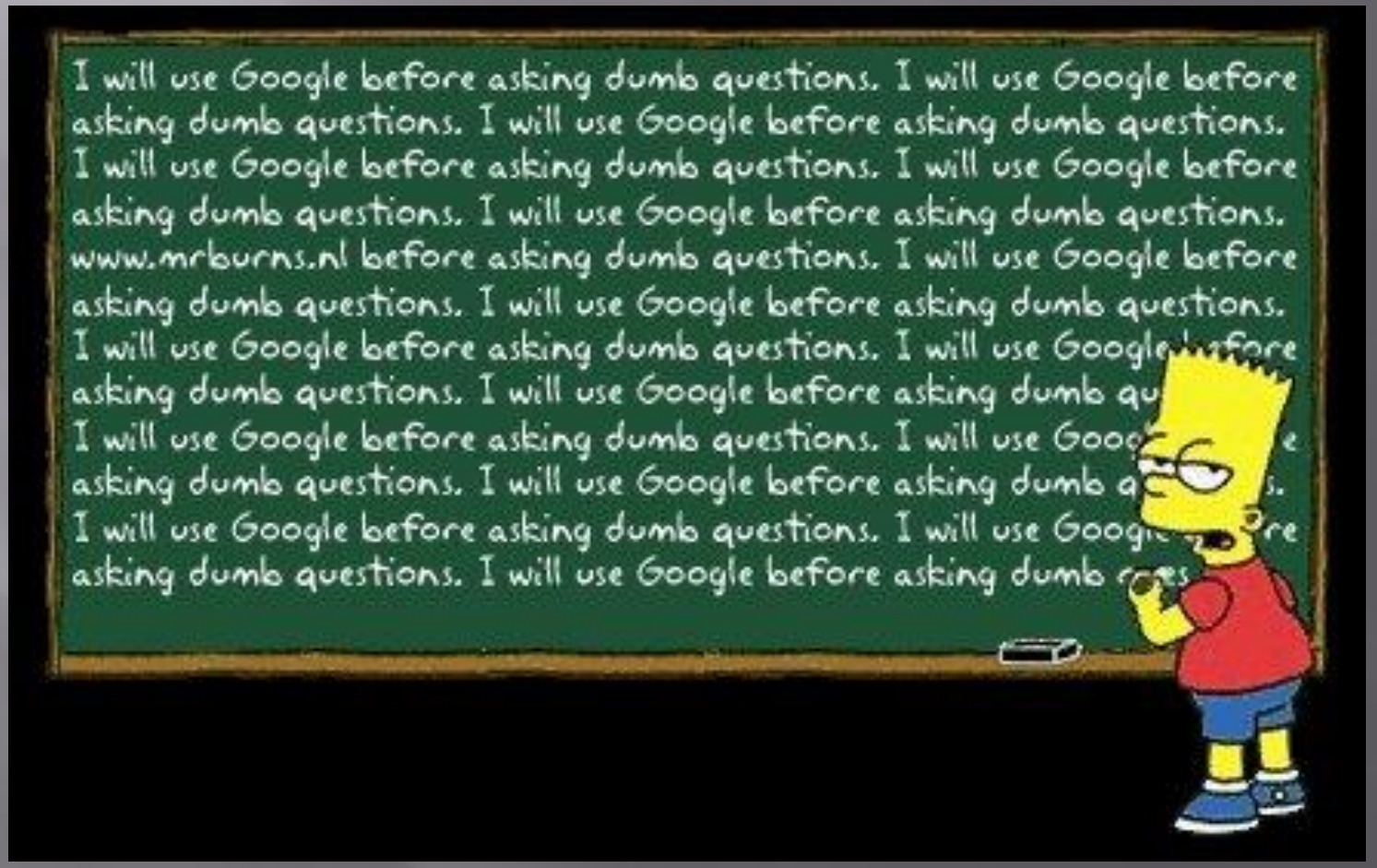


……Where we are now



danke
謝謝
ngiyabonga
teşekkür ederim
спасибо
dank je
thank you
gracias
tapadh leat
bedankt
hvala
mauruuru
mochchakkeram
dziękuję
go raibh maith agat
sagolun
sukriya
kop khun krap
obrigado
arigato
takk
dakujem
grazie
мерси
terima kasih
merci

Questions, Dude?



References

- McCrory P, et al. *Br J Sports Med 2013;47:250–258*. 4th Intl Conference on Concussion in Sport
- SCAT-3- Download at http://bjsm.bmj.com/content/47/5/259.full.pdf
- CDC. 2013. Implementing return to play: Learning from the experiences of early implementers. http://www.cdc.gov/concussion/policies/rtp_implementation.html
- Thomas D, Apps *J et al Pediatrics 2015;135 (2); 213-223*

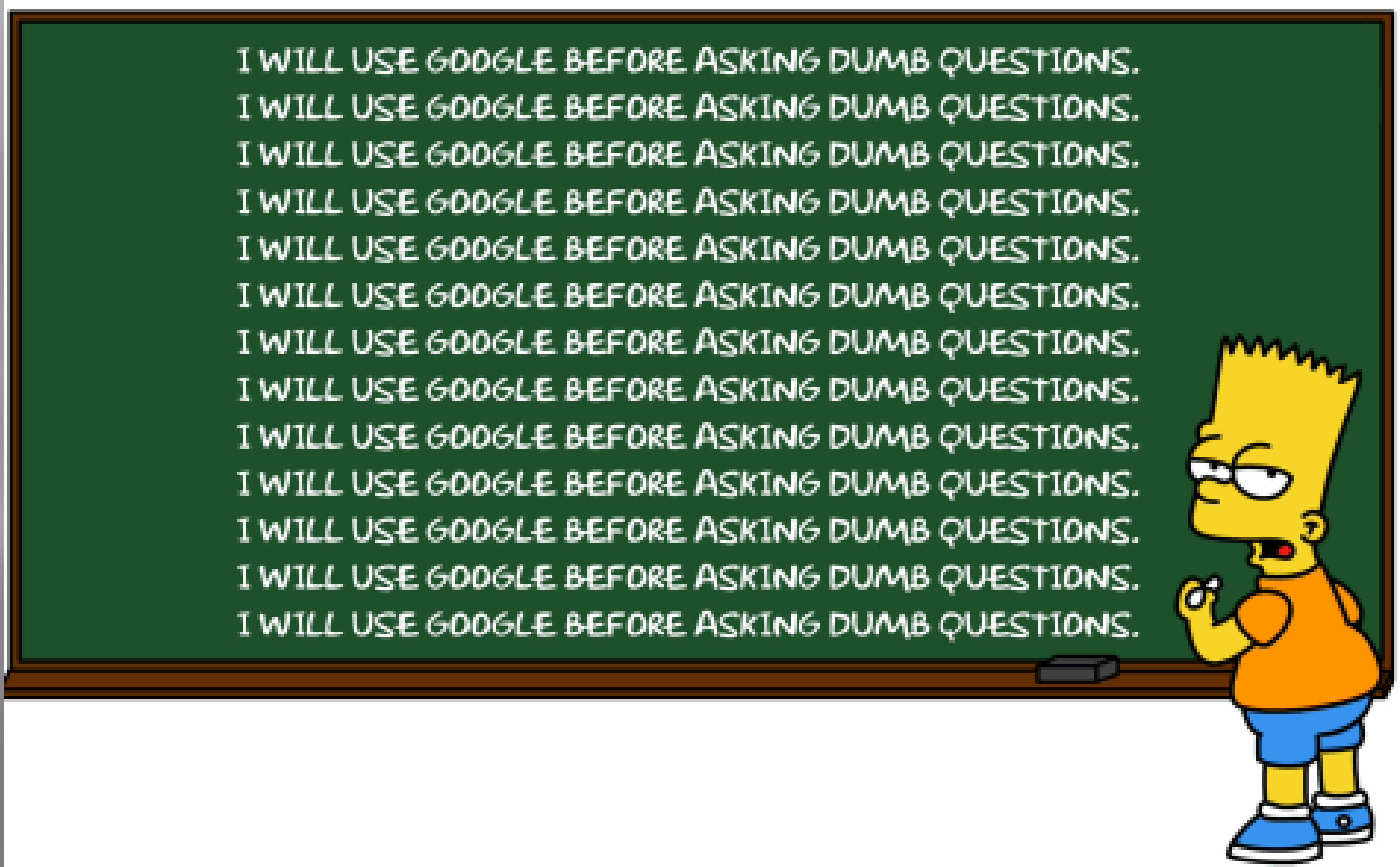
References

- Collins CL et al *J Primary Prevent (2014) 35:309–319*
- Bailes J et al *J Neurosurg 2013;119(5):1235-1245*
- Navarro, R *Curr Sp Med Rep. 10(1):27-31, 2011*
- Jaffe M, et al *Brain Inj, 2015; 29(2): 221–227*
- Meehan WP *Clin Sports Med; 30(1): 115*
- Gomez-Pinilla F *Nature Rev Neuro* **9**, 568-578 2008
- Giza C, Hovda D *Neurosurgery 75:S24–S33, 2014*
- Collins M et al *Knee Surg Sports Traumatol Arthrosc (2014) 22:235–246*

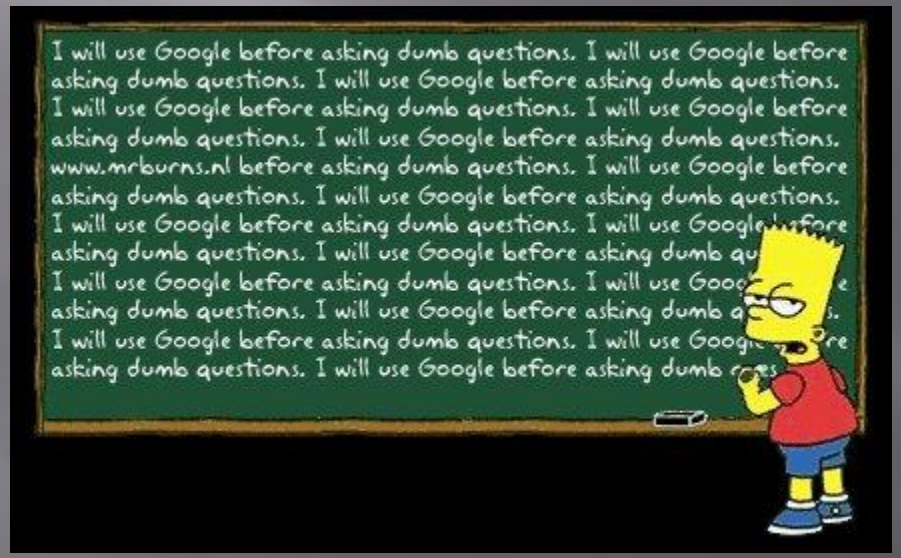
Donald E. Porter, MD
Campus Health Services, University of Arizona
Head Team Physician, University of Arizona
Arizona Institute for Sports Medicine
Phone: 520-626-6363
E-mail: dporter@email.arizona.edu

Integrating all data in decision-making in concussion management

Questions, Dude?



Questions, Dude?



Concussion in Sport, An Update

Saturday, April 25, 2015

Donald E. Porter, MD
dporter@email.arizona.edu