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Objectives

- Definitions
- **Clinical evaluation & management**
- Return to Play Recommendations
- Post concussive syndrome
- **2nd impact syndrome**

Position Statements

- NATA position statement
- Summary and Agreement Statements of the 1st, 2nd and 3rd International Conference on Concussion in Sport
- Congress of Neurological Surgeons: Committee of Head Injury Nomenclature
- American Medical Society for Sports Medicine (AMSSM)
- Team Physician Consensus Statement
- CDC

Epidemiology

- CDC estimates 1.6 – 3.2 MILLION concussions in sport or recreation each year (adults & children)
 - Previous estimates were 300,000
 - 63,000 occur annually in high school athletes



Epidemiology

- 5% of all collegiate athletes receive a concussion each season
- 5 – 20% of HS athletes receive a concussion each season
 - 89.6% = 1 concussion
 - 9.3% = 2 concussions
 - <1% had >3 concussions



Epidemiology

- 300,000 sports-related brain injuries/year
- 100,000 in football
- Conservative estimates depending on self reporting
 - Football – 70%
 - Soccer – 63%
 - **But among the concussed football players, only 23% knew they had a concussion**
 - **Among concussed soccer players, only 20% recognized the concussion**

A cerebral concussion is the most common athletic head injury



Among findings from the NFL concussion study:

- Blows that caused concussions packed an average 980-pound force, strong enough to cause skull fractures if no helmet were worn
- Collisions occurred at an average 20 mph over 15 microseconds of contact
- On average, players' heads snapped back with an acceleration 98 times stronger than the force of gravity
- 61% of game concussions result from helmet-to-helmet hits

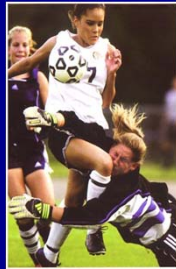
Why Is This Important?

- **Since July, 2011-**
 - Derek Sheely (22)
 - College FB (8/22/11)
 - Kainen Boring (17)
 - HS Football (9/2/11)
 - Gregory Green (17)
 - HS Baseball (10/5/11)
 - Ridge Barden (16)
 - HS Football (10/14/11)



Definition

- Derived from the Latin *concussus* which means **"to shake violently"**
- **"A complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces"**



Defining Concussion

- Common features that incorporate the clinical, pathological and biochemical injury constructs that may be utilized in defining the nature of a concussive head injury include...



Vienna Guidelines

Defining Concussion

- 1. Concussion may be caused by a **direct blow or torsional force** to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head
- 2. Concussion typically results in the **rapid onset of short-lived impairment** of neurological function that **resolves spontaneously**

Defining Concussion

- 3. Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a **functional disturbance rather than structural injury**

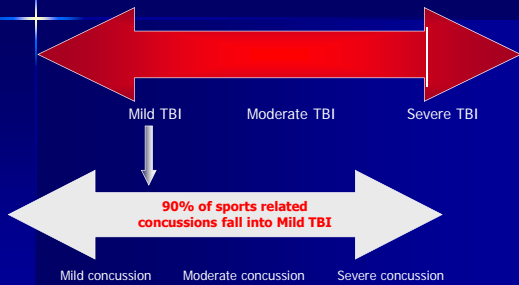
Defining Concussion

- 4. Concussion results in a characteristic graded set of **clinical syndromes** that may or may not involve loss of consciousness
 - Resolution of the clinical and cognitive symptoms typically follows a **sequential course**
 - In some cases, post-concussive symptoms may be prolonged or persistent

Defining Concussion

- 5. Concussion is typically associated with grossly normal structural neuroimaging studies
- Concussions are usually not structural defects
 - Lesions that can be seen on neuroimaging are structural defects
 - Structural defects = brain damage

So what's a concussion?

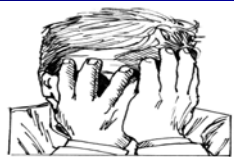
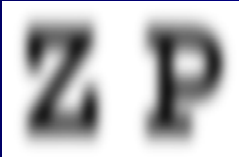


Defining Concussion

- **Concussion** = ■ **Minimal traumatic brain injury**



Signs and Symptoms



Important Point

- **"Headache AND"** disease
- Headache alone is not a concussion ... **BUT**
 - It is a cause for a further, detailed, & serial examination.

Loss of Consciousness

- Rare
- Usually less than 1 minute, almost always less than 5 minutes
- People often confuse lack of memory with LOC
- Best elicited from a witness



Alves et al.

Loss of Consciousness

- Historically, the presence of LOC has been considered the pivotal event in the grading of severity and return to play
- **Today, several literature reviews fail to support LOC as a prognostic factor for prediction of severity or as a factor in return to play**

Cognitive Features

- Loss of consciousness
- Amnesia
- Confusion
- Disorientation – Patient is unaware of period, opposition, score of game

Typical Symptoms

- **Headache** or pressure in the head
- Confusion
- Balance problems or dizziness
- Nausea
- Feeling “dinged”, “foggy”, “stunned” or “dazed”
- Visual problems (seeing stars, flashing lights, light sensitivity, blurred vision)

Typical Symptoms

- Hearing problems (ringing in the ears, sensitivity to noise)
- Irritability, anxiety, or emotional changes
- Feeling of slowness or fatigue
- Drowsiness
- Concentration difficulties
- Memory loss

Physical Signs


- Loss of consciousness
- Impaired conscious state
- Poor coordination or loss of balance
- Slow to answer questions or follow directions
- Easily distracted or poor concentration
- Vomiting

Physical Signs

- Slurred speech
- Personality changes
- Vacant stare/glassy eyed
- Displaying inappropriate emotions (eg, laughing, crying)
- Inappropriate playing behavior
- Significantly decreased playing ability

Memory


- **Memory loss is an important clinical sign of a concussion**
 - **Predictive of injury severity**
 - May be a delayed finding (20 minutes)



A cartoon illustration of a soccer player sitting on the ground, looking dazed with stars around his head, representing a concussion.

Concussion does NOT cause loss of autobiographical information

- "Who are you"
 - "I don't know"
- "What's your name"
 - "I don't know"
- "When were you born"
 - "I don't know"
- **Diagnosis: Malingering or hysteria**



A photograph of a soccer player in a red and yellow jersey holding a soccer ball.

Post Traumatic Amnesia

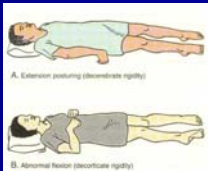
- **Anterograde** amnesia
 - The inability to retain new information
- **Retrograde** amnesia
 - The inability to recall information/events prior to the injury (from the moments before the injury to perhaps days before)
- Both tend to occur together and improve over time
- **Length of post traumatic amnesia correlates well with time to recovery**

Post Traumatic Amnesia

- The period of anterograde memory loss tends to be briefer than the period of retrograde memory loss
- Retrograde amnesia is considered by some to represent a more serious concussion than anterograde amnesia (tend to occur together)

Convulsive and Motor Phenomena

- A variety of concerning and worrisome motor phenomena (e.g., transient tonic posturing) or convulsive movements may accompany a concussion
- **These clinical features are generally benign and require no specific management beyond that of the underlying concussive injury**




A. Extension posturing (dystonics rigids)
B. Abnormal flexor (pronator) rigidity

Summary

- **Cognitive signs (cortical)** – amnesia, confusion, disorientation
- **Non-cognitive signs (brainstem)** – balance difficulty, vertigo, tinnitus, nausea, blurry vision
- **Emotional** – changes in mood, anxiety, depression, agitation

• Maroon/Marjarity

■ More than 90% of all concussions fall into the mild category where there has been no loss of consciousness and only a brief period of posttraumatic amnesia or loss of mental alertness



Post Concussion Signs/Symptoms Checklist

- Bell Rung
- Depression
- Dinged
- Dizziness
- Drowsiness
- Excessive sleep
- Fatigue
- Feeling "in a fog"
- Feeling "slowed down"
- Headache
- Irritability
- LOC
- Memory problems
- Nausea
- Nervousness
- Numbness/tingling
- Poor balance
- Poor concentration
- Ringing in the ears
- Sadness
- Sensitivity to light
- Sensitivity to noise
- Trouble falling asleep
- Vacant stare/glassy eyed
- Vomiting

Canlu 2005

Sideline Assessment



Develop a systematic method to evaluate concussions as you do with other injuries / illnesses!

Physical Evaluation Self-Reported Symptoms Neurocognitive Function Imaging Studies

Exertional Tests Posturography

**"How many fingers am I holding up?"
"What's your name, where are you, what's the date?"**

- Standard orientation questions (like you see in the movies) have been shown to be unreliable in the sporting situation when compared to memory assessment

THE LONGEST YARD

PARAMOUNT PICTURES PRESENTS AN ALBERT S. RUDOFF PRODUCTION
STARRING ROBERT REDFORD IN "THE LONGEST YARD" AND DENZEL WASHINGTON
AS "TIGER" ROBERT ROBERTSON - "BOY" THOMAS - Produced by ALBERT S. RUDOFF
Directed by ROBERT ALDRICH - Screenplay by FRANK CROCK AND
ALAN BROWN - Music by ROBERT S. MAYER - ©1999 Paramount Pictures. All Rights Reserved.

Maddocks et al., 1995. McCrea et al., 1997)

Sideline Assessment

1. **Thorough Hx**
2. **LOC / GCS**
3. **Symptom Scale**
4. **Orientation**

Symptom Scale

SYMPTOM		MILO	MODERATE	SEVERE			
1. Headache	0	1	2	3	4	5	6
2. "Pressure in Head"	0	1	2	3	4	5	6
3. Neck Pain	0	1	2	3	4	5	6
4. Nausea or Vomiting	0	1	2	3	4	5	6
5. Balance Problems / Dizziness	0	1	2	3	4	5	6
6. Vision Problems	0	1	2	3	4	5	6
7. Hearing Problems	0	1	2	3	4	5	6
8. Sensitivity to Light	0	1	2	3	4	5	6
9. Sensitivity to Noise	0	1	2	3	4	5	6
10. Feeling Slowed Down	0	1	2	3	4	5	6
11. Feeling like "in a fog"	0	1	2	3	4	5	6
12. "Don't feel right"	0	1	2	3	4	5	6
13. Difficulty concentrating	0	1	2	3	4	5	6
14. Difficulty remembering	0	1	2	3	4	5	6
15. Fatigue or low energy	0	1	2	3	4	5	6
16. Confusion	0	1	2	3	4	5	6
17. Drowsiness	0	1	2	3	4	5	6
18. Trouble falling asleep (if applicable)	0	1	2	3	4	5	6
19. More emotional	0	1	2	3	4	5	6
20. Irritability	0	1	2	3	4	5	6
21. Sadness	0	1	2	3	4	5	6
22. Nervous or anxious	0	1	2	3	4	5	6

Sideline Assessment

5. **Memory / Recall (Immediate & Delayed)**
 - 3 – 5 words
 - Anterograde
 - Retrograde

6. **Concentration / Analytical Processing**
 - Spell 'WORLD' backwards
 - Months of the year backwards
 - 100 – 7
 - Serial numbers backwards

Maddock's Questions

- Which field are we at?
- Which team are we playing today?
- Which half/period is it?
- How far into the half is it?
- Which side scored the last touchdown/goal/point?
- Which team did we play last week?
- Did we win last week?

Sideline Assessment

7. Balance / Coordination

8. Cranial Nerves

9. Neurological Exam (PMS)

Cranial Nerves

- I. Olfactory (smell)
- II. Optic (sight)
- III. Oculomotor (pupil reaction; eye downward)
- IV. Trochlear (eye upward)
- V. Trigeminal (mastication; facial sensation)
- VI. Abducens (lateral eye movement)
- VII. Facial (smile)
- VIII. Vestibulocochlear (hearing; balance)
- IX. Glossopharyngeal (taste; swallow)
- X. Vagus (gag reflex)
- XI. Accessory (shoulder shrug)
- XII. Hypoglossal (stick tongue out)

Note-

Any student-athlete that serially exhibits signs, symptoms or behaviors consistent with a concussive injury, including, but not limited to:

- 1) Altered level and/or loss of consciousness;
- 2) Confusion, as evidenced by disorientation to person, time, or place; inability to respond appropriately to questions; inability to process information correctly and/or respond appropriately analytical questions; or inability to remember assignments and/or plays;
- 3) Amnesia (antegrade and/or retrograde; immediate or delayed);
- 4) Abnormal neurological examination (i.e. abnormal pupillary response, persistent dizziness or vertigo, abnormal balance, etc.)
- 5) New and persistent headache, particularly if accompanied by photosensitivity or other visual disturbances, tinnitus, nausea, vomiting, or dizziness; and/or
- 6) Any other persistent signs or symptoms of a concussive injury.

should be withheld from participation for the remainder of that day.

Once removed from participation, the student-athlete must follow the outlined guidelines for management of his/her injury and will not be considered for return to participation until he/she is fully asymptomatic at both rest and exertion, post-exertion assessments are within normal baseline limits, and he/she has been cleared for participation by the University of Maryland Team Physician and/or his/her designee.

Concussion Grading

- More than 15 different concussion-grading systems and return-to-play guidelines
- There is no universal agreement on the definition and grading of concussions OR when an athlete may return to play



Home Instructions

One of my (many) pet peeves...

- Night wakings to confirm arousability
 - If you are that worried, hospitalize them
 - Who wouldn't be groggy after being woken at 3am from a deep sleep*
- The brain needs rest to heal**

RED FLAGS

- Young age
- Confusion lasting > 30 minutes
- Loss of consciousness > 5 minutes
- Focal neurologic deficit
- Deteriorating level of consciousness
- **Signs & Symptoms that are progressively getting worse**

Post Concussion Syndrome

- Persistent physical, emotional and cognitive symptoms lasting greater than 24 hours that
 - May be the direct consequence of brain injury verses emotional sequelae of brain injury verses combination of both
 - Without evidence of structural injury

Post Concussion Syndrome

- A constellation of symptoms:
 - Headache (especially with exertion), dizziness, fatigue, irritability, difficulties with memory and concentration in the days and weeks following concussion
- In case series incidences of headache and dizziness have been as high as 90% at one month and 25% at one year
- At various times memory difficulties have ranged from 4 to 59%

Criteria for Post Concussion Syndrome

- Interval between head trauma and development of symptoms → ≤4 wk
- Symptoms in at least **three** of the following categories:
 - Headache, dizziness, fatigue, noise intolerance
 - Irritability, depression, anxiety, emotional lability
 - Insomnia
 - Reduced alcohol tolerance
 - Subjective concentration, memory, or intellectual difficulties without neuropsychological evidence of marked impairment

International Classification of Diseases, 10th Revision, (Code 310.2)

Food for thought...

- Persistence of these symptoms correlates with the duration of post traumatic amnesia
- The problem is almost unknown in children
- **After athletes sustain one concussion, they are three times more likely to sustain a second concussion compared to other players who have not been concussed.**

Return to Play

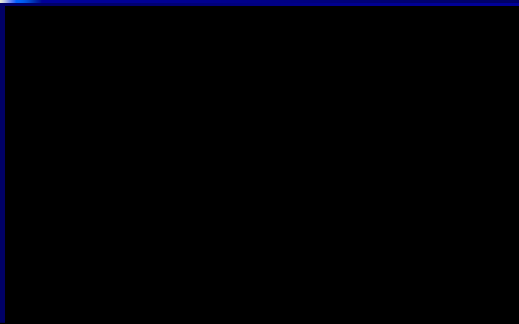
- **Step-wise, multi-stage process-**
 - Baseline Testing
 - Initial Evaluation
 - Post-Concussion Follow-Up
- **Stage 1 (Day 1 SRA)**
- **Stage 2 (Exertional Testing)**
- **Stage 3 (Sports Specific, Non-Contact)**
- **State 4 (Modified / Limited Contact)**
- In order to be considered for return to play, the student-athlete must-
 1. **Be fully asymptomatic at rest, with exertional testing, and with supervised non-contact and contact sports-specific activities.**
 2. **Be within normal baseline limits on all post-exertion assessments; and**
 1. Neuropsychological testing
 2. Balance
 3. Diagnostic
 4. Other
 3. **Be cleared for participation by a physician.**

PRESTON PLEVRETES



Courtesy of the Plevretes Family

PRESTON PLEVRETES




BRANDON SCHULTZ


- Fourteen years ago, Schultz, a high school sophomore with an 3.6 grade average, suffered a concussion while playing in a football game. He doesn't remember it. He got on the bus, came home. His parents picked him up at school to bring him home, and he complained of a headache.
- He said "I took a hit. Got a headache."
- The headache persisted the next day and the next. He skipped football practice.
- But he needed only a few games to qualify for his varsity letter.



- Schultz pulled on his number, 61, and played his next junior varsity game
- On the last play of the first half, Schultz made a tackle and goes down. According to video footage, it does not appear that he makes head contact with any other player



- Immediately following the tackle, Schultz makes his way to the far end zone for a half-time huddle. A few minutes into the huddle, he suffers a seizure and collapses on the ground, unconscious.
- This occurs less than ten minutes after his tackle



- He went into a coma for four days and underwent four brain surgeries
- Six years of rehabilitation leave him, today, partially blind, physically disabled, and unable to think quickly
- Today, physical and psychological problems have forced Brandon to live in supervised housing in another state. He can no longer think clearly or express himself adequately
- Clinical experts describe Brandon's condition as a "permanent state of adolescence". He is haunted by the memory of the above-average student, athlete and carefree teenager he used to be.

- On behalf of the family, attorney Michael Nelson filed a lawsuit against the Anacortes School District. The suit claimed the district failed to use reasonable policies and procedures for head injury management, did not provide its coaches with proper training, and did not require a "return to play" note from a doctor following a concussion.
- Nelson's suit, filed upon these conclusions, was the first such litigation to argue SIS as both a liability theory and as a damage consequence.

The Results

- A settlement with the Anacortes School District that was felt to be adequate to cover Brandon's lifetime needs which experts placed at over twelve million dollars **(\$12,000,000)**.
- As part of the settlement, the Anacortes School District also volunteered to help fund a speaking tour for Brandon's mother, allowing her to educate coaches, school officials and parents about the dangers of concussion, return to play and SIS.

Second-Impact Syndrome

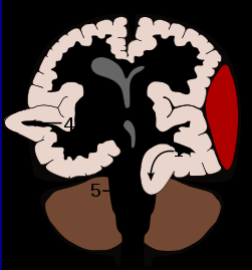
- **A rapid and often fatal neurologic deterioration in an athlete from a relatively minor second head injury**
- When a second concussion occurs while the athlete is still symptomatic and healing from a previous concussion
 - **The second injury may occur from days to weeks following the first**
 - The second impact is more likely to cause brain swelling and other widespread damage, and can be fatal.
 - Loss of consciousness is not required
 - **SIS is relatively preventable**

Second-Impact Syndrome

- **History-**
 - 1st described in 1973
 - SIS coined in 1984
- **Incidence-**
 - Relatively unknown
 - Most cases have occurred in younger people (< 20yo)
- **Controversy-**
 - Only 17 confirmed cases in the medical literature
 - Given the universality of contact sports & head injuries, why are there virtually no reports of SIS outside of the United States??
 - Teammate recall is the basis on which the *first impact* is documented
 - Found to be unreliable
 - Shouldn't boxers be susceptible to 60th impact?

Second-Impact Syndrome

- **Cause-**
 - brain's arterioles lose their ability to regulate their diameter & therefore lose control over cerebral blood flow resulting in **massive cerebral edema & a rapid & severe increase in intracranial pressure.**




Second-Impact Syndrome

- **Signs & Symptoms-**
 - Headache
 - Cognitive difficulties
 - Visual changes
 - Motor or sensory changes
 - Dilated pupils / loss of eye movement
 - LOC → sudden collapse
 - Respiratory failure
- **2nd impact may be very minor**
- **Sx progress quickly & condition rapidly worsens**



Second-Impact Syndrome

- **Treatment-**
 - Immediate recognition & stabilization
 - Airway management
 - Hyperventilation
 - Administration of osmotic agents
- **Prognosis-**
 - **Mortality rate = > 50%**
 - **Morbidity rate = 100%**



Second-Impact Syndrome

- **Effect on Medical Personnel-**
 - Are left wondering about their relationship with the athlete
 - Are confused as to why the athlete did not speak of his/her symptoms
 - Question whether or not there were other steps that they could have taken in order to prevent the injury
 - Start to fear that other athletes are perhaps downplaying their sx in order to return to play & therefore are at risk
 - Are often reluctant to allow future athletes to return after sustaining a concussion
- **SEEK HELP IF NEEDED!**

Second-Impact Syndrome

- **Prevention-**
 - **IS PREVENTABLE!!**
 - **EDUCATION-**
 - Student-athletes
 - Parents
 - Coaches
 - Providers
 - Prevent the 1st Concussion
 - **Return to Play Protocols**

NOTE:
 Any observations that satisfy criteria suggest symptoms or behaviors consistent with a concussion injury, including but not limited to:
 1. Altered level and/or loss of consciousness
 2. Confusion, as evidenced by disorientation to person, time, or place, inability to respond appropriately to questions, inability to provide information correctly, motor, sensory, appropriately medical treatment, or inability to remember important information
 3. Ataxic gait/signs of cerebellar involvement or ataxic
 4. Abnormal neurological examination (e.g., abnormal pupil(s) response, persistent abnormal eye signs, abnormal balance, etc.)
 5. Two and/or more headache, vomiting, or accompanied by unconsciousness or other vital disturbances, tremor, seizure, swelling, or abnormal pupil
 6. Any other possible signs or symptoms of a concussion injury

Should be withheld from participation for the remainder of that day.

Once removed from participation, the student-athlete must follow the outlined guidelines for management of his/her injury and will not be considered for return to participation until he/she is fully asymptomatic of both head and neck, post-traumatic symptoms are either normal baseline levels, and he/she has been cleared for participation by the University of Maryland Team Physician and/or health-care provider.

What is the utility of SIS ?

To scare athletes into not participating while symptomatic!



CONCUSSIONS TAKE HOME POINTS

- Amnesia correlates best with cognitive deficit
- When in doubt, err on the side of conservative management
- Individualized management is best
- Involve parents in decisions of minors
- Advocate for the athlete not the coach or team

CONCUSSIONS TAKE HOME POINTS

- No return to play if symptomatic
- Assume cervical spine injury in unconscious players
- Athletes commonly do NOT recognize they have or have had a concussion
- Deteriorating LOC = bleed until proven otherwise

Questions



CONCUSSION

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