Update: 4th International Consensus Conference on Concussions in Sports

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Disclosures

NFL Head, Neck and Spine Committee

Football and Wellness Committee USA Football

Medical Advisory Board Pop Warner Football

NCAA Task Force on concussion

Medical Advisory Board X2IMPACT

Sports and Recreation Concussions

- CDC estimates that there may be as many as 3.8 million sports and recreation concussions annually in the United States
- Good news/bad news situation
  - In sports, tragedies due to concussions are often preventable



4th International Conference on Concussion in Sports

- 1st Vienna 2001, 2nd Prague 2004, 3rd Zurich 2008
- 4th meeting in Zurich 2012
  - NIH consensus development conference format
    - Pre-defined group of questions
    - Body of literature identified
    - Presentation by experts in open session day 1 and day 2
    - Discussion/debate closed session with consensus panel on day 3
    - Document drafted by authors and circulated to panel
    - Knowledge translation

Sports Concussion Definition

- *"Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic and biomechanical injury constructs that may be utilized in defining the nature of a concussive head injury include…"*

McCrory P et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012 Br J Sports Med 2013;47:250–258.

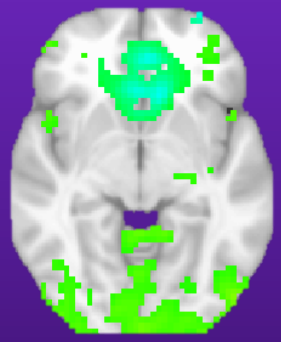
Definition

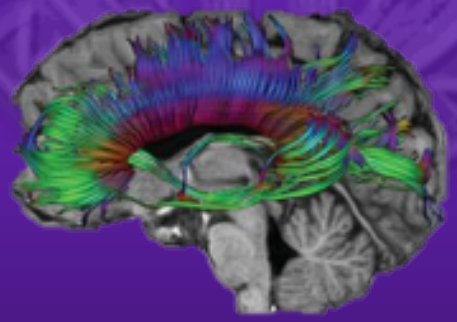
1. *Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an ‘‘impulsive’’ force transmitted to the head.*
2. *Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously. However in some cases symptoms and signs may evolve over a number of minutes to hours.*
3. *Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury and as such, no abnormality is seen on standard structural neuroimaging studies.*
4. *Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. However it is important to note that in some cases, post-concussive symptoms may be prolonged.*

McCrory P et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012 Br J Sports Med 2013;47:250–258

Advanced Imaging

- Functional MRI (fMRI)
- Diffusion Tensor Imaging (DTI)
- MR-Spectroscopy (MRS)





Advanced Imaging

- fMRI, DTI and MRS represent new neuroimaging techniques
- Evaluate brain injury & function;
  - Blood oxygenation
  - White matter axonal / structural integrity
  - Neurometabolites
- Research Tools
- Not yet ready for clearance/management decisions

Pathophysiology

- Metabolic changes that occur in the animal model, and thought to occur in humans include:
  - Alterations in intracellular/extracellular glutamate, potassium and calcium.
  - A relative decrease in cerebral blood flow in the setting of an increased requirement for glucose (i.e. increased glycolysis).
- This mismatch in the supply and demand of metabolism may potentially result in cell dysfunction and increase the vulnerability of the cell to a second insult.

Harmon K et al.: " American Medicine Society for Sports Medicine position statement: concussion in sport." Br J Sports Medicine, 47:15-26, 2013

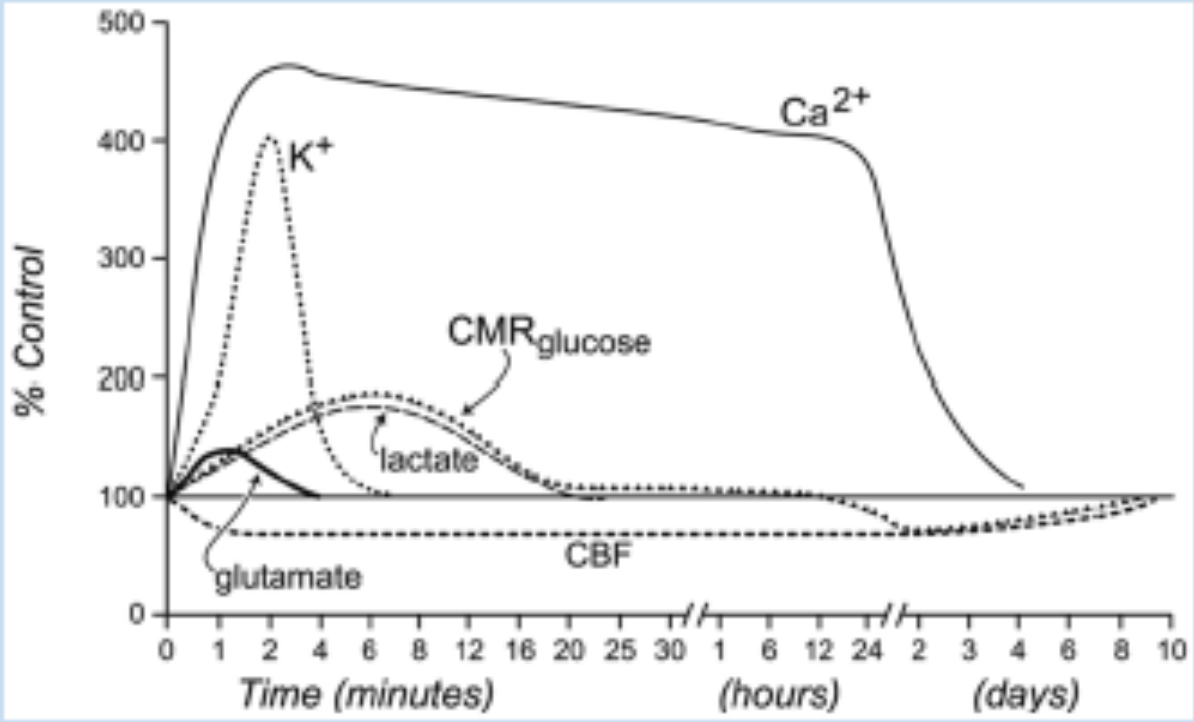


Figure 1. Neurometabolic cascade following concussion. K^+, potassium; $CMR_{glucose}$, cerebral metabolic rate of glucose utilization; Ca^{2+}, calcium; CBF, cerebral blood flow. With permission (adapted from Hovda et al[50]).

Pathophysiology

- Brain injury evolves- not static
- Neuronal tissue vulnerability
- Hyperglycolysis and reduced CBF (regional)
- Brain needs time to recover

SELECTED ACUTE SIGNS AND SYMPTOMS SUGGESTIVE OF CONCUSSION

COGNITIVE	SOMATIC	AFFECTIVE
Confusion	Headache	Emotional lability
Post-traumatic amnesia (PTA)	Fatigue	Irritability
Retrograde amnesia (RGA)	Disequilibrium, dizziness	
Loss of consciousness (LOC)	Nausea/vomiting	
Disorientation	Visual disturbances (photophobia, blurry/ double vision)	
Feeling “in a fog,” “zoned out”	Phonophobia	
Vacant stare		
Inability to focus		
Delayed verbal and motor responses		
Slurred/incoherent speech		
Excessive drowsiness		

Herring SA (chair), et al.: “Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement.-2011 Update” Medicine and Science in Sports and Exercise 2011; 43:2412-2422

SELECTED SIGNS AND SYMPTOMS SUGGESTIVE OF CONCUSSION

COGNITIVE	SOMATIC	AFFECTIVE	SLEEP
Confusion Post-traumatic amnesia (PTA) Retrograde amnesia (RGA) Loss of consciousness (LOC) Disorientation Feeling "in a fog," "zoned out" Vacant stare Inability to focus Delayed verbal and motor responses Slurred/inco-herent speech	Headache Fatigue Disequilibrium, dizziness Nausea/vomiting Visual disturbances (photophobia, blurry/ double vision) Phonophobia	Emotional lability Irritability	Drowsiness Sleeping less Sleeping more Trouble falling asleep

Herring SA (chair), et al.: "Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement.-2011 Update" Medicine and Science in Sports and Exercise 2011; 43:2412-2422

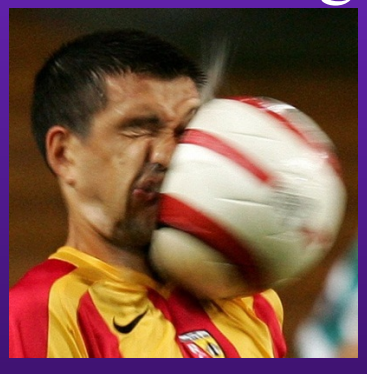
Epidemiology: Concussion Rates in High School Sports

	Concussions			Athlete Exposures (AEs)			Rate per 10,000 AEs			
Sport[b]	Competition	Practice	Total	Competition	Practice	Total	Competition	Practice	Total	Rate Ratio (95% CI)[f]
Football	548	364	912	239,445	1,176,395	1,415,840	22.9	3.1	6.4	7.4 (6.5-8.4)
Boys' ice hockey	69	11	80	47,418	99,857	147,275	14.6	1.1	5.4	13.2 (7.0-25.0)
Boys' lacrosse	75	18	93	71,990	159,980	231,970	10.4	1.1	4.0	9.5 (5.5-15.5)
Girls' soccer	133	26	159	145,139	328,241	473,380	9.2	0.8	3.4	11.6 (7.6-17.6)
Girls' lacrosse	45	15	60	52,331	117,865	170,196	8.6	1.3	3.5	6.6 (3.8-12.1)
Girls' basketball	85	22	107	153,655	350,554	504,209	5.5	0.6	2.1	9.2 (5.5-14.1)
Boys' soccer	88	15	103	166,572	383,076	549,648	5.3	0.4	1.9	13.5 (7.8-23.3)
Boys' wrestling	63	49	112	132,203	365,981	498,184	4.8	1.3	2.2	3.6 (2.5-5.2)
Girls' field hockey	29	22	51	70,430	156,735	227,165	4.1	1.4	2.2	2.9 (1.7-5.1)
Boys' basketball	71	25	96	181,941	433,661	615,602	3.9	0.6	1.6	6.8 (4.3-10.7)

Marar M et al. Epidemiology of Concussions Among United States High School Athletes in 20 Sports AJSM 2012;40:747-755

Gender Comparable Sports

- Girls had a higher rate of concussions than boys
- Concussions represented a greater proportion of all injuries in girls' sports
- Girls had a greater proportion of concussions due to player-playing surface contact and player-equipment contact
- Except for track and field and swimming, girls had a higher proportion of recurrent concussion



Marar,M et al. AJSM 2012;40:747-755

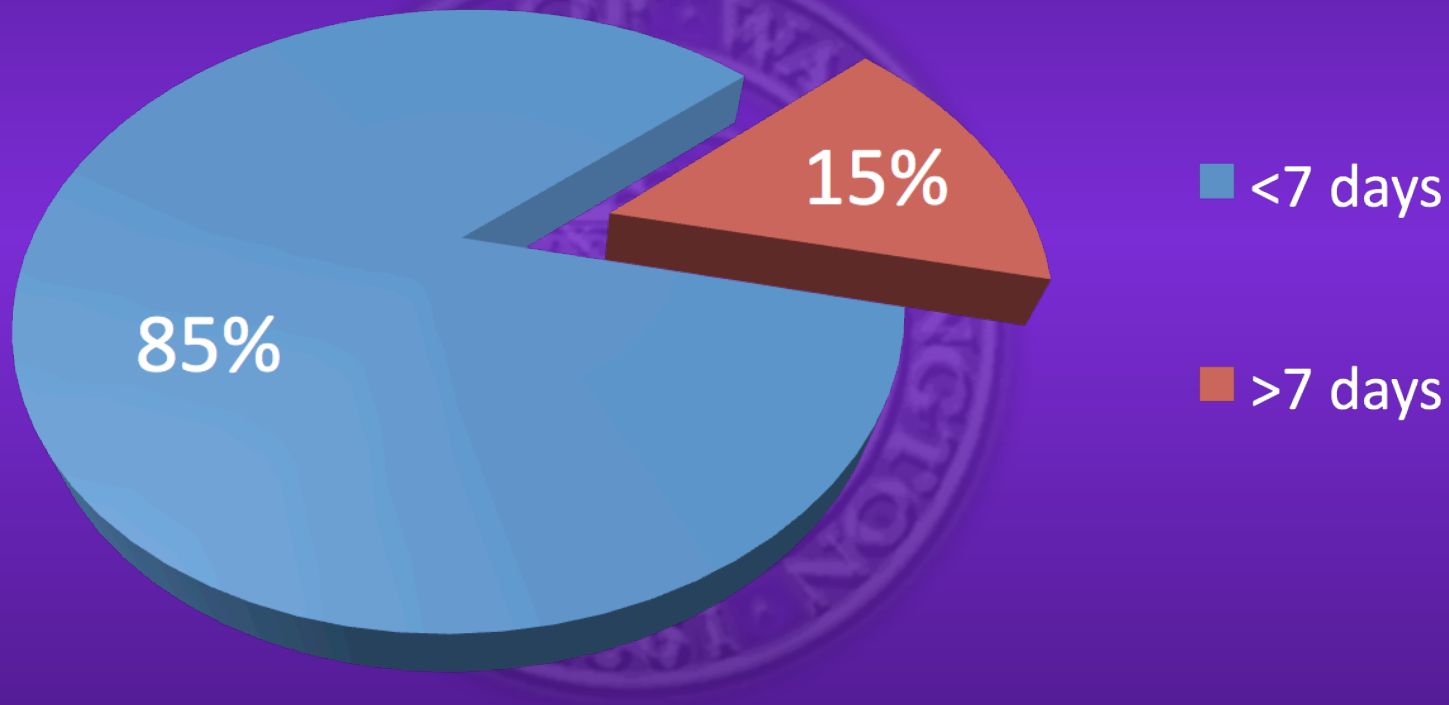
Gender and Sports Concussions

- The role of female gender as a possible modifier in the management of concussion was discussed at length by the panel. There was no unanimous agreement that the current published research evidence is conclusive enough for this to be included as a modifying factor, although it was accepted that gender may be a risk factor for injury and/or influence injury severity

McCrory P et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012 Br J Sports Med 2013;47:250–258.

Symptom Duration

Multicenter, prospective, 5 year study
16,624 college and high school athletes
637 concussions



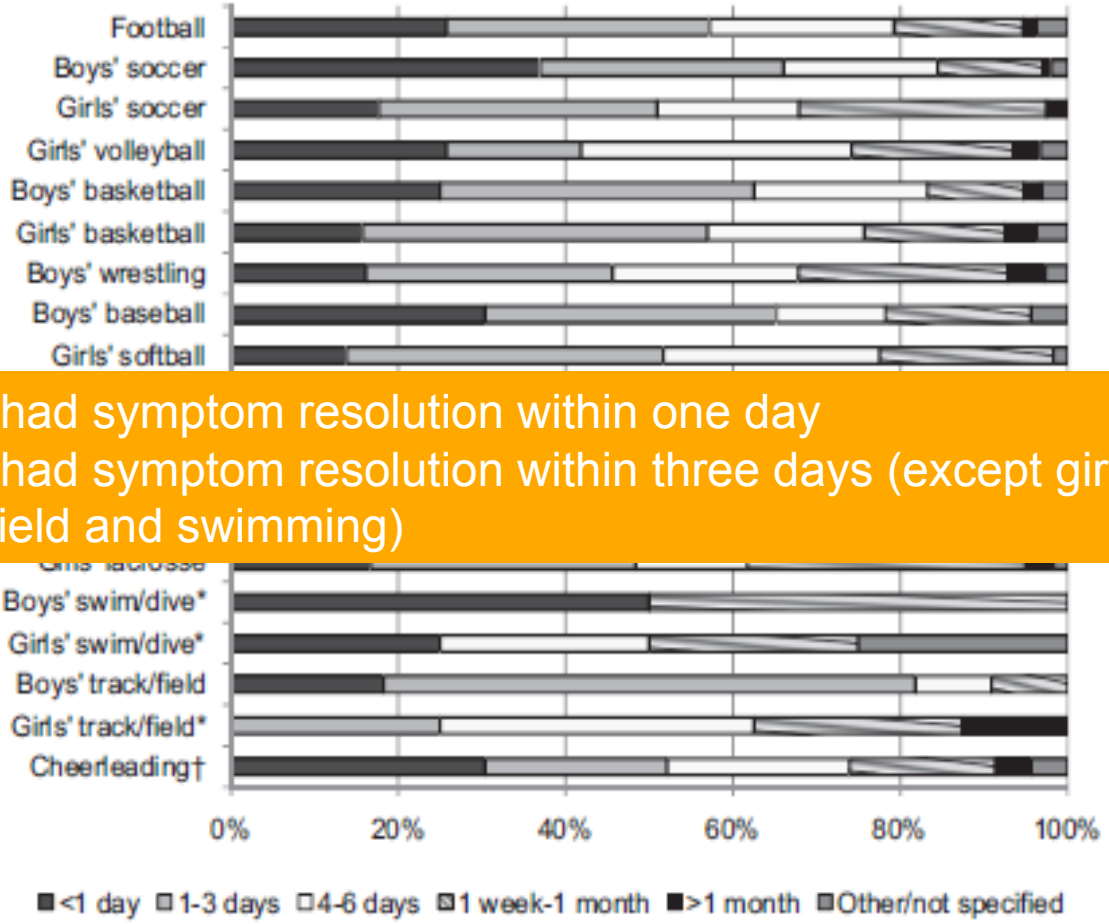
Mcrea M et al. Neurosurgery 2009;65:876-82

Sports Concussion Recovery

- Majority (80-90%) resolve in short (7-10 day) period
- May take longer in children and adolescents

McCrory P et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012 Br J Sports Med 2013;47:250–258.

Concussion Symptom Resolution



25% had symptom resolution within one day
40% had symptom resolution within three days (except girl's track and field and swimming)

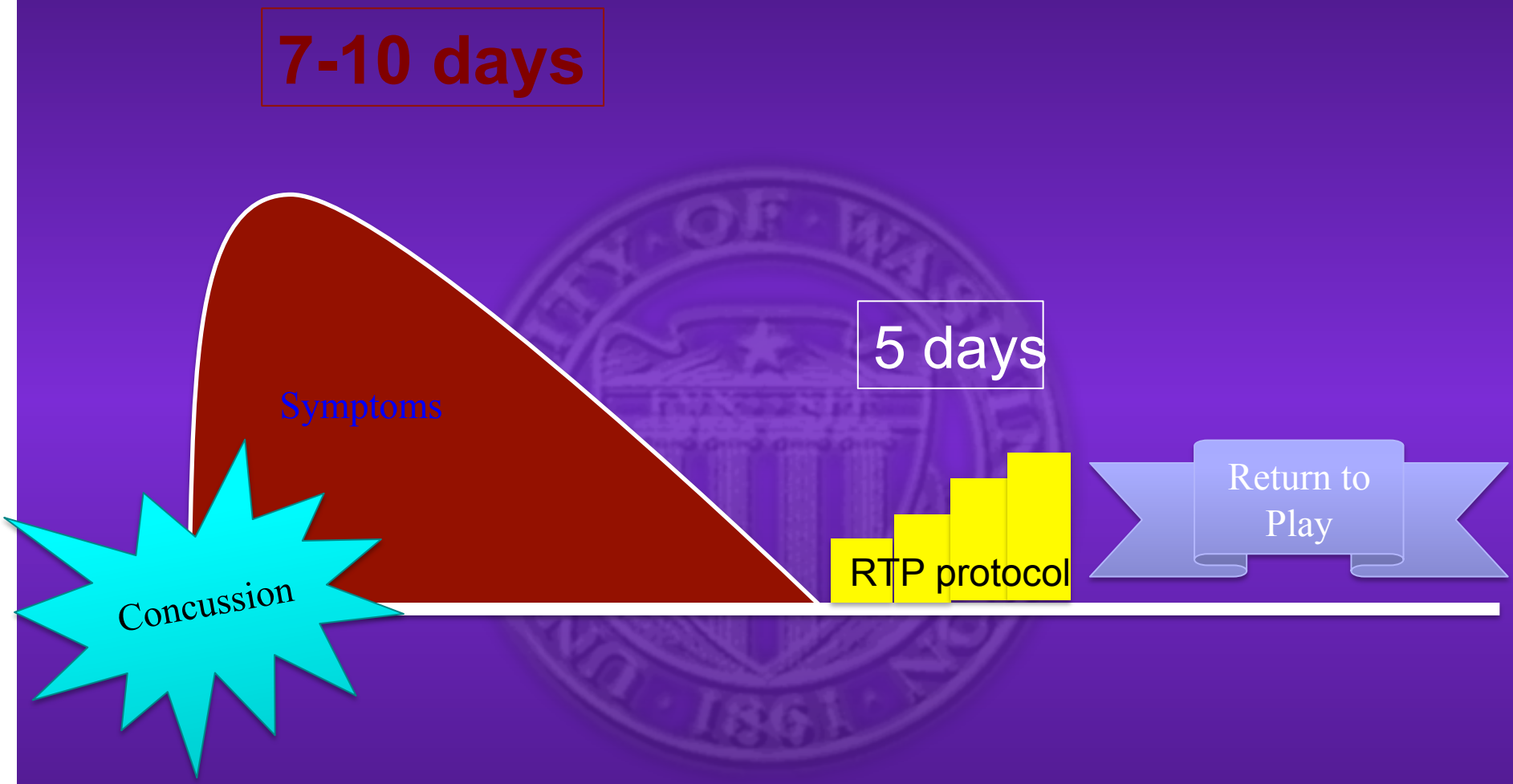
Marar M et al. Epidemiology of Concussions Among United States High School Athletes in 20 Sports AJSM 2012;40:747-755

Epidemiology of Severe Injuries Among United States High School Athletes

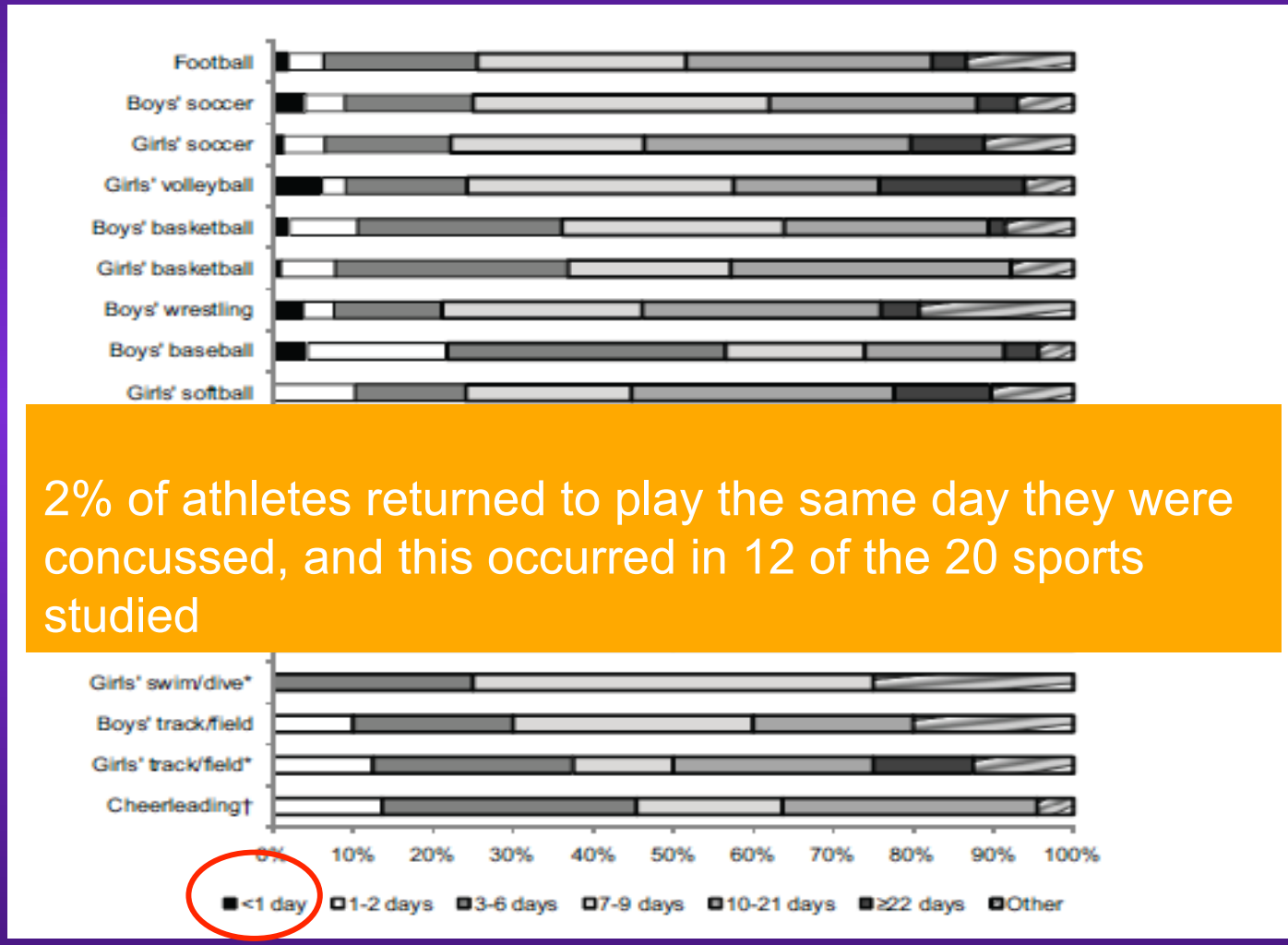
sport	Concussion (% >21 days)
Boy's football	5.9%
Boy's soccer	11.8%
Girl's soccer	7.7%
Girl's volleyball	8.9%
Boy's basketball	1.2%
Girl's basketball	6.6%
Boy's wrestling	3.3%
Boy's baseball	1.4%
Girl's softball	1.2%

Darrow, CJ et al. Am J Sports Medicine 2009 Sep;37(9):1798-805

The Basic Youth Sports Concussion Map



Length of Time For RTP After Concussion



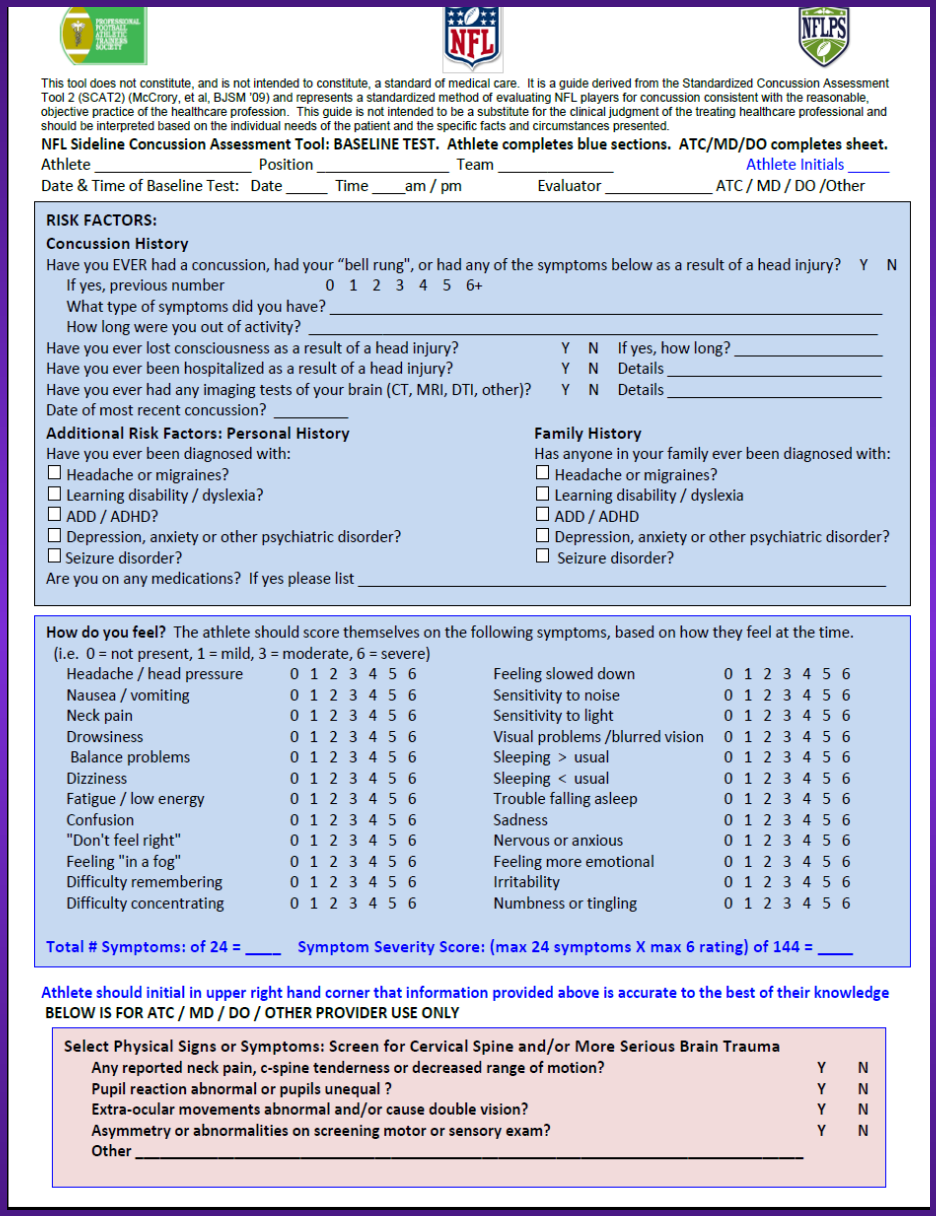
2% of athletes returned to play the same day they were concussed, and this occurred in 12 of the 20 sports studied

Marar M et al. Epidemiology of Concussions Among United States High School Athletes in 20 Sports AJSM 2012;40:747-755

Pre-Season

Pre-Season Planning

- Develop an emergency medical action plan, including guidelines specific to concussion management
- Incorporate a standardized baseline assessment tool for concussion that includes prior concussion history, risk factors for prolonged or complicated recovery, symptom checklist and neurological examination emphasizing cognitive function and balance (NFL, SCAT 3, Child-SCAT 3)
- Consider baseline neuropsychological testing
- Coordinate a team for concussion management (*e.g.,* physicians, certified athletic trainers and other health care providers, neuropsychologists, school officials) that is compliant with state laws and rules and regulations of governing bodies
- Educate athletes, parents/guardians, coaches, school officials and others



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NFL Sideline Concussion Assessment Tool: BASELINE TEST. Athlete completes blue sections. ATC/MD/DO completes sheet.

Athlete _____ Position _____ Team _____ Athlete Initials _____

Date & Time of Baseline Test: Date _____ Time ____am / pm Evaluator _____ ATC / MD / DO /Other

RISK FACTORS:

Concussion History

Have you EVER had a concussion, had your "bell rung", or had any of the symptoms below as a result of a head injury? Y N

If yes, previous number 0 1 2 3 4 5 6+

What type of symptoms did you have? _____

How long were you out of activity? _____

Have you ever lost consciousness as a result of a head injury? Y N If yes, how long? _____

Have you ever been hospitalized as a result of a head injury? Y N Details _____

Have you ever had any imaging tests of your brain (CT, MRI, DTI, other)? Y N Details _____

Date of most recent concussion? _____

Additional Risk Factors: Personal History

Have you ever been diagnosed with:

- ☐ Headache or migraines?
- ☐ Learning disability / dyslexia?
- ☐ ADD / ADHD?
- ☐ Depression, anxiety or other psychiatric disorder?
- ☐ Seizure disorder?

Family History

Has anyone in your family ever been diagnosed with:

- ☐ Headache or migraines?
- ☐ Learning disability / dyslexia
- ☐ ADD / ADHD
- ☐ Depression, anxiety or other psychiatric disorder?
- ☐ Seizure disorder?

Are you on any medications? If yes please list _____

How do you feel? The athlete should score themselves on the following symptoms, based on how they feel at the time.

(i.e. 0 = not present, 1 = mild, 3 = moderate, 6 = severe)

Headache / head pressure	0 1 2 3 4 5 6	Feeling slowed down	0 1 2 3 4 5 6
Nausea / vomiting	0 1 2 3 4 5 6	Sensitivity to noise	0 1 2 3 4 5 6
Neck pain	0 1 2 3 4 5 6	Sensitivity to light	0 1 2 3 4 5 6
Drowsiness	0 1 2 3 4 5 6	Visual problems /blurred vision	0 1 2 3 4 5 6
Balance problems	0 1 2 3 4 5 6	Sleeping > usual	0 1 2 3 4 5 6
Dizziness	0 1 2 3 4 5 6	Sleeping < usual	0 1 2 3 4 5 6
Fatigue / low energy	0 1 2 3 4 5 6	Trouble falling asleep	0 1 2 3 4 5 6
Confusion	0 1 2 3 4 5 6	Sadness	0 1 2 3 4 5 6
"Don't feel right"	0 1 2 3 4 5 6	Nervous or anxious	0 1 2 3 4 5 6
Feeling "in a fog"	0 1 2 3 4 5 6	Feeling more emotional	0 1 2 3 4 5 6
Difficulty remembering	0 1 2 3 4 5 6	Irritability	0 1 2 3 4 5 6
Difficulty concentrating	0 1 2 3 4 5 6	Numbness or tingling	0 1 2 3 4 5 6

Total # Symptoms: of 24 = ____ Symptom Severity Score: (max 24 symptoms X max 6 rating) of 144 = ____

Athlete should initial in upper right hand corner that information provided above is accurate to the best of their knowledge

BELOW IS FOR ATC / MD / DO / OTHER PROVIDER USE ONLY

Select Physical Signs or Symptoms: Screen for Cervical Spine and/or More Serious Brain Trauma

- **Any reported neck pain, c-spine tenderness or decreased range of motion?** Y N
- **Pupil reaction abnormal or pupils unequal ?** Y N
- **Extra-ocular movements abnormal and/or cause double vision?** Y N
- **Asymmetry or abnormalities on screening motor or sensory exam?** Y N
- **Other** _____

Baseline

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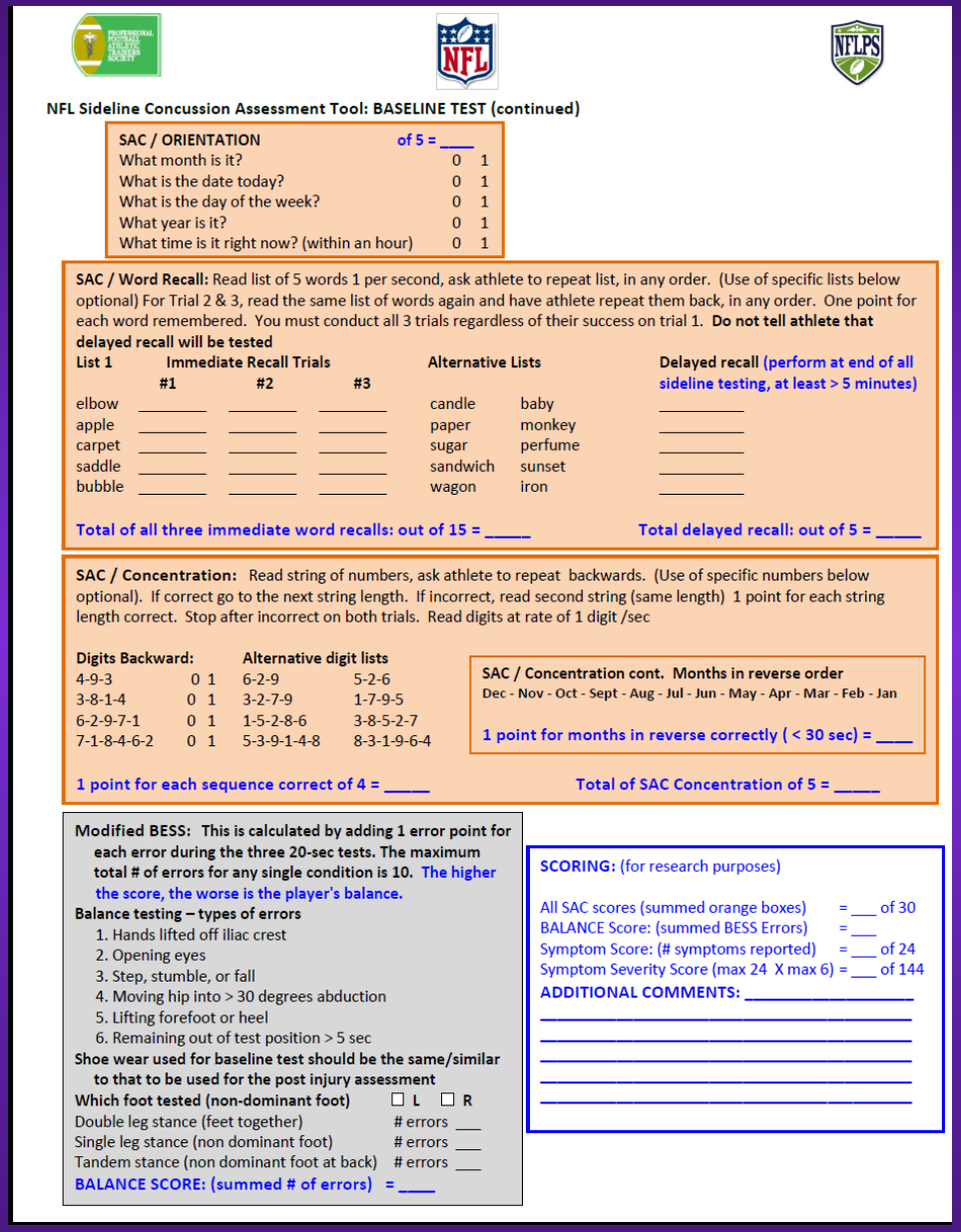

NFL Sideline Concussion Assessment Tool: BASELINE TEST (continued)

SAC / ORIENTATION of 5 = ____

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 an hour)	0	1

SAC / Word Recall: Read list of 5 words 1 per second, ask athlete to repeat list, in any order. (Use of specific lists below optional) For Trial 2 & 3, read the same list of words again and have athlete repeat them back, in any order. One point for each word remembered. You must conduct all 3 trials regardless of their success on trial 1. **Do not tell athlete that delayed recall will be tested**

List 1	Immediate Recall Trials #1	#2	#3	Alternative Lists		Delayed recall (perform at end of all sideline testing, at least > 5 minutes)
elbow	_____	_____	_____	candle	baby	_____
apple	_____	_____	_____	paper	monkey	_____
carpet	_____	_____	_____	sugar	perfume	_____
saddle	_____	_____	_____	sandwich	sunset	_____
bubble	_____	_____	_____	wagon	iron	_____

Total of all three immediate word recalls: out of 15 = _____ Total delayed recall: out of 5 = _____

SAC / Concentration: Read string of numbers, ask athlete to repeat backwards. (Use of specific numbers below optional). If correct go to the next string length. If incorrect, read second string (same length) 1 point for each string length correct. Stop after incorrect on both trials. Read digits at rate of 1 digit /sec

Digits Backward:		Alternative digit lists	
4-9-3	0 1	6-2-9	5-2-6
3-8-1-4	0 1	3-2-7-9	1-7-9-5
6-2-9-7-1	0 1	1-5-2-8-6	3-8-5-2-7
7-1-8-4-6-2	0 1	5-3-9-1-4-8	8-3-1-9-6-4

SAC / Concentration cont. Months in reverse order
Dec - Nov - Oct - Sept - Aug - Jul - Jun - May - Apr - Mar - Feb - Jan

1 point for months in reverse correctly (< 30 sec) = ____

1 point for each sequence correct of 4 = _____ Total of SAC Concentration of 5 = _____

Modified BESS: This is calculated by adding 1 error point for each error during the three 20-sec tests. The maximum total # of errors for any single condition is 10. The higher the score, the worse is the player's balance.

Balance testing – types of errors

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

Shoe wear used for baseline test should be the same/similar to that to be used for the post injury assessment

Which foot tested (non-dominant foot) ☐ L ☐ R

Double leg stance (feet together)	# errors ___
Single leg stance (non dominant foot)	# errors ___
Tandem stance (non dominant foot at back)	# errors ___

BALANCE SCORE: (summed # of errors) = ____

SCORING: (for research purposes)

All SAC scores (summed orange boxes) = ___ of 30
BALANCE Score: (summed BESS Errors) = ___
Symptom Score: (# symptoms reported) = ___ of 24
Symptom Severity Score (max 24 X max 6) = ___ of 144

ADDITIONAL COMMENTS: _____

Baseline
Page 2

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Br J Sports Med 2013 47: 259 -262 , Br J Sports Med 2013 47:263-266, Br J Sports Med 2013 47: 267


Sideline
Clinic
Return to play

Sideline evaluation

Game-Day Evaluation & Treatment *Pre-Game*

It is *essential* to:

- Implement the game-day medical action plan specific to concussion.
- Understand the indications for cervical spine immobilization and emergency transport.

Game-Day Evaluation & Treatment

It is *essential* to:

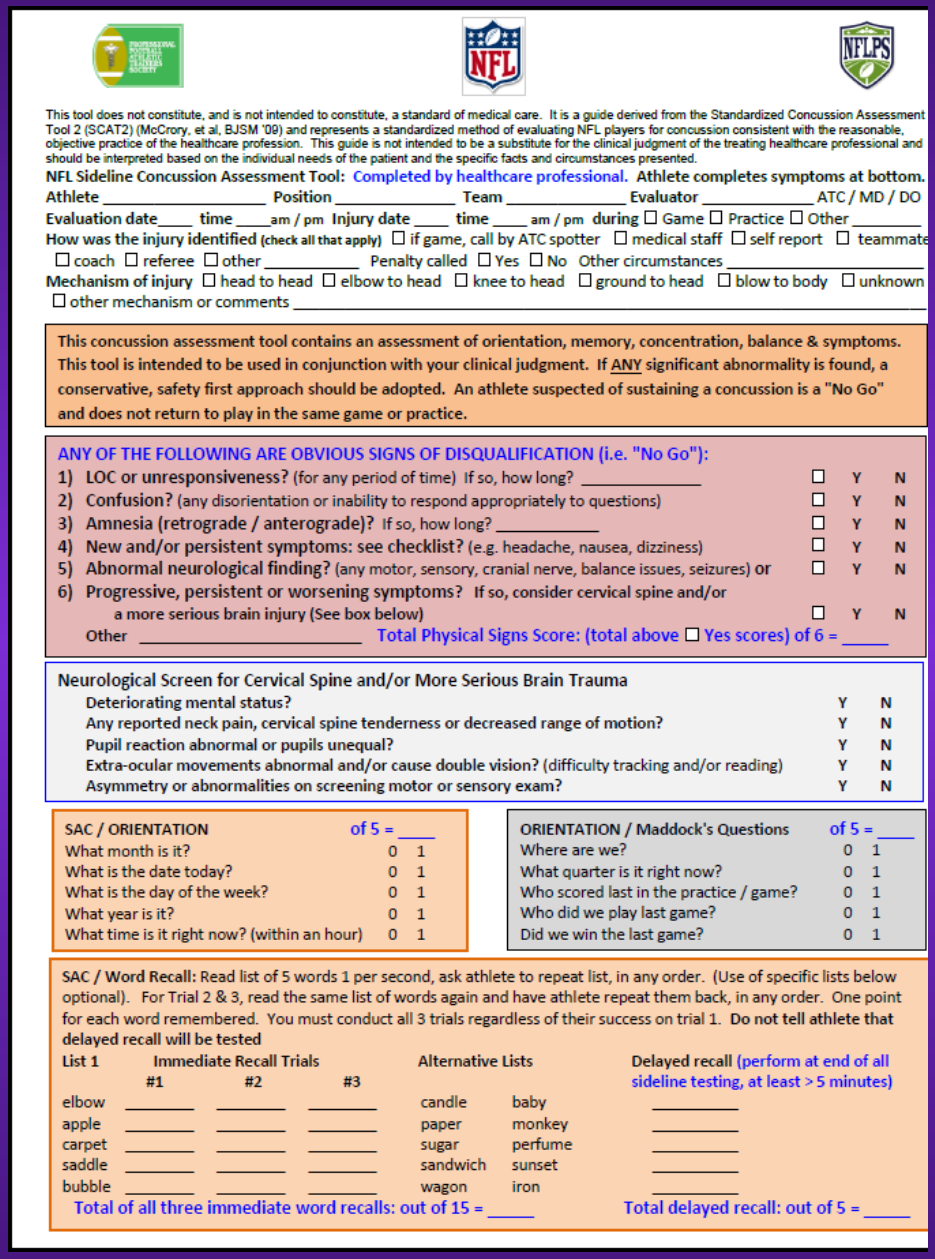
- Evaluate the injured athlete on-the-field in a systematic fashion:
  - Assess for adequate airway, breathing, and circulation (ABC's).
  - Followed by focused neurological assessment emphasizing mental status, neurological deficit, and cervical spine status.
  - Determine initial disposition (emergency transport vs. sideline evaluation).

Game-Day Evaluation & Treatment

Sideline/Dugout/Locker Room

It is *essential* to:

- Obtain a more detailed history and perform a more detailed physical examination (NFL, SCAT 3, Child-SCAT 3) and compare to baseline data if available
  - –Assess for cognitive, somatic, and affective signs and symptoms of acute concussion with particular attention paid to the number and severity of symptoms because of their prognostic significance



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NFL Sideline Concussion Assessment Tool: Completed by healthcare professional. **Athlete completes symptoms at bottom.**

Athlete _____ **Position** _____ **Team** _____ **Evaluator** _____ ATC / MD / DO

Evaluation date____ **time** ____am / pm **Injury date** ____ **time** ____ am / pm **during** ☐ Game ☐ Practice ☐ Other _____

How was the injury identified (check all that apply) ☐ if game, call by ATC spotter ☐ medical staff ☐ self report ☐ teammate ☐ coach ☐ referee ☐ other _____ Penalty called ☐ Yes ☐ No Other circumstances _____

Mechanism of injury ☐ head to head ☐ elbow to head ☐ knee to head ☐ ground to head ☐ blow to body ☐ unknown ☐ other mechanism or comments _____

This concussion assessment tool contains an assessment of orientation, memory, concentration, balance & symptoms. This tool is intended to be used in conjunction with your clinical judgment. If ANY significant abnormality is found, a conservative, safety first approach should be adopted. An athlete suspected of sustaining a concussion is a "No Go" and does not return to play in the same game or practice.

ANY OF THE FOLLOWING ARE OBVIOUS SIGNS OF DISQUALIFICATION (i.e. "No Go"):

1)	**LOC or unresponsiveness?** (for any period of time) If so, how long? _____	Y	N
2)	**Confusion?** (any disorientation or inability to respond appropriately to questions)	Y	N
3)	**Amnesia (retrograde / anterograde)?** If so, how long? _____	Y	N
4)	**New and/or persistent symptoms: see checklist?** (e.g. headache, nausea, dizziness)	Y	N
5)	**Abnormal neurological finding?** (any motor, sensory, cranial nerve, balance issues, seizures) or	Y	N
6)	**Progressive, persistent or worsening symptoms?** If so, consider cervical spine and/or a more serious brain injury (See box below)	Y	N

Other _____ Total Physical Signs Score: (total above ☐ Yes scores) of 6 = _____

Neurological Screen for Cervical Spine and/or More Serious Brain Trauma

Deteriorating mental status?	Y	N
Any reported neck pain, cervical spine tenderness or decreased range of motion?	Y	N
Pupil reaction abnormal or pupils unequal?	Y	N
Extra-ocular movements abnormal and/or cause double vision? (difficulty tracking and/or reading)	Y	N
Asymmetry or abnormalities on screening motor or sensory exam?	Y	N

SAC / ORIENTATION	of 5 = ____	
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 an hour)	0	1

ORIENTATION / Maddock's Questions	of 5 = ____	
Where are we?	0	1
What quarter is it right now?	0	1
Who scored last in the practice / game?	0	1
Who did we play last game?	0	1
Did we win the last game?	0	1

SAC / Word Recall: Read list of 5 words 1 per second, ask athlete to repeat list, in any order. (Use of specific lists below optional). For Trial 2 & 3, read the same list of words again and have athlete repeat them back, in any order. One point for each word remembered. You must conduct all 3 trials regardless of their success on trial 1. **Do not tell athlete that delayed recall will be tested**

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apple	_____	_____	_____	paper	monkey	_____
carpet	_____	_____	_____	sugar	perfume	_____
saddle	_____	_____	_____	sandwich	sunset	_____
bubble	_____	_____	_____	wagon	iron	_____

Total of all three immediate word recalls: out of 15 = _____ Total delayed recall: out of 5 = _____

Post injury

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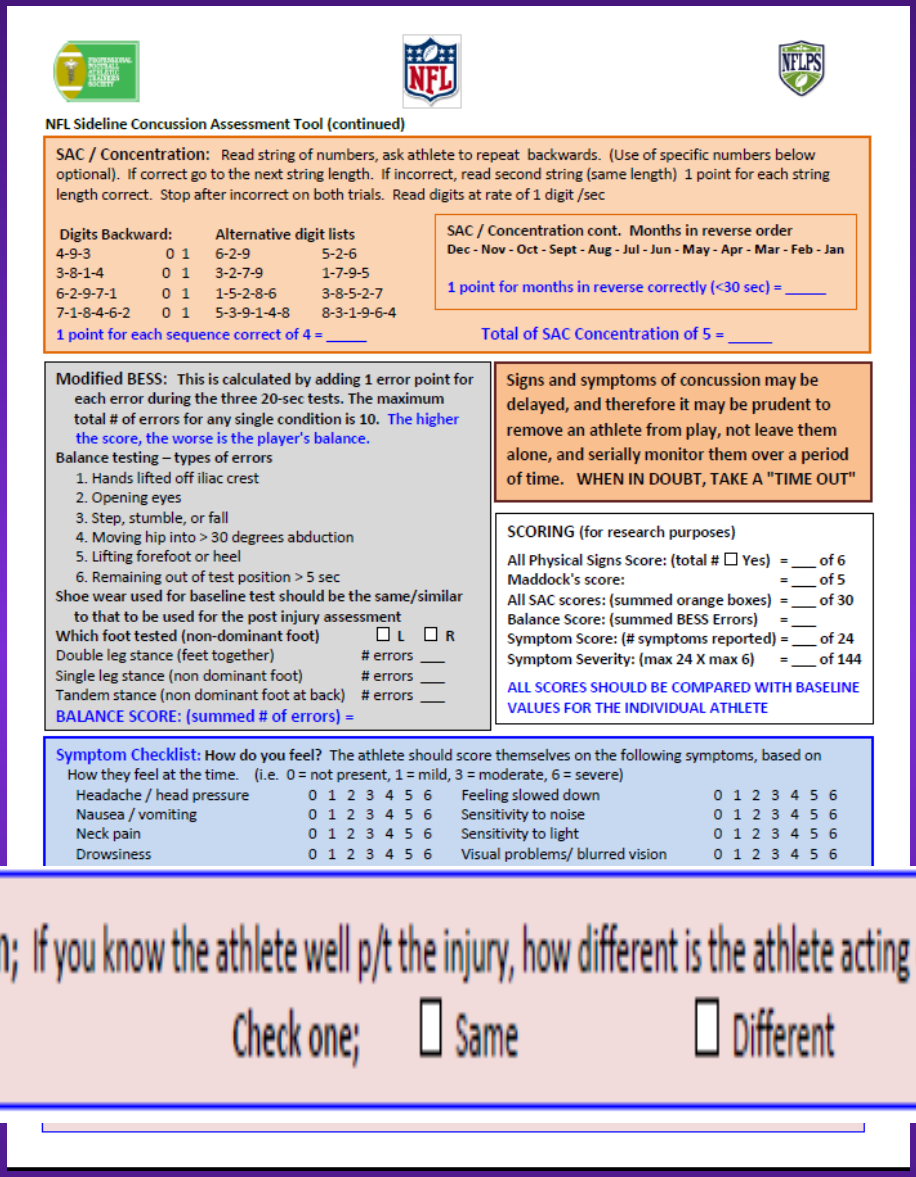

NFL Sideline Concussion Assessment Tool (continued)

SAC / Concentration: Read string of numbers, ask athlete to repeat backwards. (Use of specific numbers below optional). If correct go to the next string length. If incorrect, read second string (same length) 1 point for each string length correct. Stop after incorrect on both trials. Read digits at rate of 1 digit /sec

Digits Backward:		Alternative digit lists	
4-9-3	0 1	6-2-9	5-2-6
3-8-1-4	0 1	3-2-7-9	1-7-9-5
6-2-9-7-1	0 1	1-5-2-8-6	3-8-5-2-7
7-1-8-4-6-2	0 1	5-3-9-1-4-8	8-3-1-9-6-4

1 point for each sequence correct of 4 = _____

SAC / Concentration cont. Months in reverse order
Dec - Nov - Oct - Sept - Aug - Jul - Jun - May - Apr - Mar - Feb - Jan

1 point for months in reverse correctly (<30 sec) = _____

Total of SAC Concentration of 5 = _____

Modified BESS: This is calculated by adding 1 error point for each error during the three 20-sec tests. The maximum total # of errors for any single condition is 10. The higher the score, the worse is the player's balance.

Balance testing – types of errors
1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

Shoe wear used for baseline test should be the same/similar to that to be used for the post injury assessment

Which foot tested (non-dominant foot) ☐ L ☐ R

Double leg stance (feet together) # errors ___

Single leg stance (non dominant foot) # errors ___

Tandem stance (non dominant foot at back) # errors ___

BALANCE SCORE: (summed # of errors) =

Signs and symptoms of concussion may be delayed, and therefore it may be prudent to remove an athlete from play, not leave them alone, and serially monitor them over a period of time. WHEN IN DOUBT, TAKE A "TIME OUT"

SCORING (for research purposes)

All Physical Signs Score: (total # ☐ Yes) = ___ of 6
Maddock's score: = ___ of 5
All SAC scores: (summed orange boxes) = ___ of 30
Balance Score: (summed BESS Errors) = ___
Symptom Score: (# symptoms reported) = ___ of 24
Symptom Severity: (max 24 X max 6) = ___ of 144

ALL SCORES SHOULD BE COMPARED WITH BASELINE VALUES FOR THE INDIVIDUAL ATHLETE

Symptom Checklist: How do you feel? The athlete should score themselves on the following symptoms, based on How they feel at the time. (i.e. 0 = not present, 1 = mild, 3 = moderate, 6 = severe)

Headache / head pressure	0 1 2 3 4 5 6	Feeling slowed down	0 1 2 3 4 5 6
Nausea / vomiting	0 1 2 3 4 5 6	Sensitivity to noise	0 1 2 3 4 5 6
Neck pain	0 1 2 3 4 5 6	Sensitivity to light	0 1 2 3 4 5 6
Drowsiness	0 1 2 3 4 5 6	Visual problems/ blurred vision	0 1 2 3 4 5 6

Clinical Impression; If you know the athlete well p/t the injury, how different is the athlete acting compared to his usual self? Check one; ☐ Same ☐ Different ☐ Unsure

Post injury
Page 2

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Game-Day Evaluation & Treatment *Sideline/Dugout* continued It is *essential* to:

- Not leave the player unsupervised.
- Perform serial neurological assessments.
- Determine disposition for symptomatic and non-symptomatic players, including post-injury follow-up (options include home with observation or transport to hospital).
- Provide post-event instructions to the athlete and others (e.g., regarding alcohol, medications, physical exertion and medical follow-up).

Catastrophic Head Injuries in High School and College Football

- National Center for Catastrophic Sports Injury Research data from 1989-2002
- 94 cases
  - 75 subdural hematomas, 10 subdural with diffuse brain swelling, 5 diffuse brain swelling, 4 AVM or aneurysm
- 92 cases were in high school players
  - Boden et al. AJSM 2007; 35: 1075 - 1081

Catastrophic Head Injuries in High School and College Football

- 59% of athletes had a previous history of concussion(s):
  - 71% of those injuries occurred in the same season as the catastrophic injury
- 39% (21 of 54) of athletes at time of catastrophic injury were playing with residual symptoms from a previous concussion
  - Boden et al. AJSM 2007; 35: 1075 - 1081

Return-To-Play ***Same-Day***
It is *essential* to understand:

- It is the safest course of action to hold an athlete out.
- When in doubt, sit them out.

Return To Play

- It was unanimously agreed that no return to play on the day of concussive injury should occur.
- There are data demonstrating that at the collegiate and high school level, athletes allowed to RTP on the same day may demonstrate NP deficits post-injury that may not be evident on the sidelines and are more likely to have delayed onset of symptoms.

McCrory P et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012 Br J Sports Med 2013;47:250–258.


Clinical
management

Management Principles

- All return to play guidelines are empiric
- Originally designed to prevent Second Impact Syndrome
- None were developed specifically for the young athlete

Post Game-Day Evaluation & Treatment It is *essential* to:

- Obtain a comprehensive history of the current concussion and of any previous concussion
  - Perform a physical examination, including a detailed neurological/cognitive evaluation. (NFL, SCAT 3, child-SCAT 3 as a component)
  - Determine the need for further evaluation and consultation.
  - Determine return-to-play status.

Physical Rest

- Activity can exacerbate symptoms
- Activity can prolong symptom duration

(Relative) Mental Rest


SAMSUNG

Rest

- The cornerstone of concussion management is physical and cognitive rest until the acute symptoms resolve and then a graded programme of exertion prior to medical clearance and RTP.

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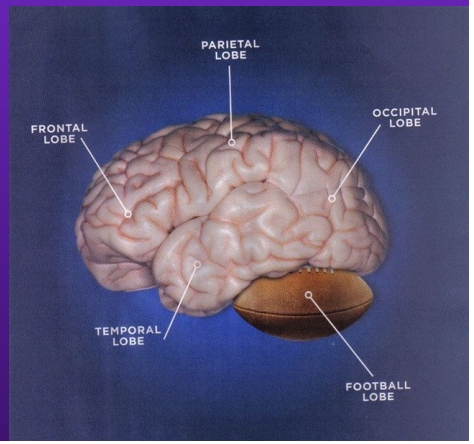
Rest

- The cornerstone of concussion management is physical and cognitive rest until the acute symptoms resolve and then a graded programme of exertion prior to medical clearance and RTP.
- The current published evidence evaluating the effect of rest following a sports-related concussion is sparse
- Low-level exercise for those who are slow to recover may be of benefit, although the optimal timing following injury for initiation of this treatment is currently unknown

McCrory P et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012 Br J Sports Med 2013;47:250–258

Post Game-Day Evaluation Neuropsychological Testing

- Understand the indications and limitations of neuropsychological testing.
  - Type and content of test data
  - Player age
  - One component of the evaluation process.



Neuropsychological Testing

- NP testing may be used to assist RTP decisions and is typically performed when an athlete is clinically asymptomatic; however, NP assessment may add important information in the early stages following injury.
- There may be particular situations where testing is performed early to assist in determining aspects of management, for example, return to school in a paediatric athlete. This will normally be best determined in consultation with a trained neuropsychologist.

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Neuropsychological Testing

- Neuropsychological Tests
  - Baseline NP testing was considered by the panel and was not considered to be required as a mandatory aspect of every assessment however may be helpful or add useful information to the overall interpretation of these tests. It also provides an additional educative opportunity for the physician to discuss the significance of this injury with the athlete.

McCrory P et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012
Br J Sports Med 2013;47:250–258

Management Principles

It is *essential* to

- Understand:
  - Brief LOC (seconds, not minutes) is associated with specific early deficits, but does not predict the severity of injury; therefore classification systems or RTP guidelines based solely on brief LOC are not accurate.
  - The number and duration of additional signs and symptoms (and neuropsychological data) are more accurate in predicting severity and outcome. RTP guidelines which address these issues are more useful.
  - Duration of symptoms is a major factor in determining severity, therefore severity of injury should not be determined until all signs and symptoms have cleared.
  - Initial treatment is rest-physical and cognitive
  - The treatment of and the RTP decision for the athlete with concussion must be individualized.

Herring SA (chair), et al.: "Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement-2011 Update" Medicine and Science in Sports and Exercise 2011; 43:2412-2422

Management Modifiers

Post-Game Day

It is *essential* to:

- Consider modifiers which may affect RTP, including:
  - Severity of the current injury
  - Previous concussions (number, severity, proximity)
  - Significant injury in response to a minor blow
  - Age (developing brain may react differently to trauma than mature brain)
  - Sport
  - Learning disabilities
  - ADD/ADHD
  - Anxiety/Depression
  - Migraine Headache
- Understand controversy exists for post-game RTP decisions.

Herring SA (chair), et al.: "Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement -2011 Update" Medicine and Science in Sports and Exercise 2011; 43:2412-2422

FACTORS	MODIFIER
Symptoms	Number Duration (>10 days) Severity
Signs	Prolonged LOC (>1min) Amnesia
Sequelae	Concussive convulsions
Temporal	Frequency –repeated concussion over time Timing – injuries close together “Recency” – recent concussion or TBI
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion
Age	Child and adolescent (< 18 years old)
Co and Pre-morbidities	Migraine, depression or other mental health disorders, attention deficit hyperactivity disorder (ADHD), learning disabilities (LD), sleep disorders
Medication	Psychoactive drugs Anticoagulants
Behaviour	Dangerous style of play
Sport	High risk activity Contact and collision sport High sporting level

McCrory P et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012 Br J Sports Med 2013;47:250–258

Concussion Management
Potential Pitfalls

- Care at the time of injury particularly for youth athletes
- Care for athletes with persistent symptoms

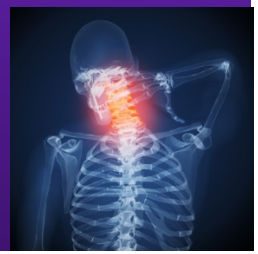
Confounders: Baseline Symptoms

- Headache is common at baseline
  - 18% of patients w/ HA following brain injury had pre-existing primary HA disorder.

--Hoffmann et al. Natural history of headache after traumatic brain injury. journal of neurotrauma. 2011. 28:1719–1725.

- Neck pain is common baseline symptom in athletes
  - 260 athletes, 167 no concussion hx and 17% reported neck pain on SCAT baseline.

--Shehata N. et al. Sport concussion assessment tool: baseline values for varsity collision sport athletes. BJSM 2009 43:730-4.



Confounders: Concussion Symptoms

- In concussed athletes, 20-35% report cervical pain
  - Guskiewicz K et al. Epidemiology of concussion in collegiate and high school football players. Am J SportsMed 2000; 28:643-650
- Post-traumatic headache is the most common symptom after a concussion (>90%)
  - Meehan et al. High school concussions in the 2008-2009 academic year: mechanism, symptoms, and management. Am J Sports Med 2010;38:2405-9.

Confounders: Influences on Post Concussive Syndrome

- Pre-morbid anxiety
  - Strong predictor of continued PCS
    - Ponsford J et al. Neuropsychology 2012;26:304-13
- Comorbid Major Depressive Disorder
  - Ranges from 26-42% in hospitalized TBI patients
  - 21.4% in mTBI
  - Can persist despite cognitive recovery
    - McCauley SR et al. Journal of Clinical and Experimental Neuropsychology,2001;23:792-808
- Negative illness perceptions
    - Hou R et al. J Neurol Neurosurg Psychiatry 2012.*83*:217-223
- Motivational factors
    - Miller L et al. Brain Injury 2001;15:297-304

Psychological and Mental Health Issues

- Psychological approaches may have application especially in selected situations (modifiers)
- Evaluate for affective symptoms (depression, anxiety) as common in all forms of traumatic brain injury
- Depression-may be consequence of concussion, underlying pathophysiological abnormality, may be multifactorial but should be considered in management

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Confounders

- Overlooking or misinterpreting pre-existing, co-existing and/or persisting musculoskeletal and psychological symptoms can result in spurious and expensive treatment, unnecessary restrictions from academic, sporting and social activities, and skewed data regarding sports concussions

Persistent Symptoms

- Persistent symptoms (>10 days) are generally reported in 10-15% of concussions. In general, symptoms are not specific to concussion and it is important to consider other pathologies.
- Cases of concussion in sport where clinical recovery falls outside the expected window (i.e. 10 days) should be managed in a multidisciplinary manner by health care providers with experience in sports-related concussion

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Return to play

Return-To-Play

Post-Game Day

It is *essential* to:

- Determine the athlete is at baseline cognitively and physically before resuming any exertional activity.
  - amnesia may be permanent.
- Utilize progressive aerobic and resistance exercise challenge tests prior to full RTP.

Graduated Return To Play Protocol

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

- **At least 24 hours per step (therefore about 1 week or longer for full protocol)**
- **If recurrence of symptoms at any stage, return to previous asymptomatic level and resume after further 24 hour or longer period of rest**
- **RETURN TO PLAY IS A MEDICAL DECISION**

Equipment

- There is no good clinical evidence that currently available protective equipment will prevent concussion

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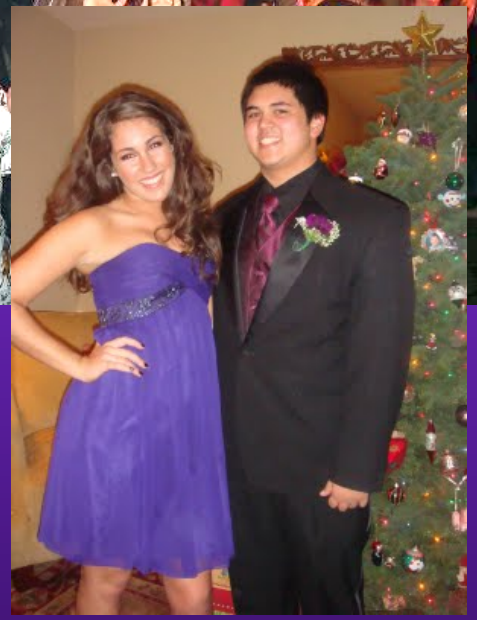
Youth Sports Concussions

- Prolong recovery in student athletes



Return-To-Play

Post-Game Day

Concerns

- Prolonging recovery from the current concussion
- 2- 4X increased risk for recurrent concussion
- Post-concussive syndrome
  - 5- 8% of MTBI
- Cumulative brain trauma

Chronic Traumatic Encephalopathy (CTE)

- Distinct tauopathy with an unknown incidence in athletic populations.
- Cause and effect relationship has not yet been demonstrated between CTE and concussions or exposure to contact sports.
- Interpretation of causation in the modern CTE case studies should proceed
- It is important to address the fears of parents/athletes from media pressure related to the possibility of CTE.

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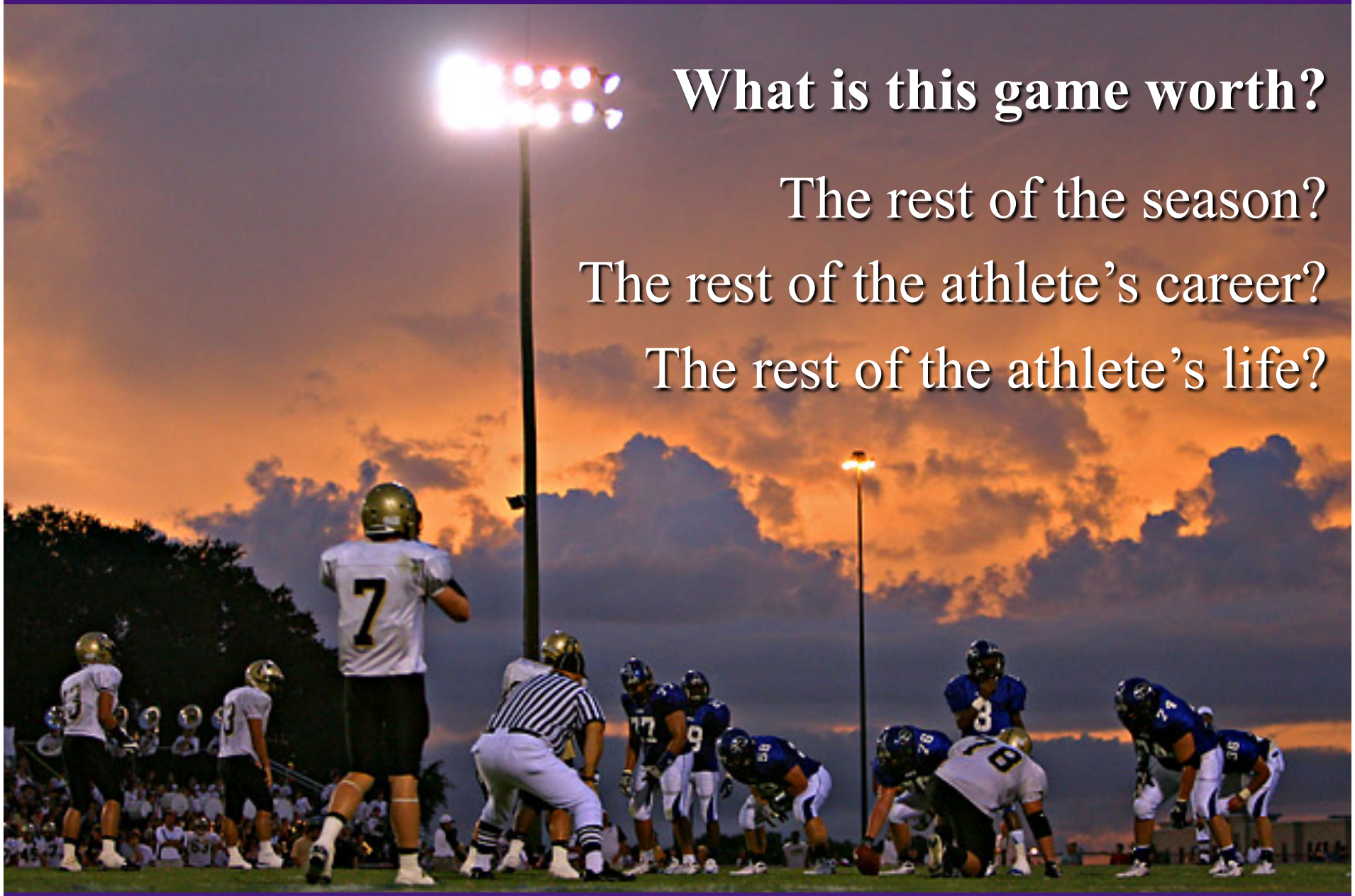
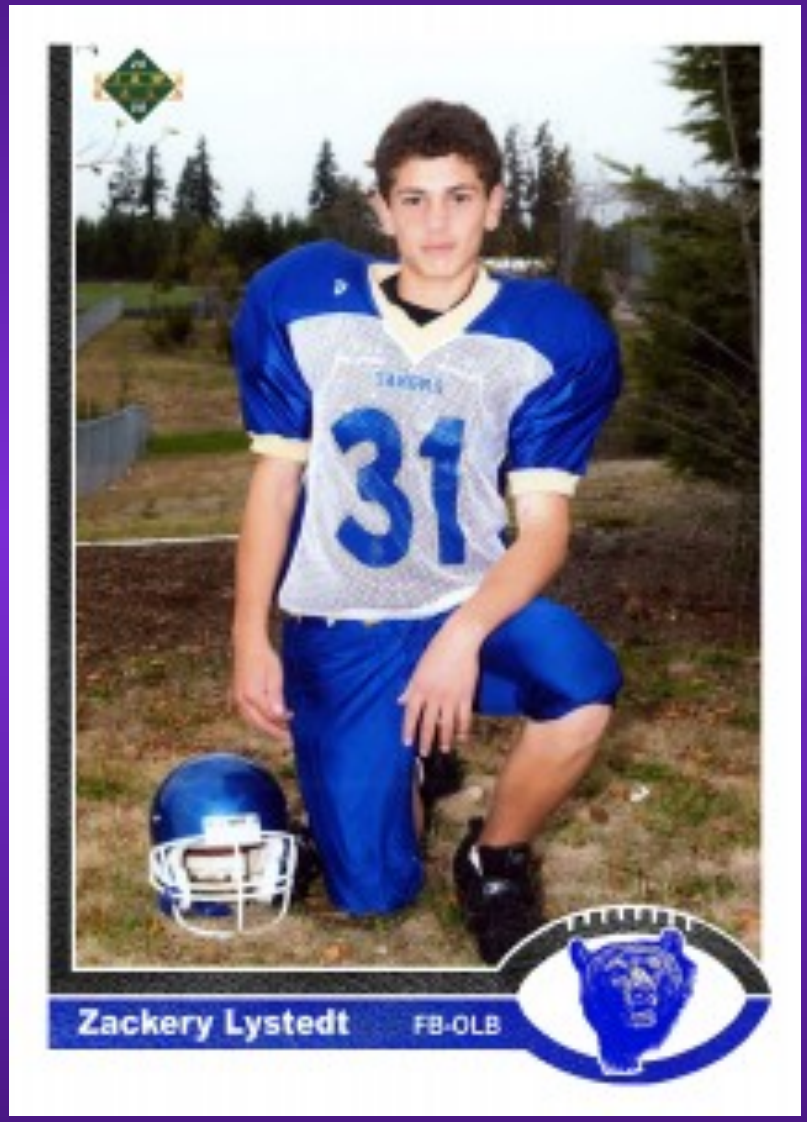
Concussion

- Remove from practice or play.
- Do not leave the player alone:
  - Assess, re-assess, and re-assess
- See a licensed healthcare provider trained in the evaluation and management of concussion.
- Return to play- medically supervised stepwise process.

Return To Play

- The younger the athlete, the more conservative the treatment. No same day return to play for youth athletes.
- There is no simple test:
  - Use signs & symptoms, not grades
  - Concussion history
  - Concussion modifiers
- Be alert to subtle deficits:
  - e.g. neuropsychological data for cognitive assessment
- Clinical judgment is the final determinant of return to play.


What is this game worth?
The rest of the season?
The rest of the athlete's career?
The rest of the athlete's life?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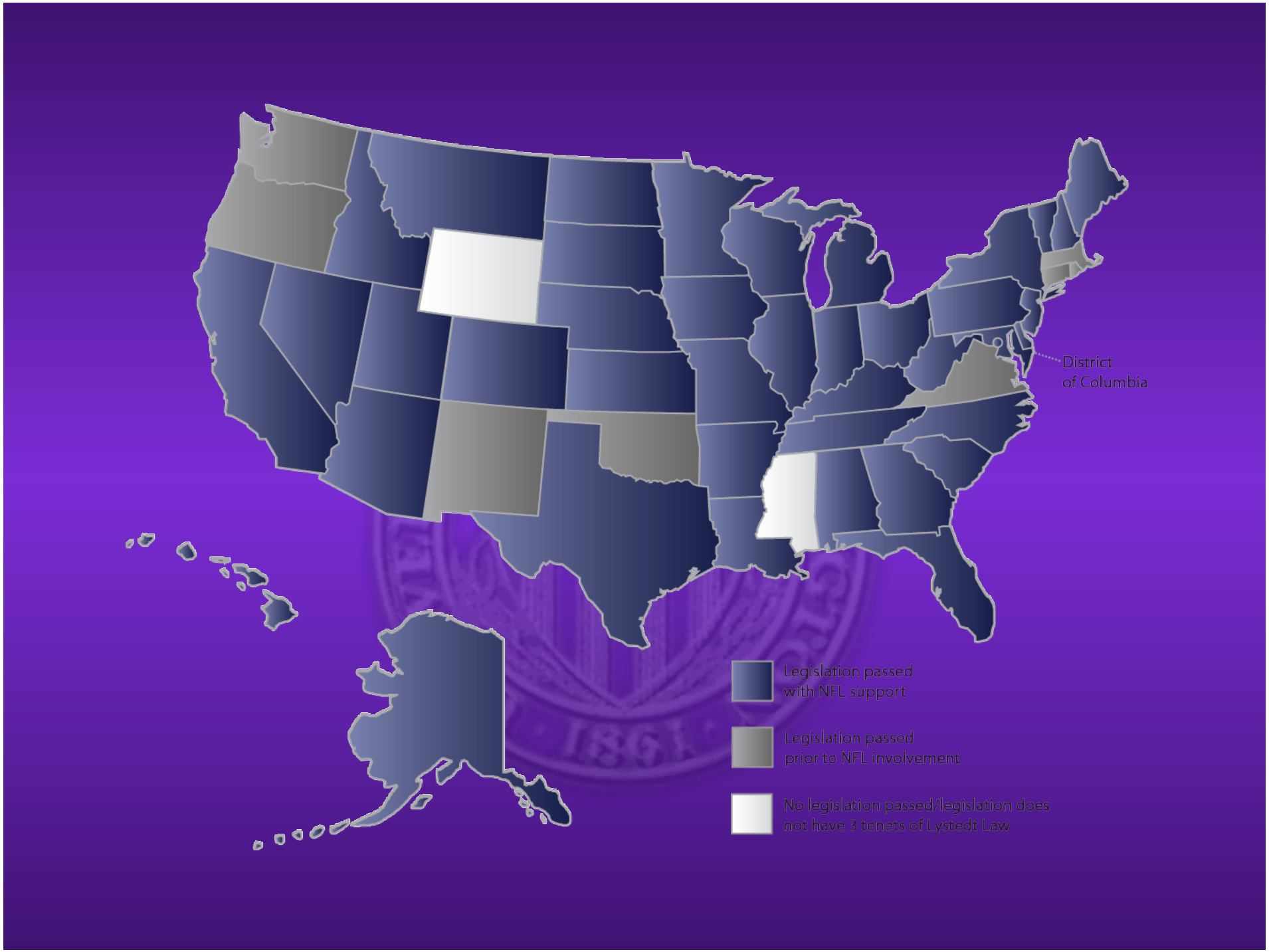
District of Columbia
Legislation passed with NFL support
Legislation passed prior to NFL involvement
No legislation passed/legislation does not have 3 tenets of Lystedt Law


Thank You

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