

Sports Related Concussions: Update 2013

Incorporating recommendations from the 4th
International Consensus Conference on
Concussion in Sport
held November 1-3, 2012 in Zurich



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Why are sports concussions such a hot topic of discussion?

- ◆ There is mounting evidence that concussions, especially multiple ones, may be associated with more impaired neurocognitive functioning than was previously recognized.
- ◆ The NFL is facing more than 3500 lawsuits over alleged cases of concussion mismanagement in the past.
- ◆ Copic, a major medical malpractice insurance provider, mentioned the importance of proper concussion management in their July, 2012 newsletter, as this could be an area of increasing medico-legal risk.

An outline of my talk

- ◆ Definition of concussion.
- ◆ The Jake Snakenberg Youth Concussion Act.
- ◆ A couple of words on concussion grading systems
- ◆ A practical sideline and office-based approach to the possibly concussed athlete.
- ◆ After the concussion: a management algorithm.

An outline of my talk (contd.)

- ◆ The team approach to concussion management in middle school, high school and college.
- ◆ A few words on neurocognitive testing.
- ◆ Imaging and the concussed athlete.
- ◆ A case presentation.
- ◆ Second impact syndrome and chronic traumatic encephalopathy.
- ◆ Our mission.

Definition of a concussion

- ◆ “Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by **biomechanical forces**” –4th International Conference on Concussion in Sport, 2012



Common features involving concussive head injuries

- ◆ May be caused by a direct or indirect blow to the head or body.
- ◆ Typically results in rapid onset of short-lived impairment of neurological function that resolves spontaneously. In some cases signs and symptoms may evolve over minutes to hours.
- ◆ Is a functional disturbance rather than a structural injury. Thus, standard imaging studies will not show abnormalities.
- ◆ May or may not involve loss of consciousness.
- ◆ Majority (80-90%) resolve in short (7-10 day) period, although recovery time may be longer in children and adolescents.

The Jake Snakenberg Youth Concussion Act

- ◆ Senate bill 11-040 was signed into law by Colorado Gov. Hickenlooper on March 29, 2011.
- ◆ Went into effect January 1, 2012.
- ◆ Currently twenty states have similar laws.
- ◆ State of Washington was the first in the U.S. to pass a law regarding concussion management in May, 2009 (the "Zachary Lystedt" law).

The Jake Snakenberg Act (contd)

- ◆ Mandates that coaches of all youth organized sports for kids aged 11 to 18 complete a training session each year on recognition of concussions in young athletes.
- ◆ Mandates that if a coach suspects a participant has had a concussion, then that athlete should be removed from play immediately.
- ◆ That athlete cannot be returned to any athletic play or practice unless the athlete is cleared in writing by a medical professional with training in neuropsychology or concussion evaluation and management.
- ◆ A medical professional is defined as a licensed M.D., D.O., Nurse Practitioner, Physicians Assistant or Doctor of Psychology.

Some pertinent points regarding the Jake Snakenberg Act

- ◆ The act applies to both paid and unpaid coaches.
- ◆ The act applies to both public and private schools.
- ◆ The act applies to public and private clubs.
- ◆ The act does not allow athletic trainers or *chiropractors to return concussed athletes to play.

Who was Jake Snakenberg?

- ✦ Jacob Snakenberg was a freshman football player at Grandview High School.
- ✦ He most likely suffered a concussion a week earlier but did not report his symptoms to anyone.
- ✦ A week later took a hit , collapsed on the field and never regained consciousness.
- ✦ Jake passed away from "Second Impact Syndrome" on September 19, 2004.



Concussion grading systems

- ◆ There are currently 25 published concussion grading and management systems
- ◆ None of these has been prospectively validated
- ◆ Several of these systems use loss of consciousness and amnesia as the primary determinant of the severity of the concussion

Commonly used old concussion grading systems

- ◆ Colorado Medical Society, 1991.
- ◆ American Academy of Neurology
1997.
- ◆ Cantu revised in 2001.

The latest words on concussion grading systems

According to the 3rd International Conference on Concussion in Sport, 2008 and re-iterated by the 4th International Conference on Concussion in Sport, 2012:

"...injury grading scales be abandoned in favor of combined measures of recovery to determine injury severity"

"concussion severity could only be determined in retrospect after all concussion symptoms have cleared"

How can we tell if an athlete may have a concussion?

- ◆ The 4th International Consensus Conference on Concussion in Sport endorses the use of the Pocket Concussion Recognition Tool.
- ◆ This is available for free and public use as long as it is not modified.
- ◆ This tool can be downloaded from the www.concussionconsultants.org site

Overview of the Pocket Concussion Recognition Tool

- ◆ Can be used in children, youth and adults
- ◆ Has 3 components
- ◆ Allows for fairly rapid evaluation on the field or sideline
- ◆ Can be used by medical and lay personnel

Details of the Pocket Concussion Recognition Tool

- ◆ 1. Visible clues of suspected concussion:
 - Loss of consciousness or responsiveness
 - Lying motionless/slow to get up
 - Unsteady on feet/balance problems/incoordination
 - Grabbing/clutching head
 - Dazed, blank or vacant look
 - Confused/Not aware of plays or events

Details of the Pocket Concussion Recognition Tool

◆ 2. Signs and symptoms of suspected concussion:

- Loss of consciousness
- Seizure or convulsion
- Balance problems
- Nausea or vomiting
- Feeling slowed down
- **"Pressure in head"**
- Sensitivity to light
- More emotional
- Fatigue or low energy
- Blurred vision
- **Feeling "like in a fog"**
- Sensitivity to noise
- Difficulty remembering
- Headache
- Dizziness
- Confusion
- Amnesia
- Drowsiness
- Irritability
- Neck pain
- Sadness
- "Don't feel right"**
- "Pressure in head"**
- Nervous or anxious
- Difficulty remembering

Details of the Pocket Concussion Recognition Tool

- ◆ 3. Memory function
 - “What venue are we at today?”
 - “Which half is it now?”
 - “Who scored last in this game?”
 - “What team did you play last week/game?”
 - “Did your team win the last game?”

A practical sideline approach for concussion management

- ✦ Any athlete who has suffered a concussion should be immediately removed from practice or play and should not be returned to practice or play the same day **with no exceptions!**
 - Endorsed by the NFL, AAP, NCAA, etc
- ✦ The concussed athlete should be evaluated by medical personnel, if available, on the sideline or courtside.
- ✦ The concussed athlete should not be left alone or allowed to drive a motor vehicle

A practical sideline approach for concussion management

- ◆ If no medical personnel are available and the concussed athlete shows any of the following, emergent transportation for urgent medical assessment should be considered:
 - Athlete complains of neck pain
 - Increasing confusion or irritability
 - Repeated vomiting
 - Seizure or convulsion
 - Weakness or tingling/burning in arms or legs
 - Deteriorating conscious state
 - Severe or increasing headache
 - Unusual behavior change
 - Double vision

Tools for medical personnel on the sideline or in the office

- ✦ The 4th International Consensus Conference on Concussion in Sport endorses the use of the **SCAT3** in the evaluation of the possibly concussed athlete aged 13 or older, and the **Child-SCAT3** for athletes aged 12 or younger.
- ✦ These tools are available for free and public use as long as they are not modified.
- ✦ These tool can be downloaded from the www.concussionconsultants.org site

What is the SCAT3?

- ◆ A. The 3rd edition of a handbook that allows identification of various wild and domestic animals by the appearance of their droppings.
- ◆ B. The 3rd edition of a book that may be useful for musicians attempting free-form jazz singing.
- ◆ C. The 3rd edition of the Sports Concussion Assessment Tool.

Components of the SCAT3

- ◆ 1. Glasgow coma scale
- ◆ 2. Maddocks score
- ◆ 3. Symptom evaluation
- ◆ 4. Cognitive assessment (from *SAC)
- ◆ 5. Neck examination
- ◆ 6. Balance examination
- ◆ 7. Coordination examination
- ◆ 8. *SAC Delayed Recall

*Standardized Assessment of Concussion

1. Glasgow coma scale

◆ 1. Best eye response (E)

- No eye opening: 1
- Eye opening to pain: 2
- Eye opening to speech 3
- Eye opening spontaneously 4

◆ 2. Best verbal response (V)

- No verbal response 1
- Incomprehensible sounds 2
- Inappropriate words 3
- Confused 4
- Oriented 5

◆ 3. 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

◆ Total of E+V+M

- Lowest possible 3
- Highest possible 15

2. Sideline assessment- Maddocks Score

- ◆ At what venue are we today?
- ◆ Which half is it now?
- ◆ Who scored last in this game?
- ◆ What team did you play last time?
- ◆ Did your team win the last game?

1 point for each correct answer, 0 for each incorrect answer: maximum is 5

3. Symptom evaluation in the SCAT3

- ◆ There are 22 questions such as headache, "pressure in head", dizziness, nausea, etc. that are graded from 0 to 6, where 0 is none, 1-2 is mild, 3-4 is moderate, 5-6 is severe
- ◆ The lowest possible score would be 0 and the maximal possible score would be 132 (22X6)

4. Cognitive Assessment (from the Standardized Assessment of Concussion or SAC)

✦ Orientation

- What month is it?
- **What is today's date?**
- What day of the week?
- What year is it?
- What time is it (to 1 hr)

5 points maximum

✦ Immediate memory

- Elbow
- Apple
- Carpet
- Saddle
- Bubble

Athlete to repeat list 3 times

15 point maximum

✦ Concentration

- Athlete to repeat strings of numbers backwards

◆ 4-9-3

◆ 3-8-1-4

◆ 6-2-9-7-1

◆ 7-1-8-4-6-2

4 points maximum

- Athlete to repeat names of months backwards starting with December

0 points if skips or incorrect

1 point if gets back to January

5 point maximum for above

5. Neck examination

- ◆ The only component of the SCAT3 that does not have a numerical assessed value
- ◆ Subjective areas to be assessed:
 - Range of motion
 - Tenderness
 - Upper and lower limb sensation and strength

6. Balance assessment (from modified Balanced Error Scoring System -BESS)

◆ Double leg stance

- Feet together, hands at hips, eyes closed for 20 seconds.

◆ Single leg stance

- Stand on non-dominant leg with dominant in slight flexion at hip and knee, hands on hips, eyes closed for 20 sec.

◆ Tandem stance

- Heel to toe with dominant in front, hands on hips, eyes closed for 20 seconds

◆ Scoring

- Points off for
- 1. hands off hips
- 2. opens eyes
- 3. steps, stumbles, falls
- 4. moving hip into >30 degrees abduction
- 5. Lifting forefoot or heel
- 6. Out of position >5 sec

Deduct max of 10 for each section out of 30

Max score possible: 30

7. Coordination examination

◆ Finger to nose task

- Athlete to have shoulders abducted to 90 degrees, elbows and fingers extended, eyes open.
- To touch tip of nose as rapidly as possible
- 5 correct repetitions in 4 seconds=1
- Not touching nose or not extending elbows or fingers=0

8. Cognitive assessment: delayed recall

◆ Have patient recall list of 5 objects asked earlier

- Elbow
- Apple
- Carpet
- Saddle
- Bubble

1 point for each correct, maximum of 5

Comparison of the SCAT2 vs SCAT3

- ✦ 1. Symptom score
- ✦ 2. Physical signs
- ✦ 3. Glasgow coma score
- ✦ 4. Sideline Assessment – Maddocks Score
- ✦ 5. Cognitive assessment (from SAC)
- ✦ 6. Balance examination
- ✦ 7. Coordination examination
- ✦ 8. SAC Delayed recall

- ✦ 1. Glasgow coma scale
- ✦ 2. Sideline Assessment - Maddocks score
- ✦ 3. Symptom evaluation
- ✦ 4. Cognitive assessment (from SAC)
- ✦ 5. Neck examination
- ✦ 6. Balance examination
- ✦ 7. Coordination examination
- ✦ 8. SAC Delayed Recall

Child-SCAT3

- ◆ Has been developed to evaluate possibly concussed children between the ages of 5-12 years of age
- ◆ Has the same sections as the SCAT3 except the symptom evaluation has two subsections: one is based on the **child's report**, the other on the **parent's report**
- ◆ Uses the child-Maddocks Score instead of the Maddocks Score

Concussion management in 2013

1. Any athlete who has suffered a concussion should not be allowed back in the game on the same day, even if completely asymptomatic and free of any signs of impairment
2. All athletes who have suffered a concussion should be medically evaluated by qualified personnel to exclude possible catastrophic injuries

Concussion management in 2013

3. Any athlete who has a concussion should be given physical and cognitive rest.
4. Once completely asymptomatic at rest, the athlete starts a step wise process to return to activity

Our concussion management program

- ◆ The athlete and/or parents or guardians are given information regarding concussions.
- ◆ The athlete's coach informs the school's concussion team leader of the athlete's concussion.
- ◆ The athlete is told to make any appointment to be examined by their own PCP or alternative provider ideally within three days of the concussion.
- ◆ If cleared to do so by their PCP, the athlete starts on a graduated exercise protocol.

An example of a typical recovery program after concussion

1. No activity, complete rest (1-2 days after concussion).
2. The athlete is examined by his or her pcp or alternative provider, and if cleared by this person, proceeds to light aerobic exercise (walking, stationary cycling), no resistance (1day)
3. Sport specific exercise, progressive resistance (1 day)
4. Non-contact training drills (1 day)
5. If largely asymptomatic at rest and with exertion, the athlete is given the ImPACT test
6. If the ImPACT test is normalized, the athlete is **given a "return to play" form to be signed by his or her pcp or alternative provider.** Once this signed form is returned to the coach, the athlete can
*return to play

A word on recovery after concussion

- ✦ If the athlete becomes symptomatic at any stage, he or she must return to the previous stage for another 24 hrs
- ✦ **Cognitive rest** is now becoming more accepted as a necessary therapeutic intervention: this means getting the athlete away from hard classes, intensive study, academic tests, video games, cell phones, t.v, internet, etc. for a reasonable period of time

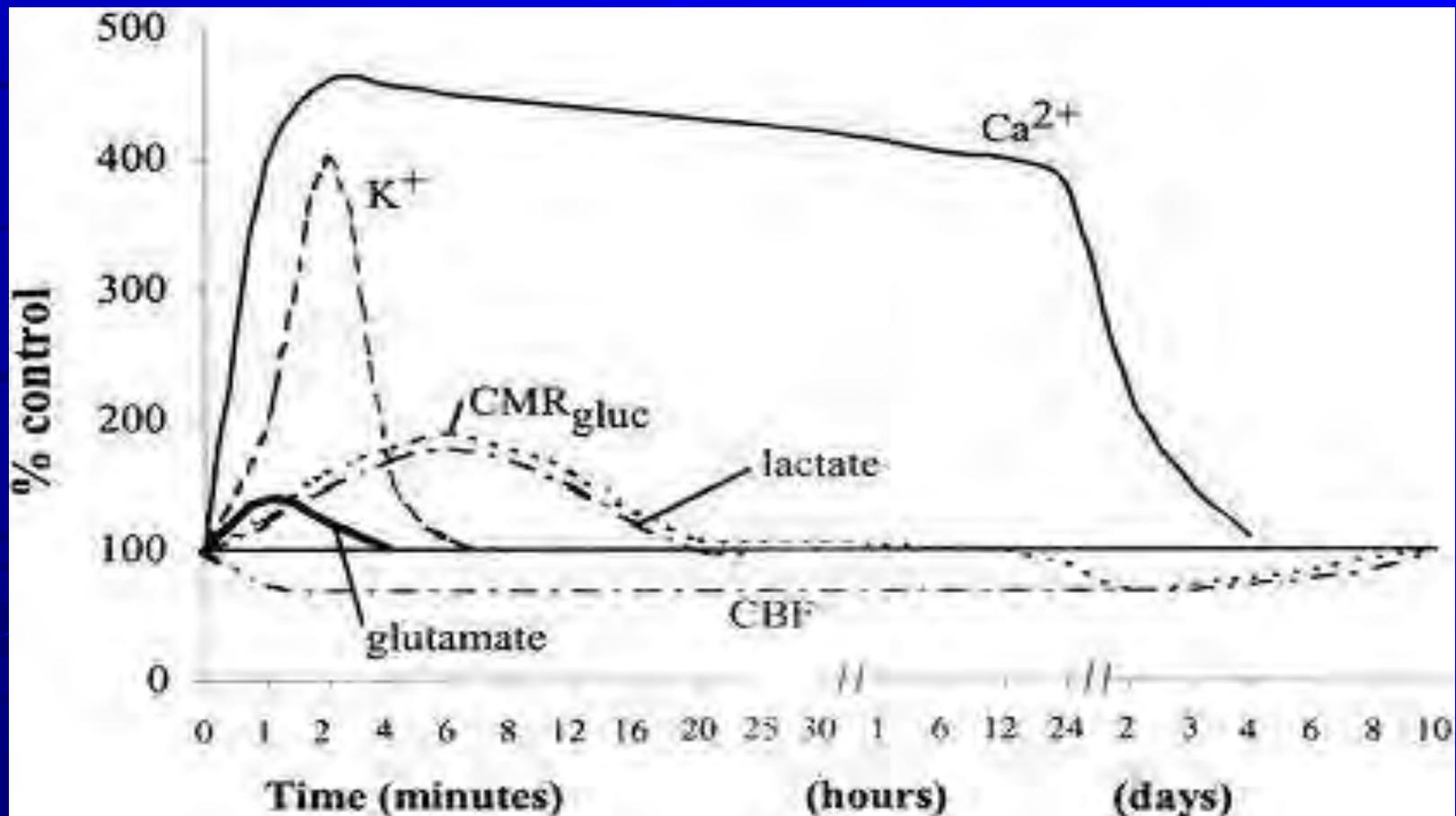
Our concussion management program in the schools

- ◆ The concussed athlete is given a post-injury ImPACT test usually 3-4 days after concussion or when not markedly symptomatic.
- ◆ The concussion team leader for the school usually administers this test to the athlete in the computer lab in their own school.
- ◆ I look at the test results, and compare those to the baseline test, if available, and inform the concussion team leader of the results of the test.

Our concussion management program (contd.)

- ◆ If the concussed athlete is free of any significant symptoms of concussion at rest and with exertion, and has a normalized post-injury ImPACT test, they are given a return-to-play (RTP) form by the concussion team leader, which, when signed by the **athlete's PCP or alternate provider allows** them to RTP.
- ◆ We would like to not have any concussed athlete RTP for at least 6 days after concussion

Why we may want to wait at least 6 days before allowing RTP



✦ From Giza CC, Hovda DA, UCLA, 2001

How concussion studies are done in animals



The Concussion Management Team

- ◆ Each school has a concussion team leader.
 - Head Athletic Trainer at the college level
 - Athletic Director at the high school level
 - Assistant Principal at the middle school level.
- ◆ The concussion team leader chooses the other members of the team which may include school nurses, athletic trainers, behaviorists, social workers, teachers and administrators.

A word about neuropsychological testing

- ◆ There are numerous pencil and paper tests available to test memory, processing speed, executive function, working memory, etc
- ◆ Pencil and paper tests are cumbersome and may have an associated training effect

The latest twist in neuropsychological testing: computerized testing

- ◆ ANAM: 7 subtests. Takes 15 to 20 mins,
- ◆ CogSport: 8 scores produced, takes 15 to 20 minutes
- ◆ Headminder CRI: Web based concussion resolution index, takes 20 to 25 minutes
- ◆ ImPACT: 6 subtests; Web based, takes 20 to 25 minutes

About ImPACT

- ◆ **ImPACT** comes from **IM**mediate **P**ost-concussion **A**ssessment **C**ognitive **T**esting
- ◆ Test has 6 components.
- ◆ Generates 6 composite scores.
- ◆ Has built in indicators of validity that may help detect intentional sandbagging.
- ◆ Is not a simple heuristic application.
- ◆ According to their own published data, ImPACT has a positive predictive value of 90% and a negative predictive value of 82%

Baseline ImPACT testing

- ◆ Done in preseason on contact-collision athletes.
- ◆ Best done at least 3 hours before exercise.
- ◆ Need internet access and computers with independent mouses (mice?)
- ◆ Valid tests are good for 2 years for middle and high schoolers. One valid test is enough for college athletes.
- ◆ We have found it most efficient to test groups of 30 to 40 athletes in their own computer labs.



Neuropsychological testing and the 4th International Consensus Conference on Concussion in Sport

- ✦ “The application of neuropsychological testing has been shown to be of value and contributes significant information in concussion evaluation”
- ✦ “Neuropsychological testing may be used to assist return to play decisions...”
- ✦ “Neuropsychological assessment should not be the sole basis of management decisions”

To image or not to image?...



- ◆ According to the 4th International Consensus Conference on Concussion in Sport:
 - “Conventional structural imaging is typically normal in concussive injury”
 - “Brain CT (or where available MR brain can) contributes little to concussion evaluation but should be employed whenever suspicion of an intracranial or structural lesion (eg, skull fracture) exists. Examples of such situations may include:
 - ◆ Prolonged disturbance of conscious state
 - ◆ Focal neurologic deficit
 - ◆ **Worsening symptoms”**

The Basic New Paradigm for Return to Play After Concussion

- ✦ The athlete must be asymptomatic at rest.
- ✦ The athlete must be asymptomatic with exertion.
- ✦ The athlete must be back to baseline or within normative range if neuro-cognitive testing is done.
- ✦ The athlete must only be cleared to return to play by medical personnel adequately trained in the diagnosis and management of concussions.

A Case Presentation

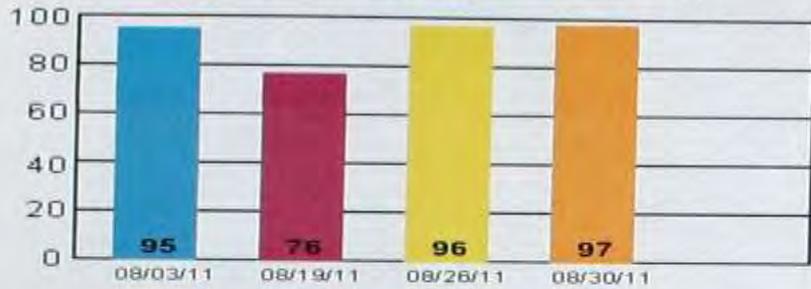
- ◆ 20 year old Colorado State University-Pueblo football player suffered a concussion on 8/18/11. **Was "dazed" but had no LOC.**
- ◆ Had a baseline ImPACT done on 8/3/11.
- ◆ Had post-injury ImPACT tests done on 8/19/11, 8/26/11, and 8/30/11

Exam Type	Baseline	Post-Injury 1	Post-Injury 2	Post-Injury 3
Date Tested	08/03/2011	08/19/2011	08/26/2011	08/30/2011
Last Concussion			08/18/2011	08/18/2011
Exam Language	English	English	English	English
Test Version	2.1	2.1	2.1	2.1

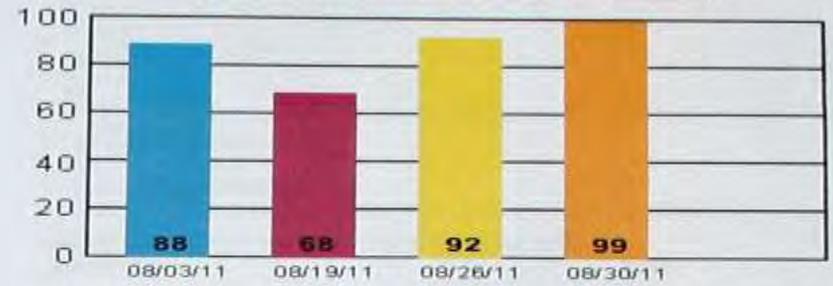
Composite Scores	Percentile scores if available are listed in small type.							
Memory composite (verbal)	95	84%	76	21%	96	88%	97	92%
Memory composite (visual)	88	86%	68	28%	92	91%	99	99%
Visual motor speed composite	48.63	87%	28.25	2%	42.75	59%	52.8	99%
Reaction time composite	0.48	90%	0.84	1%	0.55	55%	0.46	95%
Impulse control composite	4		0		8		2	
Total Symptom Score	11		50		3		3	
Cognitive Efficiency Index:	0.5		0.25		0.21		0.52	

Headache	2	3	3	0	0	0	0
Nausea	0	1	1	0	0	0	0
Vomiting	0	0	0	0	0	0	0
Balance Problems	0	2	2	0	0	0	0
Dizziness	0	3	2	0	0	0	0
Fatigue	2	5	5	2	2	1	0
Trouble falling asleep	2	3	N/A	0	N/A	0	N/A
Sleeping more than usual	0	0	N/A	0	N/A	1	N/A
Sleeping less than usual	2	1	N/A	0	N/A	0	N/A
Drowsiness	3	2	2	1	0	1	0
Sensitivity to light	0	2	3	0	1	0	0
Sensitivity to noise	0	4	4	0	0	0	0
Irritability	0	3	3	0	0	0	0
Sadness	0	2	0	0	0	0	0
Nervousness	0	0	1	0	0	0	0
Feeling more emotional	0	4	4	0	0	0	0
Numbness or tingling	0	2	2	0	0	0	0
Feeling slowed down	0	3	5	0	0	0	0
Feeling mentally foggy	0	4	2	0	0	0	0
Difficulty concentrating	0	3	3	0	0	0	0
Difficulty remembering	0	2	3	0	0	0	0
Visual problems	0	1	1	0	0	0	0
Total Symptom Score	11	50	46	3	3	3	0

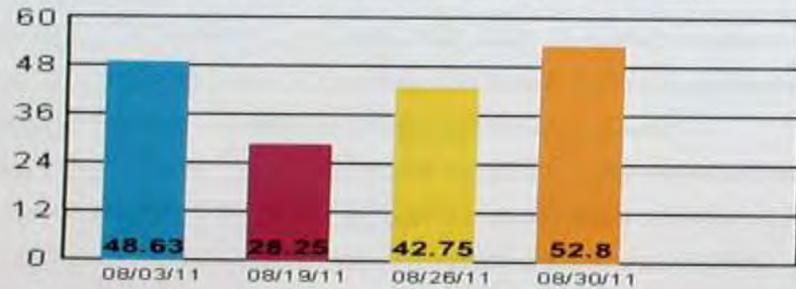
Memory Composite (Verbal)



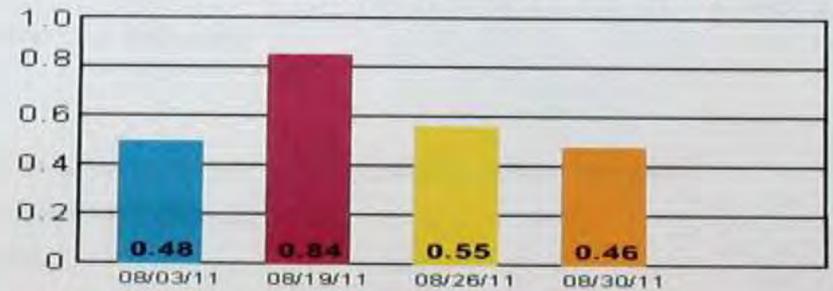
Memory Composite (Visual)



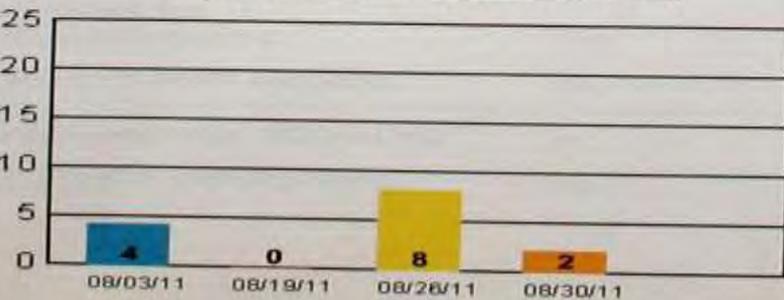
Visual Motor Composite



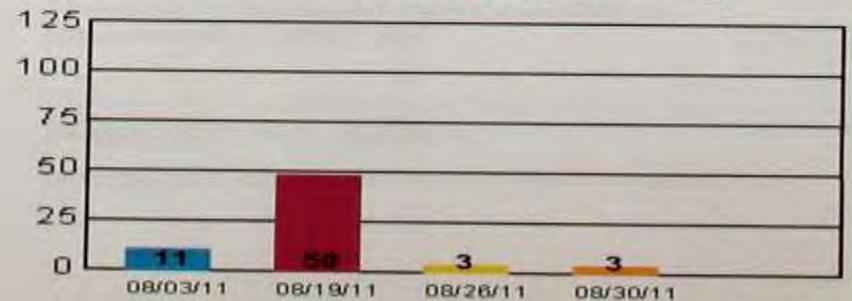
Reaction Time Composite



Impulse Control Composite



Symptom Score



Pertinent points from case

- ◆ Patient had a symptom score of (11) on baseline test.
- ◆ Had normal physical exam, but abnormal ImPACT test and symptom score of (50) 1 day after concussion.
- ◆ Had a normal physical exam, abnormal ImPACT and symptom score of (3) 8 days after concussion.
- ◆ Had a normal physical exam, normal ImPACT and symptom score of (3) 12 days after concussion.
- ◆ Had we not utilized the ImPACT test, we would probably have probably returned athlete to play 4 days prematurely.

Risks to athletes who continue to play with signs and symptoms of a concussion

- ◆ Athletes who suffer a concussion may be 3-4 times more likely to get another concussion in the near term if they continue to play.
- ◆ Athletes who suffer a concussion before all signs and symptoms of a previous concussion have resolved may be at risk of developing **second impact syndrome**.
- ◆ Athletes who have suffered multiple concussions may be at risk of developing **chronic traumatic encephalopathy**.

Second Impact Syndrome

- ◆ Athletes who have suffered a concussion and return to play before complete recovery may be at risk for this syndrome.
- ◆ The syndrome seems to be due to a cerebral autoregulatory dysfunction in susceptible populations.
- ◆ These cases have all occurred in athletes under the age of 20 years.

Chronic traumatic encephalopathy (CTE)

- ◆ First described in boxers on autopsy who had developed dementia pugilistica prior to death.
- ◆ Appears to be associated with abnormal deposition of tau protein in characteristic patterns and locations.
- ◆ The youngest person to have shown evidence of CTE on autopsy was only 18 years old.

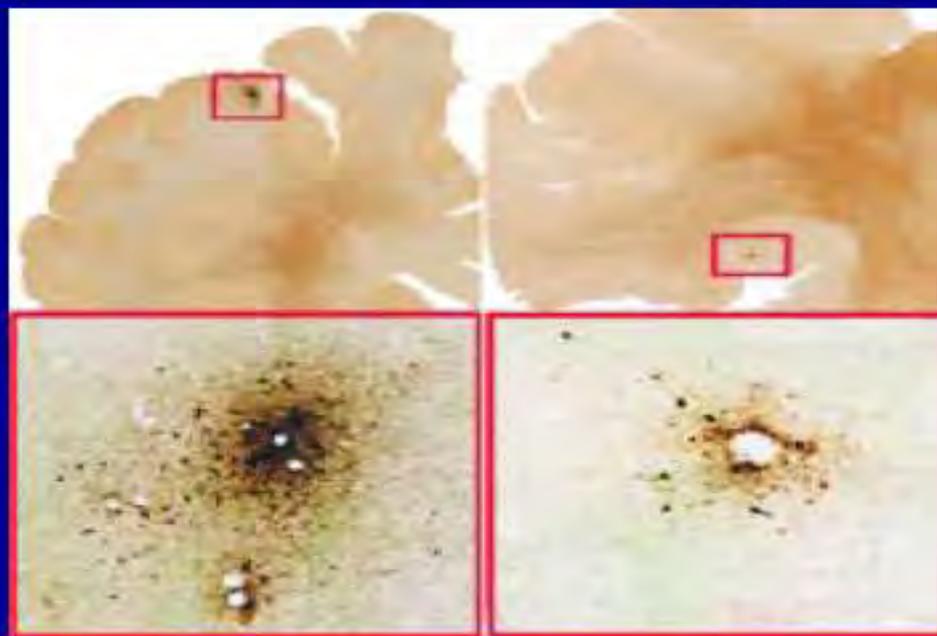
Some characteristic changes seen in CTE



Stage I CTE: High school football player

Death at age 18 - 10 days after 4th concussion
Perivascular tau in frontal cortex

P-Tau



Slide courtesy of Ann C. McKee, M.D.

Some characteristic changes seen in CTE (contd.)

BOSTON UNIVERSITY

Department of Veterans Affairs

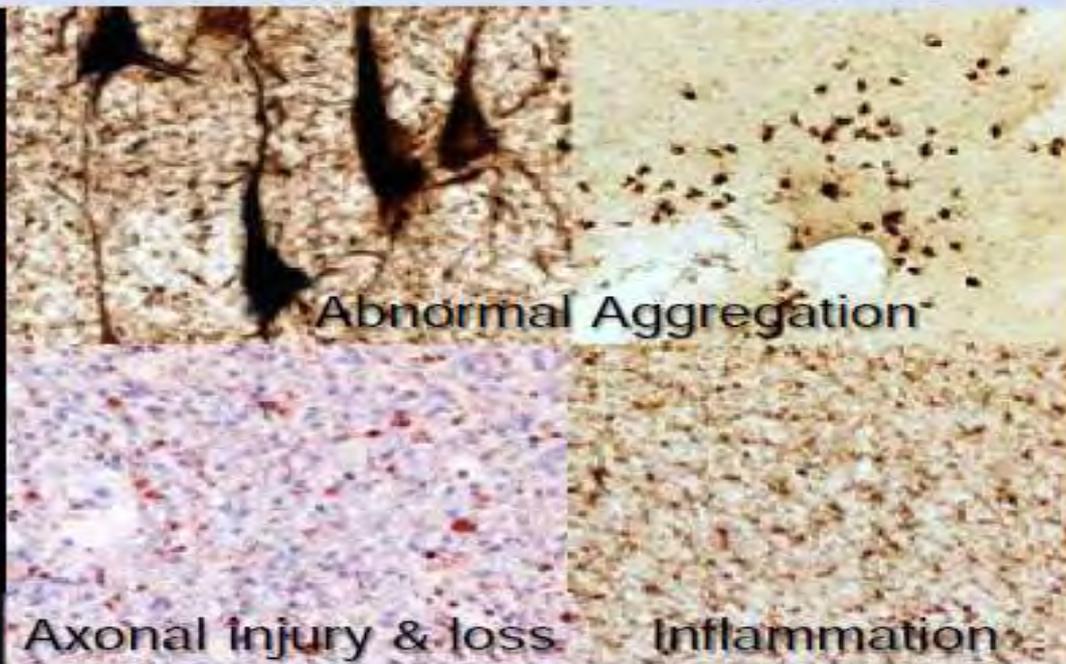
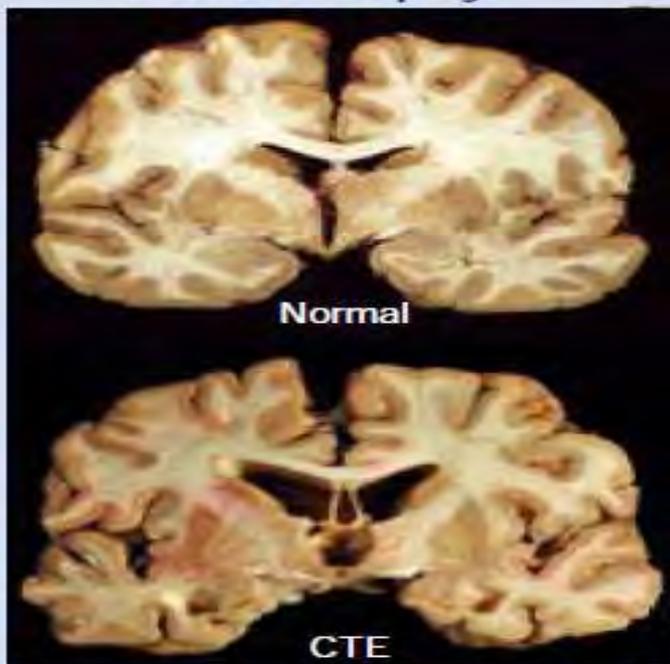
sportslegacy INSTITUTE

Unique Pathology of CTE

Brain Atrophy

P- Tau

TDP-43



Slide courtesy of Ann C. McKee, M.D.

To play or not to play...



- ◆ In an athlete who has suffered multiple concussions, there are no current universally accepted guidelines regarding athletic disqualification or retirement.
- ◆ The majority of the literature suggests that athletes with multiple concussions may be at risk for long-term cognitive deficits.

Could we have saved Jake Snakenberg?

- ◆ All the sophisticated testing in the world would not have saved Jake because he never sought medical attention and seemed to be fine until he collapsed.
- ◆ If we could have educated Jake about the importance of seeking medical attention after a possible concussion, he may be alive today.

Our mission

- ◆ To educate athletes, coaches, parents, and administrators on the importance of recognizing the signs and symptoms of a concussion.
- ◆ To convince the athletes and coaches that it is **never** acceptable to continue to play with signs and symptoms of an unresolved concussion.

Our mission (contd.)

- ✦ To educate medical personnel on the latest developments in sports concussion diagnosis and management.
- ✦ To make materials available to help make sports concussion management easier for medical professionals.
- ✦ To be available for consultation on the topic of sports concussion management with medical professionals, coaches, athletic directors, administrators, parents, athletes and EMS providers.

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