

# *SPORT-RELATED CONCUSSIONS*

*Michael Czarnota, Ph.D.*

*OHL*

*WHL*

*NOJHL*

*CENTRAL HOCKEY LEAGUE*

*ECHL*

*PHPA*

*HOCKEY CANADA*

***SportConcussions.com***

# *Current Concussion Definition*

- Complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces
- Rapid onset of short-lived impairment of function that resolves spontaneously
- Acute clinical symptoms largely reflect functional disturbances, not structural injury

# *Brain Facts*



- Around 1300-1400 g (3lbs)
- Slightly firmer than Jello
- Floating in 150 cc CSF (about 5 oz)
  
- < 2% of total body weight
- Consumes 20% of oxygen and blood flow

# *More Brain Facts*



- 100 Billion neurons
- 15 Trillion synapses (connections)
- Neurons respond electrically when Go signals exceed No-Go signals
- Waking activity 10-23 watts of power
- 150,000 km of myelinated fibers





[ebaumsworld.com](http://ebaumsworld.com)

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- [http://www.youtube.com/watch?v=bunwlS8i\\_Xc](http://www.youtube.com/watch?v=bunwlS8i_Xc)

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- [http://www.youtube.com/watch?v=wW9Jc\\_K9AXs](http://www.youtube.com/watch?v=wW9Jc_K9AXs)



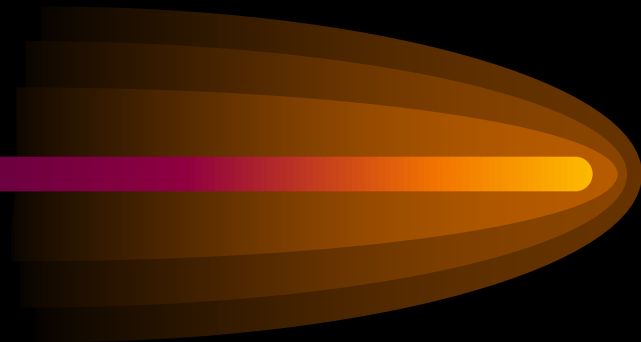
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- <http://www.youtube.com/watch?v=cIXcGOR4-04>

<http://www.youtube.com/watch?v=-GMGNAg4VPg>

- Cormier-Tam



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- <http://www.youtube.com/watch?v=Csu27WEjN54>

<http://www.youtube.com/watch?v=RNOZeBTySHw>

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- <http://www.youtube.com/watch?v=yLZiet9mhyg>






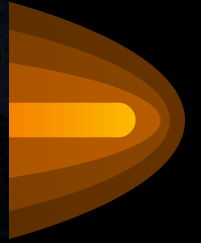




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- <http://www.youtube.com/watch?v=Tyv4du7BTOc>

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- Decerebrate posture is an abnormal body posture that involves the arms and legs being held straight out, the toes being pointed downward, and the head and neck being arched backwards. The muscles are tightened and held rigidly. This type of posturing usually means there has been severe damage to the brain.





# *Cellular Response to Injury*

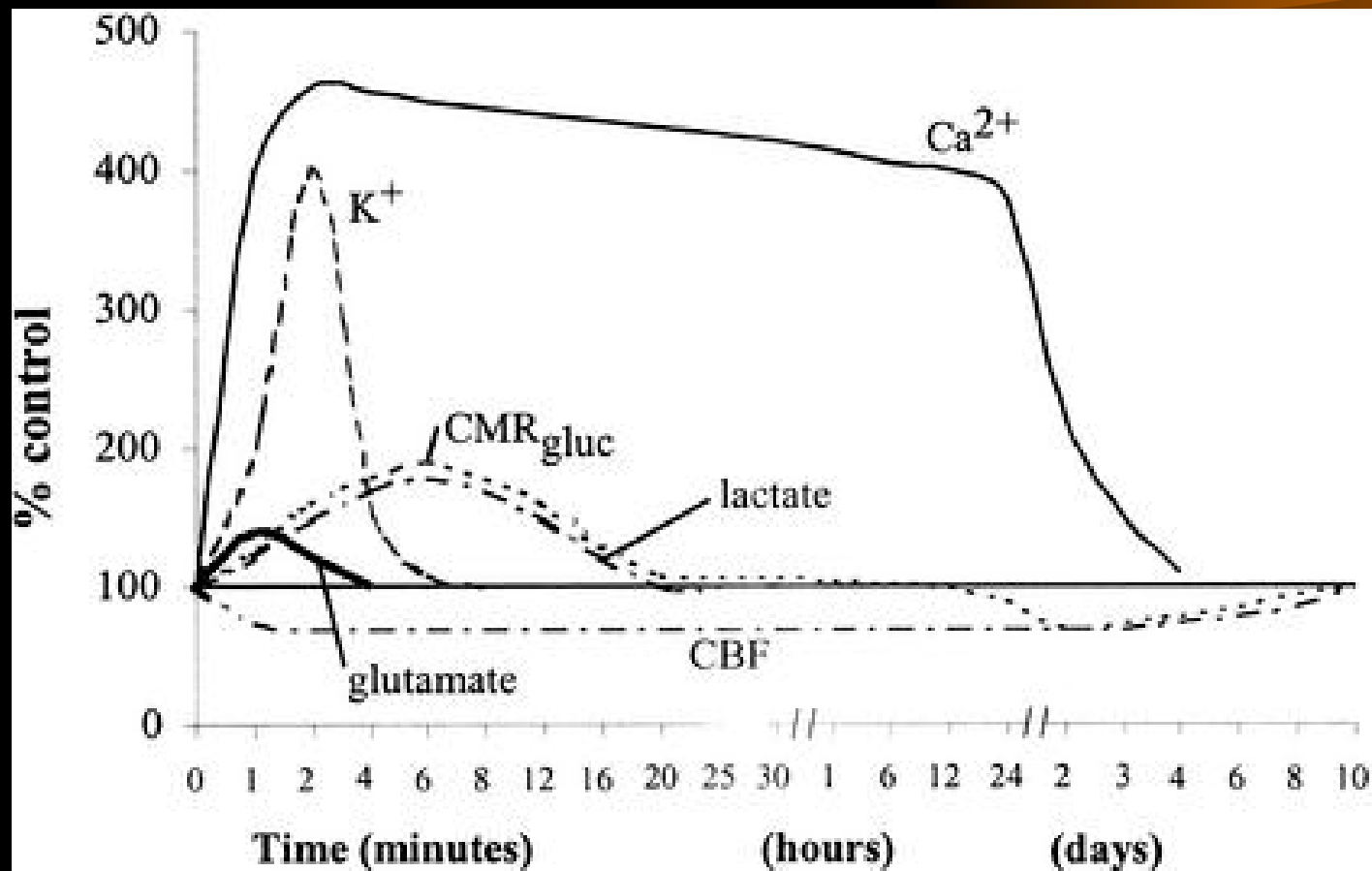
- Apoptotic proteins
- Uncontrolled release of proteases, lipases and endonucleases
- Degradation of cell membrane and cytoskeletal proteins, mitochondrial failure & production of free radicals
- Axonal swelling and degeneration of otherwise undamaged neurons

# *Cellular Response to Injury*

- Ionic flux -  $K^+$  out and  $\uparrow$  glutamate
- $\uparrow$  energy demands to re-establish intracellular  $K^+$  levels
- $\downarrow$  cerebral blood flow

*Energy crisis & potential vulnerability*

# *Neurometabolic Changes*



# *Signs & Symptoms*

Dizziness	Feeling dinged	Emotional
Confusion	Seeing stars	Vacant stare
Amnesia	Ringing ears	Slurred speech
LOC	Double vision	Change in pers.
Headaches	Unsteady gait	Altered playing
Poor Balance	Slow response	Dec. awareness
Fatigue	Poor conc.	Nausea



# *Concussion Principle #1*



*WHEN IN DOUBT, SIT THEM OUT*

# *Possible Consequences*

- **Second Impact Syndrome**

- Second impact has been shown to occur up to 14 days post-injury
- Athlete returns to competition before resolution of symptoms

## *Catastrophic increase in intracranial pressure*

- Vasomotor paralysis, edema, massive swelling, herniation, death

## *Most often occurs in athletes <21 years old*

- Neuro-chemical processes appear to differ in developing brain

# *Possible Consequences*

## **Post-Concussion Syndrome**

- Decreased Processing Speed
- Short-Term Memory Impairment
- Concentration Deficit
- Irritability/Depression
- Fatigue/Sleep Disturbance
- General Feeling of “Fogginess”
- Post-Concussion Syndrome
- Academic Difficulties

# *Relatively Common Injury*

- CDC estimates 1.8 million concussions/year
- Collision sports, i.e., football & ice hockey
- Major junior rates equivalent to NHL
- NCAA men's hockey - the injury most likely to keep a player out of competition
- Overall: 10-15% of participants/year

# *Incidence in Young Adults*

- ECAA men's hockey – 3.16/1000 AE (*Flik, et al., 2005*)
- NCAA men's hockey – 1.47/1000 AE (*Agel, et al., 2007*)
- NCAA women's hockey – 2.72/1000 AE (*Agel, et al., 2007*)
- NHL – 1.76/1000 AE

# *Risk for Further Injuries?*

- Athletes with a self-reported hx of >3 concussions have greater post-injury decrements compared to those without previous hx (*Iverson, et al., 2003*)
- No difference in neurocognitive performance between athletes with 0, 1 or 2 previous self-reported concussions (*Iverson, et al., 2006*)
- Within-season repeat injury rate of 6.5%, 92% of which occurred within 10 days of initial injury (*Guskiewicz, et al., 2003*)

# *Long-term Issues*

- Genetic risk factors (*ApoE4*)
- MCI, AD, depression (Retired athletes)
- Boxing, *cf* Jordan (2000)
- Youth recover more slowly





# *Rule 48 - Illegal Check to the Head*

- **48.1 Illegal Check to the Head** – A lateral or blind side hit to an opponent where the head is targeted and/or the principal point of contact is not permitted.
- **48.2 Minor Penalty** - There is no provision for a minor penalty for this rule.
- **48.3 Major Penalty** - For a violation of this rule, a major penalty shall be assessed (see **48.4**).
- **48.4 Game Misconduct** – An automatic game misconduct penalty shall be assessed whenever a major penalty is assessed under this rule.
- **48.5 Match Penalty** - The Referee, at his discretion, may assess a match penalty if, in his judgment, the player attempted to or deliberately injured his opponent with an illegal check to the head.
- **48.6 Fines and Suspensions** – Any player who incurs a total of two (2) game misconducts under this rule, in either regular League or playoff games, shall be suspended automatically for the next game his team plays. For each subsequent game misconduct penalty the automatic suspension shall be increased by one game.

# *OHL – Checking to the Head*

2006

- Rule 44B – Checking to the Head
- 44B.1 Checking to the Head - The act of checking an opponent to the head in any manner.
- 44B.2 Minor Penalty – A minor penalty shall be assessed to any player who checks an opponent to the head area.
- 44B.3 Major plus Game Misconduct Penalty – At the discretion of the referee and based on the degree of impact a major penalty and a game misconduct can be assessed any player who checks an opponent to the head area.
- 44B.4 Match Penalty – A match penalty shall be assessed to any player who deliberately attempts to injure an opponent by checking to the head area.
- Note: A hit to the head with a shoulder shall be considered an illegal check and shall be penalized as checking to the head.



# *NHL Protocol - 2011*

- Players showing possible concussion symptoms must now be taken to a quiet room away from the ice and bench area. They are to be evaluated for roughly 15 minutes by team medical personnel under the standardized concussion assessment method known as SCAT2, an acronym for Sport Concussion Assessment Tool.

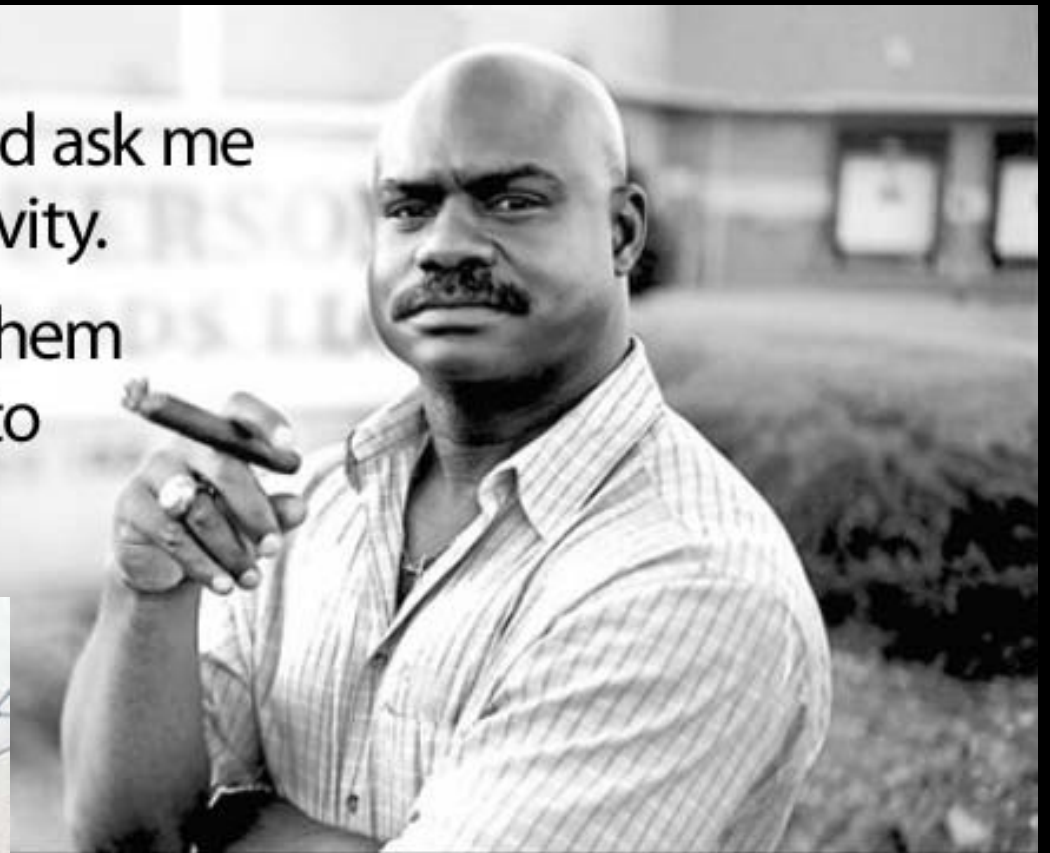
# *NHL 5 point plan*

1. 1) Mandatory removal from play if a player reports any listed symptoms or shows any listed signs (loss of consciousness ... Motor incoordination/balance problems ... Slow to get up following a hit to the head ... blank or vacant look ... Disorientation (unsure where he is) ... Clutching the head after a hit ... Visible facial injury in combination with any of the above).
2. 2) Examination by the team physician (as opposed to the athletic trainer) in a quiet place free from distraction.
3. 3) Team physician is to use 'an acute evaluation tool' such as the NHL SCAT 2 as opposed to a quick rinkside assessment.
4. 4) The Board will be approached to elevate the standard in which a Club and its Coach can be held accountable if it has a number of 'repeat offenders' with regard to Supplementary Discipline.
5. Review of player equipment and rink safety





“ People would ask me  
about longevity.  
I would tell them  
I was going to  
die at 42.”



PLEASE,  
SEE THAT MY BRAIN IS  
GIVEN TO THE NFL'S BRAIN BANK



# *Air Canada Sponsorship (2011)*

- *"From a corporate social responsibility standpoint, it is becoming increasingly difficult to associate our brand with sports events which could lead to serious and irresponsible accidents; action must be taken by the NHL before we are encountered with a fatality.  
"Unless the NHL takes immediate action with serious suspension to the players in question to curtail these life-threatening injuries, Air Canada will withdraw its sponsorship of hockey."*

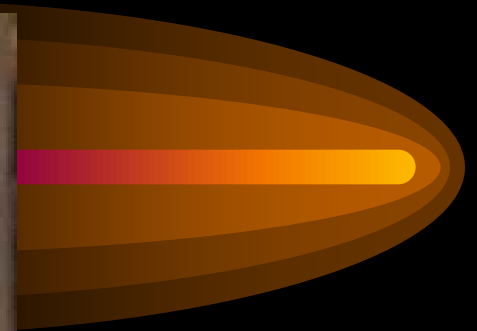
*March, 2011*

- Montreal police started a criminal investigation Thursday into the on-ice hit by Boston's Zdeno Chara that left the Canadiens' Max Pacioretty with a severe concussion and cracked vertebra.



- New concussion rule: game players will no longer be allowed the option of playing a concussed player in the same game.





# *Youth Hockey* (2011)

- OHF decides no checking in house or select hockey at any age or level.
- USAH moves to delay checking from PeeWee to Bantam

# *Hockey Canada - 2011*

- "In minor and female hockey, a minor penalty will be assessed to any player who accidentally contacts an opponent in the head, face or neck with their stick or any part of the player's body or equipment. If the contact is intentional then it's a double minor.
- In junior and senior hockey, a minor and a misconduct penalty, or a major and a game misconduct penalty, at the discretion of the referee based on the degree of violence of impact, will be assessed to any player who checks an opponent to the head area in any manner. A major and a game misconduct penalty shall be assessed any player who injures an opponent under this rule.
- A match penalty will be assessed to any player who deliberately attempts to injure or deliberately injures an opponent under this rule."

## *US Response*



- 23 States with concussion legislation aimed at education, awareness and management
- 19 States with similar legislation pending



# *NFHS - 2010*



Effective with the 2010 high school football season, any player who shows signs, symptoms or behaviors associated with a concussion must be removed from the game and shall not return to play until cleared by an appropriate health-care professional.

# *High School Lawsuit (2011)*

- Athlete continued to play even though teammates told the coach and a trainer that he was behaving strangely;
- Suing Coach, Principal and Athletic trainer for "deliberate disregard for his welfare" in allowing him to be injured repeatedly."
- ... failing to protect a student from concussions.

# *NFL Players' Lawsuit - July 2011*

- 75 former players allege that the NFL has covered up the harmful effects of -concussions
- The NFL neither informed its players about the long-term effects of concussions nor protected them from the risk of head injuries.
- NFL is claimed to be an “industry icon”, after which all lower leagues model themselves – template for other suits?

# *NCAA Lawsuit - October, 2011*

- Two more former college football players have sued the NCAA, saying it failed to protect them from concussions.
- Both claim they have suffered preventable brain trauma.
- Attorneys for the players say the NCAA failed to establish a head injury screening system and hasn't enforced safety measures introduced in the 1970s.
- The lawsuit seeks to have the NCAA institute a medical monitoring program.

# *Ivy League (2011)*

- Max. of two full-contact days per week, a 60-percent reduction from the NCAA limits.
- Full-contact Spring practices cut to a 42-percent reduction from the NCAA maximum.
- Schools will continue to provide information to student-athletes summarizing signs and symptoms of concussion, emphasizing the potential long-term risks of repetitive brain trauma, and stressing the need to report any symptoms of a concussion.
- Proper tackling techniques

# *NFL Memo 2011*

- The league reminded teams that a player should never play after suffering such an injury. The memo also explains that if a medical staff believes a player may have suffered a concussion but he has not been diagnosed, he should be taken out of the game.
- The memo includes a heading that reads, "WHEN IN DOUBT LEAVE THEM OUT," advising that teams should "always err on the side of caution."
- Also included is a reiteration of the "Madden Rule," which states that a player removed from a game with a concussion must be escorted to the locker room and observed for a potential need of immediate hospitalization, and that, under no circumstances, may he return to the field.

# *Hockey Modifications - 2011*

- The league (NHL, CHL) announced that all players must wear soft cap shoulder and elbow pads for the upcoming season.

## *New devices ?*

- Battle Sports Science – Impact Indicator chinstrap
- X2IMPACT – Impact-sensing mouthguard
- Shockstrip –





# *Impact Severity and Outcome*

- Over four seasons, 19 high school football athletes wearing instrumented helmets sustained 20 diagnosed concussions.
- Each athlete completed a baseline computer-based symptom and cognitive assessment during the pre-season and a post-Injury assessment within 24 h of injury.
- There appears to be no association between head impact biomechanics and post-concussive outcomes. As such, the use of biomechanical variables to predict injury severity does not appear feasible at this time.

*Broglio, et al. (2011). Journal of Neurotrauma*

# *Impact burden*

- 95 high school football players across four seasons of play using the (HITS); resulted in 101,994 impacts (190 practice sessions and 50 games). The number of impacts per 14 week season varied by playing position and starting status, with the average player sustaining 652 impacts.
- Seasonal linear acceleration burden of **16,746.1g**
- These findings cause conjecture on the relationship between sub-concussive head impacts incurred during football and late-life cerebral pathosis and justify discussion on ways to best minimize impacts and mitigate cognitive declines.

*Broglio, et al. (2011). Journal of Neurotrauma*

# *Reduced threshold?*

- The cumulative impact histories prior to 20 concussive impacts in 19 athletes were compared to the cumulative impact histories prior to the 3 largest magnitude non-concussive head impacts in the same athletes.
- No differences were present in any impact history variable between the concussive and non-concussive high magnitude impacts: the number of head impacts, cumulative HIT severity profile value, cumulative linear acceleration, and cumulative rotational acceleration during the same practice or game session, as well as over the 30 minutes and 1 week preceding these impacts.
- Data do not support the proposal that impact volume or intensity influence concussion threshold in high school football athletes.

*Broglio, et al. (2011). Journal of Neurotrauma*

# *Prediction of Injury*

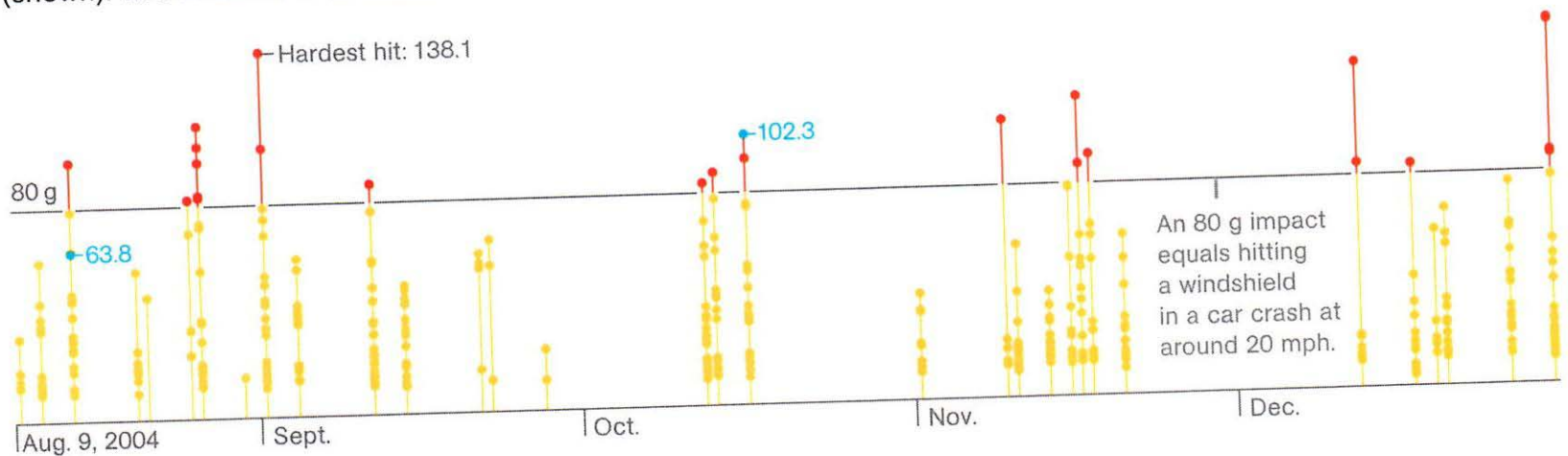


- Football studies – no relationship between force of impact (60– 168g) and onset of **concussion** (Guskiewicz, et al., 2007)
- 13-yr old male ice hockey players experience head accelerations comparable to college football players (Mihalik, et al., 2008)

## A Season of Collisions

One 21-year-old defensive end took 537 hits to the head during a season of football games and practices at the University of North Carolina. Of those, 417 had magnitudes of 10 g or more (shown). Two resulted in concussion.

When tracking head collisions, researchers focus on three variables: an impact's location and magnitude (right), and the frequency of hits (below). While magnitude matters, the biggest hits aren't necessarily the most damaging. Milder ones can add up to injury.



# *Detecting an Injury*



- Observation
- Self-report



# *Knowledge among Youth Coaches*



156 coaches of 8-14 yr old athletes surveyed

*(Valvolich McLeod, et al., 2007)*

- Average 10/16 on symptom recognition
- 53% able to correctly answer True/False statements





# *Do Professional Athletes Know One When They See One?*

- Did you have a concussion? - 8.4%
- Did you have S&S after a hit? - 44.8%
- 81.2% of players that may have been concussed failed to realize their injury

*(Delaney, et al., 1997)*

# *High School Football*

McCrea, et al., (2004) Clin J of Sport Med, 14(1), 13-17.

- Over 1,500 varsity athletes surveyed
- 15.3% reported concussion this season
- 47.3% actually reported their injuries

# *Barriers to Reporting*



- 66.4% - not serious enough to report
- 41% - fear of being withheld from play
- 36.1% - lack of awareness that injury occurred
- 19% - did not want to let teammates down

19% of NFL players hid symptoms *(AP, 11/19/09)*



*“I don’t feel I have a concussion problem. I have a problem with people giving me traumatic blows to the head.”*

*- Dean McAmmond, Ottawa Senators*

# *Traditional Methods*

- LOC is a poor predictor of symptoms and injury severity in athletic concussions
- CT and MRI are usually negative – studies are assessing *structural* not functional integrity



# *Advocacy for Better Management*

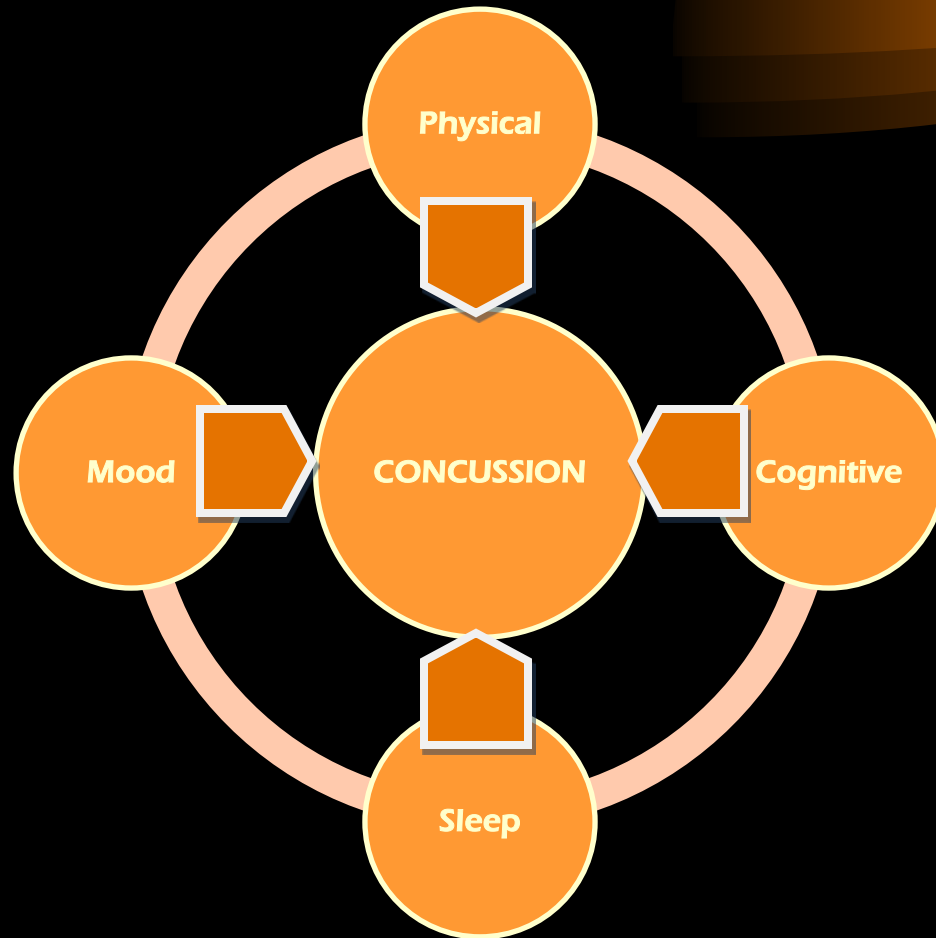
- CASM (2000)
- Concussion in Sports Group\* (2001, 2004, 2009)
- IIHF, FIFA, IOC
- NCAA\* (2004), NATA\* (2004)

*\* Identify Neuropsychological testing as a critical component to comprehensive concussion management*

# *League-wide Management Programs*

- NFL – 1995
- NHL – 1997
- OHL – 2002
- WHL – 2006
- CENTRAL HOCKEY LEAGE - 2008
- ECHL - 2009

# *Symptom Combination*





# *Concussion Principle #2*



***NEVER RETURN A SYMPTOMATIC  
PLAYER TO PLAY***

# *Need for Multiple Measures*



# *Modern Approach*

- Employ sensitive methods to objectively monitor symptoms through to resolution, i.e., neurocognitive testing via ImPACT
- Neurocognitive testing is most sensitive and clinically relevant when compared to individualized baseline data

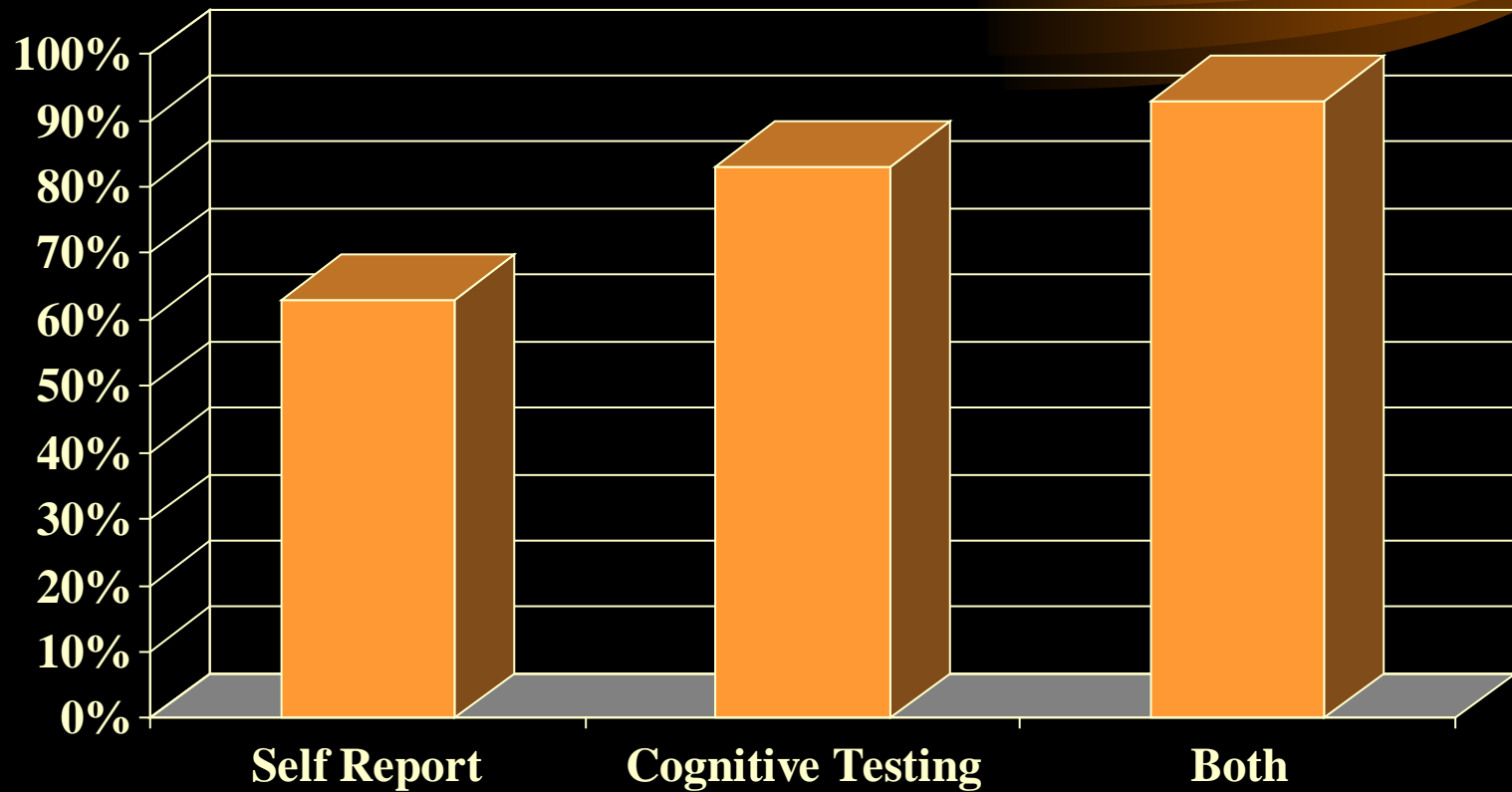
*Care is tailored to the individual athlete*

# *Neuropsychology Benefits*



- Functional evaluation by definition
- Objective
- Sensitive
- Repeatable

# *Added Value of ImPACT*



# *AAN Guidelines (1997; 2006)*

- Grade 1: Transient confusion, 0 LOC; PCSS < 15 min
- Grade 2: Transient confusion, 0 LOC; PCSS > 15 min
- Grade 3: Any LOC

# *Cantu Guidelines (1986; rev 2001)*

- Grade 1: No LOC; PTA/PCSS < 30 min
- Grade 2: LOC < 1 min or PTA > 30 min < 24 hours; PCSS > 30 min < 7 days
- Grade 3: LOC  $\geq$  1 min or PTA  $\geq$  24 hours; PCSS > 7 days

# *Prediction of Severity*

- 78 H.S./College concussions
- 72 hr. post-injury repeat ImPACT
- 44 - Good outcome
- 34 - Poor outcome
- RTA: 10 x more likely to be classified “poor”
- PTA: 4.2 x more likely to be classified “poor”
- LOC: No difference
- Disorientation: No difference



# Pathognomonic Signs

IN THE BLEACHERS

BY STEVE MOORE



# *Evaluation of RTA*



- Score of previous period
- Score at the time of the hit
- Name of stadium/rink
- Opponent's name
- Opponent's colors
- Details of the hit/play

# Rinkside Evaluation

## SCAT2

Sport Concussion Assessment Tool 2



Name \_\_\_\_\_

Sport/team \_\_\_\_\_

Date/time of injury \_\_\_\_\_

Date/time of assessment \_\_\_\_\_

Age \_\_\_\_\_ Gender  M  F

Years of education completed \_\_\_\_\_

Examiner \_\_\_\_\_

### What is the SCAT2?\*

This tool represents a standardized method of evaluating injured athletes for concussion and can be used in athletes aged from 10 years and older. It supersedes the original SCAT published in 2005<sup>1</sup>. This tool also enables the calculation of the Standardized Assessment of Concussion (SAC)<sup>2</sup> score and the Maddocks questions<sup>3</sup> for sideline concussion assessment.

### Instructions for using the SCAT2

The SCAT2 is designed for the use of medical and health professionals. Preseason baseline testing with the SCAT2 can be helpful for interpreting post-injury test scores. Words in **italics** throughout the SCAT2 are the instructions given to the athlete by the tester.

This tool may be freely copied for distribution to individuals, teams, groups and organizations.

### 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 symptoms (like those listed below) and often does not involve loss of consciousness. Concussion should be suspected in the presence of **any one or more** of the following:

- Symptoms (such as headache), or
- Physical signs (such as unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour.

**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.

## Symptom Evaluation

### 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 (if applicable)	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

(Add all scores in table, maximum possible: 22 x 6 = 132)

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

### 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

## Cognitive & Physical Evaluation

1 **Symptom score** (from page 1)  
22 minus number of symptoms of 22

2 **Physical signs score**  
Was there loss of consciousness or unresponsiveness?  Y  N  
If yes, how long? \_\_\_\_\_ minutes  
Was there a balance problem/unsteadiness?  Y  N  
Physical signs score (1 point for each negative response) of 2

3 **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  
Localises to pain \_\_\_\_\_ 5  
Obeys commands \_\_\_\_\_ 6  
Glasgow Coma score (E + V + M) of 15

4 **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 SCAT2 summary score for serial testing.

\*This tool has been developed by a group of international experts at the 3<sup>rd</sup> International Consensus Meeting on Concussion in Sport held in Zurich, Switzerland in November 2008. The full details of the conference outcomes and the status of the tool are published in British Journal of Sports Medicine, 2009, volume 43, supplement 1.  
The outcome paper will also be simultaneously co-published in the May 2009 issues of Clinical Journal of Sports Medicine, Physical Medicine & Rehabilitation, Journal of Athletic Training, Journal of Clinical Neuroscience, Journal of Science & Medicine in Sport, Neurosurgery, Scandinavian Journal of Science & Medicine in Sport and the Journal of Clinical Sports Medicine.  
†McCrea P et al. Summary and agreement statement of the 2<sup>nd</sup> International Conference on Concussion in Sport, Prague 2004. British Journal of Sports Medicine, 2005, 39: 196-204.

5 **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

**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	candle	baby	finger
apple	0	1	0	1	paper	monkey	penny
carpet	0	1	0	1	sugar	perfume	blanket
saddle	0	1	0	1	sandwich	sunset	lemon
bubble	0	1	0	1	wagon	iron	insect

Immediate memory score of 15

**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

\*McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sports Medicine, 2001, 11: 176-181.  
†McCrea M, Randolph C, Kelly J. Standardized Assessment of Concussion: Manual for administration, scoring and interpretation. Waukegan, Wisconsin, USA.

\*Maddocks DL, Dickie GD, Saling NM. The assessment of orientation following concussion in athletes. Clin J Sport Med. 1995;5(1):2-3.  
†Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003, 2: 24-30.

# Rinkside Evaluation

## 6 Balance examination

This balance testing is based on a modified version of the Balance Error Scoring System (BESS). 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 consists 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

- Hands lifted off iliac crest
- Opening eyes
- Step, stumble, or fall
- Moving hip into > 30 degrees abduction
- Lifting forefoot or heel
- 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.

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

Condition	Total errors
Double Leg Stance (feet together)	of 10
Single leg stance (non-dominant foot)	of 10
Tandem stance (non-dominant foot at back)	of 10
<b>Balance examination score</b> (10 minus total errors)	<b>of 30</b>

## 7 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 successful 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

## 8 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

### Overall score

Test domain	Score
Symptom score	of 22
Physical signs score	of 2
Glasgow Coma score (E + V + M)	of 15
Balance examination score	of 30
Coordination score	of 1
<b>Subtotal</b>	<b>of 70</b>
Orientation score	of 5
Immediate memory score	of 5
Concentration score	of 15
Delayed recall score	of 5
<b>SAC subtotal</b>	<b>of 30</b>
<b>SCAT2 total</b>	<b>of 100</b>
<b>Maddocks Score</b>	<b>of 5</b>

Definitive normative data for a SCAT2 "cut-off" score is not available at this time and will be developed in prospective studies. Embedded within the SCAT2 is the SAC score that can be utilized separately in concussion management. The scoring system also takes on particular clinical significance during serial assessment where it can be used to document either a decline or an improvement in neurological functioning.

Scoring data from the SCAT2 or SAC 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.

## 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. You should not be left alone and must go to a hospital at once if you:

- Have a headache that gets worse
- Are very drowsy or can't be awakened (woken up)
- Can't recognize people or places
- Have repeated vomiting
- Believe unusually or seem confused, are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on your 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 follow a stepwise symptom-limited program, with stages of progression. For example:

- rest until asymptomatic (physical and mental rest)
- light aerobic exercise (e.g. stationary cycle)
- sport-specific exercise
- non-contact training drills (start light resistance training)
- full contact training after medical clearance
- return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistant training should only be added in the later stages.  
**Medical clearance should be given before return to play.**

Tool	Test domain	Time	Score
		Date tested	
		Days post injury	
SCAT2	Symptom score		
	Physical signs score		
	Glasgow Coma score (E + V + M)		
	Balance examination score		
	Coordination score		
SAC	Orientation score		
	Immediate memory score		
	Concentration score		
	Delayed recall score		
	<b>SAC Score</b>		
<b>Total</b>	<b>SCAT2</b>		
<b>Symptom severity score (max possible 132)</b>			
Return to play <input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> Y <input type="checkbox"/> N			

### Additional comments

## Concussion injury advice (To be given to 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. It is expected that recovery will be rapid, but 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 telephone the clinic or the nearest hospital emergency department immediately.**

### Other important points:

- Rest and avoid strenuous activity for at least 24 hours
- No alcohol
- No sleeping tablets
- Use paracetamol or codeine for headache. Do not use aspirin or anti-inflammatory medication
- Do not drive until medically cleared
- Do not train or play sport until medically cleared

Clinic phone number

Contact details or stamp

# *Post-injury Procedures*

- Manage symptoms – *Rest is Best*
- Conduct further assessment based on injury severity, rate of recovery, age, injury history, severity of the blow, player style, etc. – usually 72 hours or more
- Often defer until subjective symptoms have attenuated or remitted
- Need cognitive recovery (as well as subjective, behavioral and medical) before RTP

# *Concussion Principle #3*



*IT'S BETTER TO MISS ONE GAME  
THAN A WHOLE SEASON*

# *RTP Recommendations*

- No activity until asymptomatic
- Light aerobics (e.g., stationary cycling)
- Sport-specific training (e.g., skating in hockey; running in soccer)
- Non-contact training drills
- Full contact following medical clearance
- Game play

# *Other Factors to Consider*

- Concussion history of the athlete
- Age of athlete
- Severity of the injury
- Persistence of symptoms
- Frequency of injuries
- Severity of the concussive blow



# *Prevention?*

- Commercially available headgear will not reduce the likelihood of concussion (*McIntosh & McCrory, 2000; McIntosh, et al., 2009*)
- Similar rates of concussion incidence despite the use of polyurethane helmet cover (*Torg, et al., 1999*)
- Mouthguards *do not* prevent concussion



# *Injury Reduction*

- Proper use of approved equipment
- Mutual respect among players
- Proper playing (tackling, checking techniques)
- Recognize an injury when it occurs
- Obtain and follow proper injury care
- Never play while symptomatic – concussion is not a toughness issue

# *Clinic Presentation*

- Predisposing Factors – previous concussion, playing while symptomatic
- Precipitating Factors – acute symptoms (number, duration, severity), fear of disability, inadequate information
- Perpetuating Factors – reluctance to return to play, loss of social status and identity, medication side effects

# *Clinic Presentation*

- From 1997 to 2007, although participation had declined, ED visits for concussions in organized team sports in 8- to 13-year-old children had doubled and had increased by >200% in the 14- to 19-year-old group.

Bahkos, et al, (2010), *Pediatrics*



Along with water bottles and towels, Annie is responsible for fetching the concussion kit.

# *Concussion Principle #4*



## **Injury to the Brain is Different:**

- Cannot be iced
- Cannot be wrapped
- Cannot be splinted
- Cannot be arthroscopically managed
- Cannot be surgically replaced

# *Treatment Options*



- Early detection and recognition of persisting PCS
- Education and reassurance often sufficient
- Symptom-specific interventions
- Individualized RTP management strategies

# *Return to Play Goal*



- *Not anti-sport*
- Return a player as quickly and as safely as possible
- Resume a basal risk of injury





# *SPORT-RELATED CONCUSSIONS*



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