

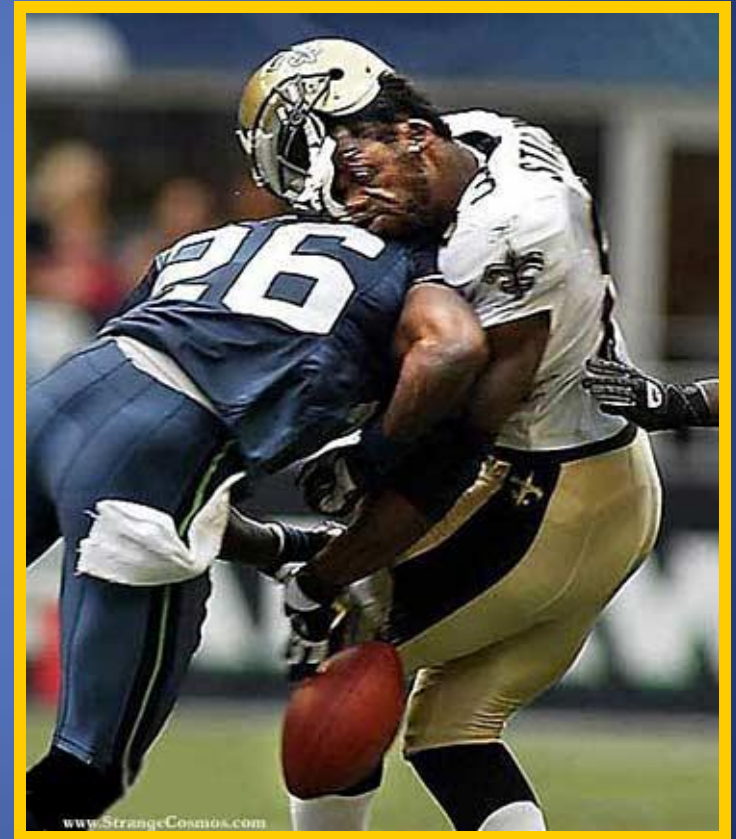
Concussions: Diagnosis and Current Management

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Introduction

- Definition
- History
- Diagnosis
- Management
- Return to play
- Controversies



Concussion- Defintion

- Zurich Nov 2012:
- “a brain injury”
- “a complex pathophysiological process affecting the brain, induced by biomechnical forces”



CONCUSSION

LOOK ON THE BRIGHT SIDE. FOR ONE BRIEF, GLORIOUS
MOMENT, YOU FORGOT YOU WERE ON THE CUBS.

Background

- Caused by:
 - “impulsive” forces transmitted to the head
- Symptoms:
 - typically rapid onset, or sx’s over minutes/hours
- Neuropathologic changes:
 - Functional but not structural injury
 - No abnormalities on current standard neuroimaging

Background

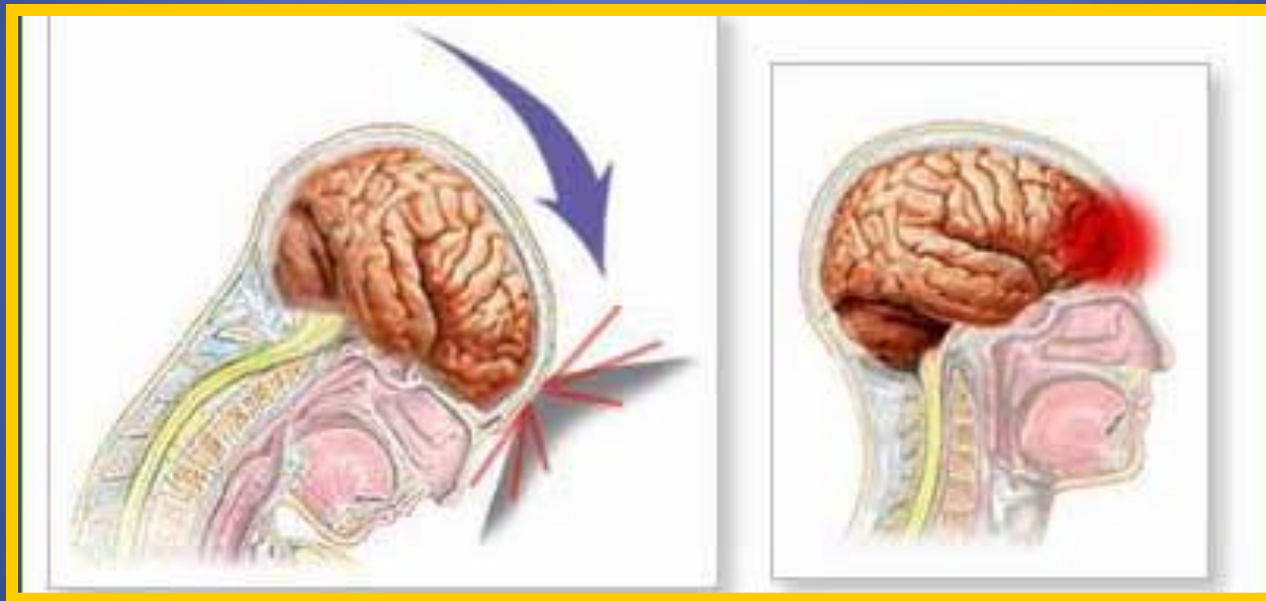
- Up to 3.8 million concussions/year in US
- 50% unreported
- Highest incidence in football
 - hockey, rugby, soccer, basketball, wrestling



RICHMOND HEIGHTS
LOCAL SCHOOLS



Pathophysiology



Pathophysiology

- Metabolic changes in IC and EC environment
 - Inc Na/K ATPase activation
 - Hyperglycolosis
 - High energy demand
- Decreased cerebral blood flow
 - Widespread cerebral neurovascular constriction
- Resultant metabolic mismatch

History of Concussion Care

- Before 2001- “grading”
 - Mostly based on LOC (10%)
- 2001- 1st International Conference on Concussion in Sport- Vienna
 - Abandoned grading
 - established no RTP same day, and RTP protocol



History of Concussion Care

- 2004- 2nd International Conference- Prague
 - “Simple” vs “Complex” (length of sx’s)
 - first SCAT card “Sport Concussion Assessment Tool”



1st SCAT- 2004

The SCAT Card (Sport Concussion Assessment Tool) MEDICAL EVALUATION

Name: _____ Date: _____
Sport/Team: _____ Mouth Guard? Y N

1) SIGNS

Was there loss of consciousness or unresponsiveness? Y N
Was there seizure or convulsive activity? Y N
Was there a balance problem/unsteadiness? Y N

2) MEMORY

Modified Maddocks questions (check those correct)

At what venue are we? ____ Which half is it? ____
Who scored last? ____ What team did we play last? ____
Did we win last game? ____

3) SYMPTOM SCORE

Total number of positive symptoms (from "SYMPTOMS" box on other side of the card) = ____

4) COGNITIVE ASSESSMENT

(Check those correct)

5 word recall	Immediate (Examples)	Delayed (after concentration tasks)
Word 1	cat	____
Word 2	pen	____
Word 3	shoe	____
Word 4	book	____
Word 5	car	____

Months in reverse order (circle those incorrect)

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

Digits backwards (check those correct)

5-2-8	3-9-1	____
6-2-9-4	4-3-7-1	____
8-3-2-7-9	1-4-9-3-6	____
7-3-9-1-4-2	5-1-8-4-6-8	____

Ask delayed 5-word recall now

5) NEUROLOGICAL SCREENING

	Pass	Fail
Speech	____	____
Eye Motion and Pupils	____	____
Pronator Drift	____	____
Gait Assessment	____	____

Any neurologic screening abnormality necessitates formal neurologic or hospital assessment.

6) 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:

1. rest until asymptomatic (physical and mental rest)
2. light aerobic exercise (e.g. stationary cycle)
3. sport-specific training
4. non-contact training drills (start light resistance training)
5. full contact training after medical clearance
6. 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. Resistance training should only be added in the later stages.

Medical clearance should be given before return to play.

INSTRUCTIONS:

This card is for the use of medical doctors, physiotherapists or athletic therapists. In order to maximize the information gathered from the card, it is strongly suggested that all athletes participating in contact sports complete a baseline evaluation prior to the beginning of their competitive season. This card is a suggested guide only for sports concussion and is not meant to assess more severe forms of brain injury.

Signs:

Assess for each of these items and circle - Y (yes) or N (no)

Memory:

Select any 5 words (an example is given). Avoid choosing related words such as "dark" and "moon" which can be recalled by means of word association. Read each word at a rate of one word per second. The athlete should not be informed of the delayed testing of memory (to be done after the reverse months and/or digits). Choose a different set of words each time you perform a follow-up exam with the same candidate.

SYMPTOMS: Headache, "pressure in the head", neck pain, balance problems or dizziness, nausea or vomiting, vision problems, hearing problems or ringing in the ears, "don't feel right", feeling "tinged" or "dazed", confusion, feeling slowed down, feeling like in a "fog", drowsiness, fatigue or low energy, emotional, irritable, difficulty concentrating or remembering

Concentration/Attention:

Ask the athlete to recite the months of the year in reverse order, starting with a random month. Do not start with December or January. Circle any months not recited in the correct sequence.

For digits backwards, if correct, go to the next string length. If incorrect, read trail 2. Stop after incorrect on both trials.

Neurologic Screening:

Trained medical personnel must administer this examination. These individuals might include medical doctors, physiotherapists or athletic therapists. Speech should be assessed for fluency and lack of slurring. Eye motion should reveal no diplopia in any of the 4 planes of movement (vertical, horizontal and both diagonal planes). The pronator drift is performed by asking the patient to hold both arms in front of them, palms up, with eyes closed. A positive test is pronating the forearm, dropping the arm, or drift away from midline. For gait assessment, ask the patient to walk away from you, turn and walk back.

Return to Play:

A structured, graded exertion protocol should be developed; individualized on the basis of sport, age and the concussion history of the athlete. Exercise or training should be commenced only after the athlete is clearly asymptomatic with physical and cognitive rest. Final decision for clearance to return to competition should ideally be made by a medical doctor.

This tool represents a standardized method of evaluating people after concussion in sport. This tool has been produced as part of the Summary and Agreement Statement of the Second International Symposium on Concussion in Sport, Prague, 2004. For more information see the "Summary and Agreement Statement of the Second International Symposium on Concussion in Sport" in the:

Clinical Journal of Sports Medicine 2005; in press

British Journal of Sports Medicine 2005;39: 196-204

Neurosurgery 2005; in press

Physician and Sportsmedicine 2005; in press

History of Concussion Care

- 2008- 3rd International Conference- Zurich
 - Abandoned “Simple vs Complex”
 - RTP expanded
 - Adult athletes may RTP more quickly. Namely “American football” players
 - Objective balance testing added
 - “BESS” Balance Error Scoring System
 - Greater recognition to neurophysiologic testing
 - Did not consider NP testing the standard of care
 - Difference between adolescents and adults (briefly) acknowledged

History of Concussion Care

- 2012- 4th International Conference- Zurich
 - Published March 2013
 - Recommended all athletes have a clinical neurological assessment (and cognitive function assessment)
 - But formal NP testing is NOT required for all athletes
 - “insufficient evidence to recommend the widespread routine use of baseline neuropsychological testing”
 - NO same day RTP

SCAT 3

Child SCAT 3

SCAT3™

Sport Concussion Assessment Tool – 3rd Edition

For use by medical professionals only



Name: _____ Date/Time of Injury: _____ Examiner: _____
Date of Assessment: _____

What is the SCAT3?

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. 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. Pre-season 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 5. 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 judgment. 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 neurological 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/abnormal movements, etc.)? ☐ Y ☐ N
- Disorientation or confusion (ability to respond appropriately to questions)? ☐ Y ☐ N
- Loss of memory: _____
- "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
- Eye 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)

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

2 Maddocks Score[®]

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

(Modified Maddocks questions (7 point for each correct answer))

- What venue are we at today?
- Which half is it now?
- Who scored last in this match?
- What team did you play last week/game?
- Did your team win the last game?

Maddocks score

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.

Child-SCAT3™

Sport Concussion Assessment Tool for children ages 5 to 12 years

For use by medical professionals only



What is childSCAT3?

The ChildSCAT3 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. No valid version, ages 13 years and over, please use the SCAT3. The ChildSCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool. Pre-season baseline testing with the ChildSCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the ChildSCAT3 are provided on page 5. If you are not familiar with the ChildSCAT3, 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 and 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 ChildSCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgment. An athlete may have a concussion even if their ChildSCAT3 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 concerned child displays any of the following, then do not proceed with the ChildSCAT3, 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 neurological signs
- Persistent vomiting
- Evidence of skull fracture
- Foot traumatic wounds
- Cerebrospinal fluid
- 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
- Eye 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)

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 child 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/abnormal movements, etc.)? ☐ Y ☐ N
- Disorientation or confusion (ability to respond appropriately to questions)? ☐ Y ☐ N
- Loss of memory: _____
- "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[®]

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

(Modified Maddocks questions (7 point for each correct answer))

- Where are we at now?
- Is it before or after lunch?
- What did you have last lesson/class?
- What is your teacher's name?

child-Maddocks score

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: _____ Gender: ☐ M ☐ F
Age: _____
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 migraine? ☐ Y ☐ N

Does the child have a learning disability, dyslexia, ADHD/ADD, autism 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: _____

Concussion Diagnosis

- An athlete that shows any feature of a concussion
 - Immediate removal from practice/play
 - Urgent evaluation by a physician or other licensed healthcare provider (ex: athletic trainer)
 - Attention to C-spine



Concussion signs/symptoms

- Headache- most common
- “Pressure in head”, neck pain, n/v, dizziness, blurred vision, balance problems, sensitivity to light/noise, feeling slowed down, feeling like “in a fog”, “don’t feel right”, difficulty concentrating/remembering, fatigue or low energy, confusion, drowsiness, trouble falling asleep, more emotional, irritability, sadness, nervous or anxious

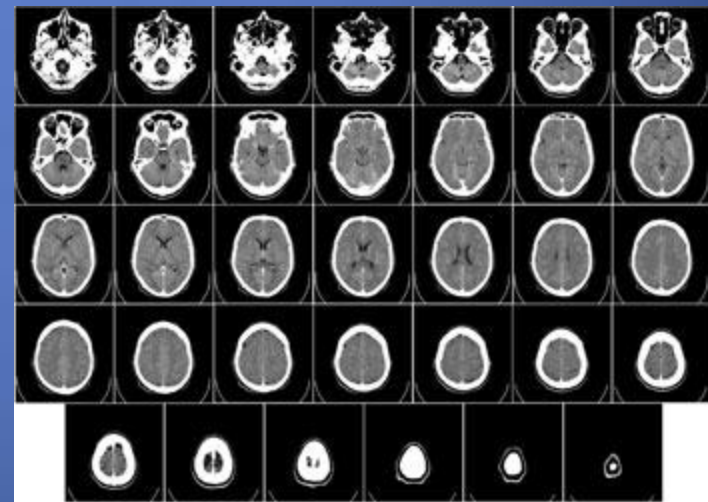
Different Clinical Presentations

- Concussions can manifest
 - Symptoms
 - Headache
 - Physical signs
 - LOC, amnesia
 - Behavioral changes
 - Mood changes
 - Cognitive impairment
 - School
 - Sleep disturbance
 - Insomnia



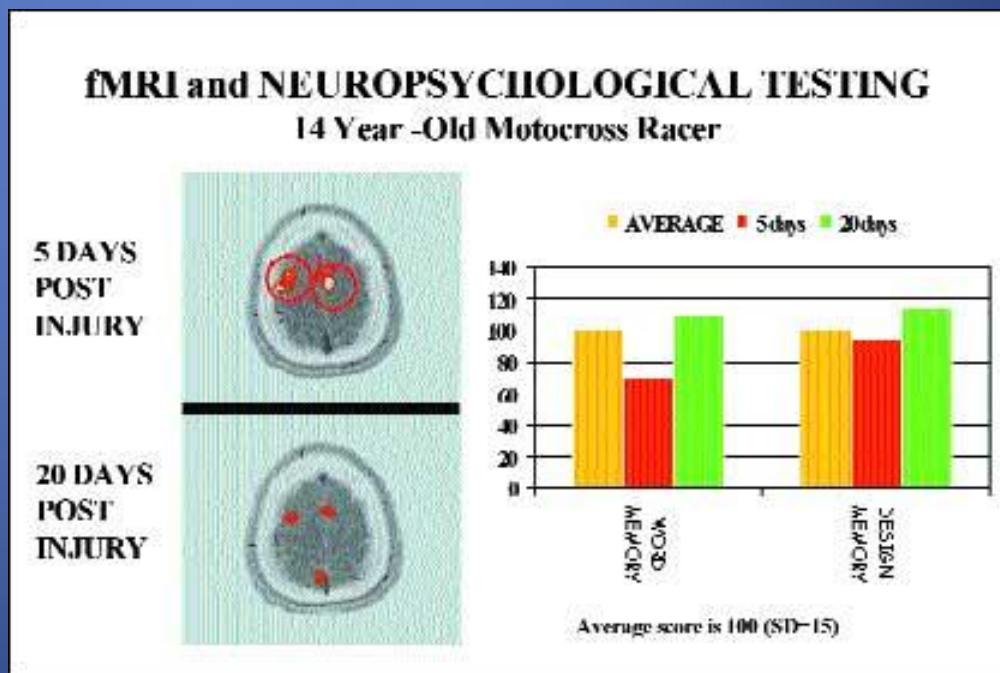
Other tools

- Imaging
- Neuropsychological testing
- Genetic testing



Imaging



- Likely in an emergency room setting
- Plain films, CT, MRI- no standard structural changes
- fMRI



Neuropsychological testing

- Common
 - Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)
 - Automated Neuropsychological Assessment Metrics (ANAM)
 - Cogsport
- Neurologic and cognitive eval should be a part of preparticipation exam, but NP testing is not required/recommended for all athletes

ANAM

  ARMY MEDICINE Serving To Heal...Honored To Serve	
HOME FAQ CONTACT US LINKS MEDCOM A-Z SITEMAP ARMY.MIL AKO SEARCH	
ACCESS TO CARE	Neurocognitive Assessment Branch (ANAM)
R2D Home	R2D Home
About R2D	If your unit is deploying within the next 12 months and needs ANAM to please send an e-mail including all pertinent contact information to usarmy.jbsa.medcom.mbx.otsg-anam-operations@mail.mil for more in the ANAM Schedule at 210-916-9231.
Aquatic Rehabilitation	There is a major focus on cognitive assessment for Service Members. The concussions seen during conflicts in which Service Members may be injured by explosions, also known as mild traumatic brain injury (mTBI).
Media/Press Room	A brain injury that may result from such blasts can range from mild to severe.
MTBI 101 Video	An mTBI/concussion may cause changes which include a slower reaction time, sleep difficulty. These symptoms may result in decreased performance. Performance may not have visible external injuries.
Neurocognitive Assessment Branch (ANAM)	One reason that an mTBI/concussion can go unnoticed is that symptoms may not have visible external injuries.
Occupational Therapy (OT)	Purpose of the ANAM:
Pain Management	
Physical Therapy Tools	

Neuropsychological testing

- Computerized NP testing
 - Administer pre-season before head injures
 - If a concussion is suffered- wait until asymptomatic, retest, compare to baseline
 - Use retest results as adjunct to clinical picture
 - Most helpful in conjunction with NP consult, or in athletes with prolonged symptoms
 - No relationship between NP testing and school performance

ImPACT example



ImPACT Clinical Report

Mark

Exam Type	Baseline	Post-concussion	Post-concussion	Post-concussion	Post-concussion	Post-concussion
Date Tested	09/21/2004	10/08/2004	10/12/2004	10/15/2004	10/19/2004	10/27/2004
Last Concussion		10/07/2004	10/07/2004	10/07/2004	10/07/2004	10/07/2004
Exam Language	English	English	English	English	English	English
Test Version	2.2.729	2.2.729	2.2.729	2.2.729	2.2.729	2.2.729

Composite Scores *

Memory composite (verbal)	93	75%	66	1%	57	<1%	63	<1%	87	55%	88	55%
Memory composite (visual)†	70	23%	41	<1%	49	1%	47	<1%	55	3%	66	12%
Visual motor speed composite	45.88	85%	46.38	86%	40.13	65%	38.93	57%	45.85	85%	41.90	72%
Reaction time composite	0.54	46%	0.60	22%	0.66	6%	0.54	46%	0.62	15%	0.54	46%
Impulse control composite	8		14		10		16		10		11	
Total Symptom Score	0		14		3		1		0		0	

* Scores in **bold** type indicate scores that exceed the Reliable Change Index score (RCI) when compared to the baseline score. However, scores that do not exceed the RCI index may still be clinically significant. Percentile scores, if available, are listed in small type. Please consult your ImPACT User Manual for more details.

† Clinical composite score is available only for exams taken in ImPACT version 2.0 or later.

Genetic testing

- Not standard of care
- APOE e4 (apolipoprotein e4)
 - Study limitations- small sample sizes, use of self-reported concussions, lack of control groups

Management

- Cornerstone of treatment: REST
 - Cognitive and Physical
- Gradual RTP



Stepwise RTP

- Athlete must remain asymptomatic
 - Day 1- no activity
 - Day 2- light aerobic exercise
 - Day 3- sport-specific training
 - Day 4- non-contact training drills
 - Day 5- full-contact practice
 - Day 6- return to play

Return to play

- What if symptoms return?
 - Return to previous level?
 - Start over at day 0?
 - adolescents

Pharmacologic management

- No NSAIDs or aspirin after concussion
- Omega-3-FA
 - Prelim encouraging data in mice
- Targeting symptoms (ex: sleep)
- Or targeting underlying pathophys
 - Antidepressants
 - Experienced provider

Complications/controversies of concussions

- Second Impact Syndrome
- Decreased threshold
- Female gender
- Legislation
- Prevention



Second Impact Syndrome

- Rare- only found in adolescents
- Literature- case reports
 - Ongoing sx after 1st concussion
 - Witnessed 2nd event with rapid deterioration
 - Evidence of cerebral swelling- brain herniation- death
- Past 15 years- approx 100 cases reported

Decreased threshold

- Evidence suggests that a second blow before the brain recovers results in worsening metabolic changes within the cell
- When premature activity (cognitive or physical) occurs before complete recovery- the brain may be vulnerable to prolonged dysfunction
- Previous concussion assoc with higher risk of sustaining another concussion
- Greater number/severity/duration of sx- predictors of prolonged recovery

Female gender



- More reported symptoms than men
- Cognitive impairment 1.7x more common than men
- With similar rules- reported incidence is higher in females
- Estrogen and diff cerebral blood flow may influence severity and outcome
- Is female gender a risk factor? Merely a predictor of symptom reporting?

NFL



NFL

- Generated most policy changes
- 4300+ out of ~12000 players filed over 200 lawsuits (\$765m ruling)
- Cannot lead with helmet; closer kickoffs
- Athletic trainer in game booth
- Sideline/locker room assessment by team doctors
- Independent neurologists

Legislation

- Zackery Lystedt
 - 2006 Washington State
 - Middle school football- head injury before 1st concussion healed



Lystedt Law

- Athletes, parents and coaches must be educated about the dangers of concussions each year.
- If a young athlete is suspected of having a concussion, he/she must be removed from a game or practice and not be permitted to return to play. When in doubt, sit them out.
- A licensed health care professional must clear the young athlete to return to play in the subsequent days or weeks.

Ohio House Bill 143

- Governor John Kasich signed youth concussion bill into law 12/20/12
- Parents need to sign letter showing understanding of this law
- Concussed athlete removed from sports
- Written clearance by physician or other licensed health care provider (in conjunction with a physician)

Prevention

- Education
- ?helmets
- ?mouth guards
- ?neck strengthening



Summary

- Up to 3.8 million/year in US (underreported)
- No RTP same day
- Stepwise RTP
- NFL/Legislation



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