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On-Field and Sideline Evaluation of Concussion

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Professor and Director, Athletic Training Programs
Research Professor, School of Osteopathic Medicine in Arizona

Conflicts of Interest

Dr. McLeod declares no conflicts of interest related to this presentation.
Learning Objectives

- Identify at least 3 red flags for immediate referral.
- Describe at least 3 critical elements of the on-field and sideline examination.
- Describe the role of at least 3 healthcare providers in the management of head trauma.
- List at least 3 assessment tools to administer for a concussion.

Overview

- Head injury spectrum
- Epidemiology of head trauma
- Role of rules and policy
- On-field examination
- Sideline screening tool administration
- Red flags for immediate referral
- Management team
- Review of recommendations
What is a Concussion

A clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation, which may involve loss of consciousness

Giza, AAN, 2013

Concussion

Mild → Moderate → Severe

Giza, AAN, 2013
**Head Injury Spectrum**

**Mild**
- Primary damage / Injury mechanism: predominantly blast, non-penetrating
- Loss of consciousness: <30 minutes
- Amnesia: ~24 hours
- GCS: 13-15
- Imaging: negative
- Comorbidity: Post Traumatic Stress Disorder; overlapping symptoms
- Outcome: Transient neuropsychiatric deficits, mostly full-recovery, long-term neuropsychiatric especially after repeated injuries are frequent

**Moderate**
- Primary damage / Injury mechanism: frequently mixed, blast + acceleration/deceleration, typically non-penetrating
- Loss of consciousness: >30 minutes, <24 hours
- Amnesia: >24 hours, <7 days
- GCS: 9-12
- Imaging: transient changes
- Comorbidity: PTSD, other injuries
- Outcome: mild-to-moderate, typically chronic, neurological and neuropsychiatric abnormalities

**Severe**
- Primary damage / Injury mechanism: complex, blast + acceleration/deceleration + penetration
- Loss of consciousness: >24 hours
- Amnesia: >7 days
- GCS: <9
- Imaging: positive, lasting abnormalities
- Comorbidity: Polytrauma, such as multiple-organ injuries
- Outcome: death, significant, neurological and neuropsychiatric deficits, severe, chronic physical and neuropsychiatric disabilities

Agoston, Front Neurol, 2012

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**Focal TBI**

- Subdural and epidural hematomas, cerebral contusions, intracerebral hemorrhages and hematomas
- Serious injuries
- Uncommon in sports
- HCP must recognize by documenting signs of clinical deterioration or worsening symptoms in serial assessments
  - LOC, cranial nerve deficits, mental status deterioration, other worsening symptoms

Continued

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Epidural Hematoma

- Intracranial hemorrhage with localized lenticular (lens-shaped) hematoma formation between the skull and the dura mater
- **Common Anatomical Sites**
  - Temporal region (middle cranial fossa)
  - Occipital / suboccipital region (posterior cranial fossa)
  - Frontal / subfrontal region (anterior cranial fossa)

Subdural Hematoma

- Intracranial hemorrhage with widespread crescentic (crescent-shaped) hematoma formation between the dura mater and the arachnoid
- Usually associated with rupture of cerebral bridging veins (superficial cerebral veins crossing the subdural space, through the arachnoid, to the dural sinuses)
Diffuse TBI

- Global disruption of neurologic function usually without visible brain lesions
- Acceleration-deceleration motion
- Linear mechanism: brain experiences violent movement
  - Velocity of head movement, deceleration of head movement, load placed on head
- Rotational mechanism: primary mechanism for the most severe diffuse TBI

Biomechanics of Injury

- The primary mechanism of intracranial pathology is acceleration of the head
- Focal lesions most commonly result from translational (linear) acceleration
- Diffuse injuries result primarily from angular (rotational) acceleration
Epidemiology

1.1-1.9 million concussions

- Outpatient: 377,000
- ED: 115-166,000
- School (AT only): 86,000

Bryan, 2016
High School Sports

Concussions account for 8.9% of all sport-related injuries

2 x increased rate in girls’ soccer

Pre-Season Preparation
Concussion History on PPE

  – PPE and concussion symptom survey
    • 8.1% reported concussion
    • 3.7% reported “knocked out”
    • 24.0% reported “bell rung”
  – 55.0% reported having concussion symptoms following a head injury
    • 86.4% did not report a concussion history in sport
    • 92.7% did not report a concussion history in recreational activities

AIA PPE Form: Neuro Section

ARIZONA INTERSCHOLASTIC ASSOCIATION, INC.
7001 North 19th Street, Phoenix, Arizona 85020-4902
Phone: (480) 385-3910
ANNUAL PREPARTICIPATION PHYSICAL EVALUATION

7. Have you ever had a head injury or concussion? □ □
   Have you ever been knocked out, become unconscious, or lost your memory? □ □
   Have you ever had a seizure? □ □
   Do you have frequent or severe headaches? □ □
   Have you ever had numbness or tingling in your arms, hands, legs, or feet? □ □
   Have you ever had a stinger, burner, or pinched nerve? □ □

http://www.aiiaonline.org/story/uploads/Form_15.7_A_1183392595.pdf
PPE

• Thorough neurologic history should be included within the medical history portion of the PPE
  – Often lacks an adequate series of questions regarding concussion history
• Ask questions regarding perceived previous concussions
• Include specific questions focusing on previous concussion-related symptoms sustained during both sport and non-sport activity

The most recent PPS guidelines recommend asking the following concussion-related questions as part of the neurologic screening:
  – “Have you ever had a head injury or concussion?”
  – “Have you been hit in the head and been confused or lost your memory?”
  – “Do you have headaches with exercise?”
Positive Concussion History: Follow Up Questions

- When the athlete had the head injury?
- Able to finish the practice or game in which the injury was sustained?
- Missed any practices or games due to the injury?
- Referred to primary care provider?
- Imaging tests such as radiographs or CT scans?
- Hospitalized for the injury?

Positive Concussion History: Follow Up Questions

- Nature and duration of concussive symptoms
- Lingering symptoms
- Was adjunct testing (neuropsychological, postural stability) used?
- Degree to which the concussion affected their performance in school?
Emergency Action Plan

- Venue-specific written EAP
- Rehearsed with all involved personnel
  - Location of emergency equipment
  - Ambulance entrance
  - Roles of all personnel
- Communication plan
- Include EMS and receiving care facilities
- Documentation
- Reviewed and approved by administration and legal

Role of Rules and Policy
Legislation

- Education
- Removal from Play
- Return to Play
- Return to School
- Liability
- Informed Consent

Concussion Reporting After Legislation

- Rate of concussion documentation in Washington HSs significantly increased in both the first (RR = 2.10; 95% CI = 1.50, 2.93) and second (RR = 2.10; 95% CI = 1.49, 2.93) years after the Lystedt Law (Bompadre et al., 2014)
  - Athletes were held out of play 6.9 days longer
- Pediatric ED visits in Rhode Island saw a doubling of the overall rate of concussion (2.20 increase; 95% CI = 1.3, 3.6) (Mackenzie et al., 2015)
Concussion Legislation

• Between 2009-2012 increase in healthcare utilization (Gibson, 2014)
  • 92% in states with legislation
  • 75% in states without
  • 40% of the increase attributed to state laws

Arizona Law

• … SUSPECTED OF SUSTAINING A CONCUSSION … BE IMMEDIATELY REMOVED FROM THE ATHLETIC ACTIVITY

• MAY RETURN TO PLAY ON THE SAME DAY IF A HEALTH CARE PROVIDER RULES OUT A SUSPECTED CONCUSSION AT THE TIME THE PUPIL IS REMOVED FROM PLAY.
Arizona Law

• ON A SUBSEQUENT DAY, THE PUPIL MAY RETURN TO PLAY IF THE PUPIL HAS BEEN EVALUATED BY AND RECEIVED WRITTEN CLEARANCE TO RESUME PARTICIPATION IN ATHLETIC ACTIVITY FROM A HEALTH CARE PROVIDER WHO HAS BEEN TRAINED IN THE EVALUATION AND MANAGEMENT OF CONCUSSIONS AND HEAD INJURIES – MD, DO, AT, NP, PA
AIA SMAC - Helmet Rule 2011 (Experimental)

- "If IN THE COURSE OF PLAY, the football helmet becomes dislodged FROM THE PLAYER’S HEAD, the helmet must be IMMEDIATELY inspected for quality and fit by a coach, equipment manager or athletic trainer, during which TIME the player is required to sit out for at least one play. If THE TEAM DOES NOT WANT THE PLAYER TO SIT OUT THEN, then the team must take a time out. IF THE AFFECTED TEAM HAS NO REMAINING TIME OUTS, THE PLAYER MUST SIT OUT FOR AT LEAST ONE PLAY."

Helmet Rule 2011

High School Football Players Must Sit Out One Play When Helmet Comes Off

FOR IMMEDIATE RELEASE

Contact: Bob Colgate

INDIANAPOLIS, IN (February 9, 2012) — High school football players must sit out one play next year if their helmet comes off while the ball is live.

In cases where the helmet comes completely off without it being directly attributable to a foul by the opponent, the player will have to leave the game for at least one down.

Rule 3-3-9
Helmet Comes Off—Timeout (New Article)
ARTICLE 9.

a. If during the down a player’s helmet comes completely off, other than as the direct result of a foul by an opponent, the player must leave the game for the next down. The game clock will stop at the end of the down.
Lower injury rates in practice and games with HUF and contact restrictions
Lower concussion rates in practice among 11-15 year olds

Athletes in HUF leagues accumulated fewer head impacts per practice at both 10g and 20g thresholds

Behavioral Modification

• Helmetless tackling reduced the number of head impacts

• Ivy League restricts ALL contact in practice
Rule Changes

• NCAA Wrestling
  – Rule 6.1.3 Injury Timeout. Emphasize to referees that when injury time runs out in the case of a possible concussion, the referee should allow addition recovery time to ensure medical personnel have adequate time to complete their evaluation.

• NCAA Soccer
  – Rule 5.6.7. Players with... signs of a concussion shall be substituted for and may re-enter the game... at any stoppage of play or at any of the allowable times for normal substitution, provided they have received clearance from the appropriate medical personnel.

On-Field Examination
# Head Collisions 2014 FIFA World Cup

- 61 players (81 head collisions in 72 events)
  - 17% showed 0 or 1 sign of concussion
  - 56% had 2 signs
  - 27% had 3+ signs

- 16% = no assessment
- 63% RTP after assessment by another player, official, or HCP
- 16% assessed on sideline by HCP
- 5% removed from match

- 86% RTP same game
- Mean assessment duration = **86 seconds**

On-field stoppage for assessment = **53 seconds** (15-118)
Stoppage for HCP Sideline assessment = **107 seconds** (64-180)

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# Goals of the On-Field Evaluation

- **Implementation of EAP**
- Main goal is to rule out more serious injuries
  - Must recognize signs and symptoms of serious trauma such as LOC, cranial nerve deficits, decreasing mental status, and worsening symptoms
  - LOC, GCS < 15, focal neurology, and skull fracture were predictive of intracranial hemorrhage in children and adolescents (Dunning et al., 2004)

- Sideline evaluation serves as the benchmark for serial assessments
On-Field Examination

Blood Time
5:00

Injury Time
1:30

Recovery Time
2:00

Effective Sports Concussion Program
On-Field Assessment

Knowledge and Preparation of All is the Foundation

Pre-Injury Concussion Education
Parent, athlete, coach, ATC
Emergency Dept
Primary Care Physician
Other Medical Specialist
School Personnel
(School RN, Psychologist)

Preseason BL Testing

Evidence of concussion?

Decision

Yes

No

Return To Play (RTP)

Withhold from Play / Refer

On-field evaluation AT/MD

Athlete Concussion Suspected

Early Identification

Injury Monitoring

Slide Courtesy of Gerry Gioia, PhD
On-Field Assessment

Athlete Concussion Suspected → On-field/Sideline Evaluation → Evidence of Concussion?

No → Consider Return

Yes → Monitor / Refer

Performed by HCP

On-Field Assessment

Athlete Concussion Suspected → On-field/Sideline Evaluation → Evidence of Concussion?

No → Return

Yes → Remove and Refer

Performed by HCP
On-Field Primary Survey

- ABCC
  - Airway
  - Breathing
    - Respirations*
  - Circulation
    - Pulse*
    - Blood pressure*
  - C-spine
* Vitals = vital that they are recorded and monitored

Level of Consciousness

- Alert
- Lethargic
- Stuporous
- Semi-comatose
- Comatose

Only 6.3%-8.9% of collegiate athletes demonstrated LOC following a concussion (Guskiewicz et al, 2000 & 2003; McCrea et al, 2003)

LOC does not necessarily imply severity (McCrory et al, 2004)
### Berlin On-Field Screen

- Rapid screen
- Clear on-field signs
  - LOC
  - Ataxia
  - Tonic posturing
  - Post-traumatic seizure

### SCAT5 Immediate / On-Field Assessment

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Red Flags&lt;br&gt;• Head pain or tenderness&lt;br&gt;• Nausea&lt;br&gt;• Visual difficulties&lt;br&gt;• Altered speech or behavior&lt;br&gt;• Inability to follow commands or remember instructions&lt;br&gt;• Balance problems&lt;br&gt;• Other symptoms</td>
</tr>
<tr>
<td>2</td>
<td>Observable Signs&lt;br&gt;• Slurred speech&lt;br&gt;• Loss of consciousness&lt;br&gt;• Post-traumatic amnesia&lt;br&gt;• Focal findings&lt;br&gt;• Pupil response&lt;br&gt;• Reflexes&lt;br&gt;• Motor or sensory deficits&lt;br&gt;• Limp&lt;br&gt;• Cervical spine assessment</td>
</tr>
<tr>
<td>3</td>
<td>Memory Assessment&lt;br&gt;• Word list memory&lt;br&gt;• Recall of 3 unrelated events&lt;br&gt;• Short-term memory&lt;br&gt;• Calculation of 9s&lt;br&gt;• Attention span&lt;br&gt;• Language difficulty&lt;br&gt;• Delayed recall&lt;br&gt;• Fidgeting&lt;br&gt;• Comprehension</td>
</tr>
<tr>
<td>4</td>
<td>Examination&lt;br&gt;• Orientation&lt;br&gt;• Attention&lt;br&gt;• Memory&lt;br&gt;• Calculation&lt;br&gt;• Language&lt;br&gt;• Cognition&lt;br&gt;• Motor function&lt;br&gt;• Reflexes&lt;br&gt;• Cranial nerve examination&lt;br&gt;• Neurologic examination&lt;br&gt;• Gait&lt;br&gt;• Posture&lt;br&gt;• Balance&lt;br&gt;• Postural response&lt;br&gt;• Reflexes&lt;br&gt;• Cervical spine assessment</td>
</tr>
</tbody>
</table>

Source: McCrory, 2017

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**Patricios, 2017**

**McCrory, 2017**
IMMEDIATE OR ON-FIELD ASSESSMENT

The following elements should be assessed for all athletes who are suspected of having a concussion prior to proceeding to the neurocognitive assessment and ideally should be done on-field after the first aid / emergency care priorities are completed.

If any of the "Red Flags" or observable signs are noted after a direct or indirect blow to the head, the athlete should be immediately and safely removed from participation and evaluated by a physician or licensed healthcare professional.

Consideration of transportation to a medical facility should be at the discretion of the physician or licensed healthcare professional.

The GCS is important as a standard measure for all patients to be done serially if necessary in the event of deterioration state. The Maddocks questions and cervical spine exam steps of the immediate assessment; however, these should be done serially.

STEP 1: RED FLAGS

- Neck pain or tenderness
- Double vision
- Weakness or tingling/burning in arms or legs
- Severe or increasing headache
- Seizure or convulsion
- Loss of consciousness
- Deteriorating conscious state
- Vomiting
- Increasingly restless, agitated or combative

Immediate Referral

- Deteriorating level of consciousness (LOC)
- Loss of or fluctuating LOC
- Increased confusion
- Inability to recognize people and places
- Increased irritability
- Worsening headache
- Repeated vomiting
- Extremity numbness
- Signs of skull fracture
- Focal findings on neuro exam
- Seizure
- GCS <13

Anderson & Schnebel, 2016; Hyden & Petty, 2016
Immediate Referral

- Physician referral on day of injury if
  - LOC
  - Amnesia >15 min
  - GCS < 13 or abnormal with verbal = 4
  - Symptomatic at end of game
  - ↓ neurologic function
  - ↓ pulse
  - ↑ pulse pressure
  - Cranial nerve deficits
  - Unequal, unreactive pupils
  - Associated injuries
  - Mental status changes
  - Repeating questions
  - Seizure activity
  - Deficits from initial assessment


STEP 2: OBSERVABLE SIGNS

<table>
<thead>
<tr>
<th>Witnessed</th>
<th>Observed on Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Lying motionless on the playing surface</td>
<td>Y</td>
</tr>
<tr>
<td>Balance / gait difficulties / motor incoordination: stumbling, slow / laboured movements</td>
<td>Y</td>
</tr>
<tr>
<td>Disorientation or confusion, or an inability to respond appropriately to questions</td>
<td>Y</td>
</tr>
<tr>
<td>Blank or vacant look</td>
<td>Y</td>
</tr>
<tr>
<td>Facial injury after head trauma</td>
<td>Y</td>
</tr>
</tbody>
</table>
STEP 3: MEMORY ASSESSMENT
MADDOCKS QUESTIONS²

“I am going to ask you a few questions, please listen carefully and give your best effort. First, tell me what happened?”

Mark Y for correct answer / N for incorrect
What venue are we at today? Y N
Which half is it now? Y N
Who scored last in this match? Y N
What team did you play last week / game? Y N
Did your team win the last game? Y N

Note: Appropriate sport-specific questions may be substituted.

STEP 4: EXAMINATION
GLASGOW COMA SCALE (GCS)³

<table>
<thead>
<tr>
<th>Time of assessment</th>
<th>Date of assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best eye response (E)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No eye opening</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Eye opening in response to pain</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Eye opening to speech</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Eyes opening spontaneously</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best verbal response (V)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No verbal response</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Incomprehensible sounds</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Inappropriate words</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Confused</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Oriented</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best motor response (M)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No motor response</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Extension to pain</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Abnormal flexion to pain</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Flexion / Withdrawal to pain</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Localizes to pain</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Obey commands</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

Glasgow Coma score (E + V + M)
Palpation

- Establish baseline measures of
  - Pulse
  - Blood pressure
- Palpate for signs of trauma
  - Painful areas
  - Deformities
  - Swelling
Effective Communication Considerations

- Who are you transitioning care to will direct the nature and quantity of information shared
  - Parent, fellow AT, EMT, Paramedic, MD / DO
- Often overlooked key pieces of information
  - Mechanism
  - Vital signs / GCS / LOC information
  - Past medical history
  - Medications / allergies

Berlin Consensus Statement 11 Rs

- Recognize
- Remove
- Re-evaluate
- Rest
- Rehabilitation
- Refer
- Recover
- Return to sport
- Reconsider
- Residual Effects
- Risk reduction

McCrory et al, Br J Sport Med. 2017
Recognize: Sideline Screen

Rapid screening for a suspected SRC, rather than the definitive diagnosis

Clear on-field signs of SRC (should immediately be removed)
- LOC, tonic posturing, balance impairments

Suspected SRC following a significant head impact or with symptoms can proceed to sideline screening using appropriate assessment tools

More thorough diagnostic evaluation, which should be performed in a distraction-free environment

McCrory, 2017; Patricios, 2017

Recognize: Features of 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
- Typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously
  - However, in some cases, signs and symptoms evolve over a number of minutes to hours
- May result in neuropathological changes, but the acute clinical signs and symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies
- Results in a range of clinical signs and symptoms that may or may not involve loss of consciousness
  - Resolution of the clinical and cognitive features typically follows a sequential course
  - However, in some cases symptoms may be prolonged

McCrory et al, Br J Sport Med. 2017
Suspicion of Concussion

- Signs and symptoms
  - Any ONE or more present to suspect concussion
- Clinical domains
  - Cognitive symptoms
  - Somatic symptoms
  - Emotional symptoms
  - Physical signs
  - Behavioral changes
  - Cognitive impairment
  - Sleep disturbances

McCrory, 2009

Critical
- Observe signs
- Symptom reporting and interview
- Verbal cognitive evaluation (eg. SAC)
- Balance evaluation (BESS, Tandem gait)
- Serial Assessments
- Clinical examination

Corroborating
- Video replay
- Great to have if available

Complimentary
- King-Devick
- Needs more studies

Confounding
- Head impact sensors
- Research tool only

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Berlin Sideline Screen

- Observation of signs
- Symptom reporting and interview
- Verbal cognitive evaluation (eg. SAC)
  - Maddocks questions, SAC
  - Not meant to replace formal cognitive testing
- Balance evaluation (BESS, Tandem gait)
- Serial Assessments
- Clinical examination

McCrory et al., Br J Sport Med. 2017

SCAT-5

- On-field assessment
- Office assessment
  - Symptoms
  - Cognition
  - Neurological screen
- Take home instructions
Observation of Signs

- Mechanism of injury
- Visible signs of concussion

Impact Forces

- G forces
  - 1 g = gravity
  - 3 g = space shuttle
  - 5 g = formula one race care
  - 9 – 12 g = fighter jet in 90 degree turn

Football collision = 95 – 103 g
Impact Magnitude

- Threshold is elusive
  - <0.38% of impacts exceeding 80g resulted in mTBI (Mihalik, 2007)
  - Wayne State University tolerance curve suggests 80g non-injurious and >90g can produce TBI
  - 90g hit in college athletes did not result in immediate symptoms or cognitive/balance deficits (McCaffrey, 2007)

- Clinical implications uncertain
Impact Modeling

<table>
<thead>
<tr>
<th>Probability Level</th>
<th>Translational (g)</th>
<th>Rotational (rad/s²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25% Probability</td>
<td>66</td>
<td>4.6 x 10³</td>
</tr>
<tr>
<td>50% Probability</td>
<td>82</td>
<td>5.9 x 10³</td>
</tr>
<tr>
<td>80% Probability</td>
<td>106</td>
<td>7.9 x 10³</td>
</tr>
</tbody>
</table>

Zhang, 2004

Observational Video

- National Rugby League (Australia)
- Australian Football League
- NHL
- NFL
### Video Signs for Concussion

<table>
<thead>
<tr>
<th>National Rugby League</th>
<th>Australian Football League</th>
<th>National Hockey League</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clutch or shake head</td>
<td>Clutching head / face</td>
<td>Clutching of head</td>
</tr>
<tr>
<td>Slow to get up</td>
<td>Slow to get up</td>
<td>Slow to get up</td>
</tr>
<tr>
<td>Wobbly legs</td>
<td>Incoordination</td>
<td>Motor incoordination / balance problems</td>
</tr>
<tr>
<td>Blank / vacant stare</td>
<td>Blank / vacant look</td>
<td>Blank / vacant stare</td>
</tr>
<tr>
<td>Unresponsiveness</td>
<td>Loss of responsiveness</td>
<td>Suspected LOC</td>
</tr>
<tr>
<td>Post-impact seizure</td>
<td>Impact seizure</td>
<td>Disorientation</td>
</tr>
<tr>
<td></td>
<td>Facial injury</td>
<td>Visible facial injury with any of above</td>
</tr>
<tr>
<td></td>
<td>No protective action</td>
<td></td>
</tr>
</tbody>
</table>


---

**Video assessment for Concussion**

![Flow diagram for video assessment of concussion](image)

- **No Protective Action**
  - Floppy or Stiff: No → Concussion Probable Needs Assessment
  - Yes → Balance Poor, May Not Return to Same Day
- **Impact Seizure**
  - No → Concussion Probable Needs Assessment
  - Yes → Concussion Probable Needs Assessment
- **Motor Incoordination**
  - No → Concussion Probable Needs Assessment
  - Yes → Concussion Probable Needs Assessment
- **Blank/Vacant Look**
  - No → Concussion Probable Needs Assessment
  - Yes → Concussion Probable Needs Assessment
- **Loss of Responsiveness**
  - No → Concussion Probable Needs Assessment
  - Yes → Concussion Probable Needs Assessment
- **Facial Injury**
  - No → Concussion Probable Needs Assessment
  - Yes → Concussion Probable Needs Assessment
- **Clutching at Head**
  - No → Concussion Probable Needs Assessment
  - Yes → Concussion Probable Needs Assessment
- **Slow to get up**
  - No → Concussion Probable Needs Assessment
  - Yes → Concussion Probable Needs Assessment
- **No video evidence of signs of concussion**
  - No → Video not available
  - Yes → Concussion Probable Needs Assessment

Fig. 1. Flow diagram for video assessment of concussion.

Davis & Makdissi, 2016

---

69
70
Risk Prediction Model

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head Injury</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Concussion History</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Neck or Back Pain</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Memory Problems</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Mood Changes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

Use this chart to determine concussion probability.

Total Score | Model Estimated Probability of Concussion Diagnosis | Percent Diagnosed with Concussion in this sample
---|---|---
0-3 | Lower Risk: 0% | 0%
3.5-6 | Elevated Risk: 10% | 3% (95% CI: 3-4.4)
6.5-9 | High Risk: 30% | 10% (95% CI: 8-11.4)
9.5-12 | | 40% (95% CI: 37-43.6)
12.5-15 | | 45% (95% CI: 43-47.7)
15.5-18 | | 50% (95% CI: 48-52.3)
18.5-21 | | 55% (95% CI: 53-58.4)
21.5-24 | | 60% (95% CI: 58-62.9)
24.5-27 | | 65% (95% CI: 63-67.5)
27.5-30 | | 70% (95% CI: 68-72.9)
30.5-33 | | 75% (95% CI: 73-77.4)
33.5-36 | | 80% (95% CI: 78-82.8)
36.5-39 | | 85% (95% CI: 83-87.4)
39.5-42 | | 90% (95% CI: 88-92.8)
42.5-45 | | 95% (95% CI: 93-97.4)
45.5-48 | | 100% (95% CI: 98-100)

Bruce, 2017
Primary Survey: Observation

- Abnormal posturing (Hosseini, 2009)
  - Fencing response in 66% of reviewed videos of reviewed head impacts that did not result in convulsions
  - 25 boxers or MMA
  - Duration: 6.3±4.0s
  - Does not imply severity of injury

Clinical Examination
### Neurologic Status Assessment

- Alert and awake and responding meaningfully?
- Drowsy/sleepy?
- Speech slowed/slurred?
- Confused?
  - Amnesia
  - Asking same questions over again
  - Agitated
  - Speak inappropriately
  - Difficulty recognizing people/places

**Amnesia**

- Retrograde
- Anterograde
- Ask questions of recent memory
- Do not ask questions of orientation

---

*Anderson & Schnebel, 2016*

---

*75*
Amnesia / Cognitive Function

- Alert and oriented X 3
- Standard orientation questions (time, place, person) **unreliable**!

Amnesia

- Retrograde / Anterograde
- Ask questions of recent memory
- Do not ask questions of orientation

---

**MHI**

Control

---

Cs, 1995
### Cranial Nerve Physical Examination

<table>
<thead>
<tr>
<th>Cranial Nerve</th>
<th>Physical Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Olfactory</td>
<td>Test sense of smell</td>
</tr>
<tr>
<td>II Optic</td>
<td>Assess visual acuity, visual fields, pupillary reactivity, ophthalmoscope exam</td>
</tr>
<tr>
<td>III Oculomotor</td>
<td>Assess tracking in 6 cardinal positions, convergence on near targets, pursuits, saccades, pupillary reaction and eyelid elevation</td>
</tr>
<tr>
<td>IV Trochlear</td>
<td>Assess adduction with downward gaze</td>
</tr>
<tr>
<td>V Trigeminal</td>
<td>Test facial sensation, corneal reflex, jaw motor function</td>
</tr>
<tr>
<td>VI Abducens</td>
<td>Evaluate deficiency in lateral gaze when assessing eye movement in horizontal plane</td>
</tr>
<tr>
<td>VII Facial</td>
<td>Facial expression (smile, wrinkle forehead, puff cheeks, close eyes tightly), taste identification, external ear sensation, stapedius muscle function, lacrimal and salivary gland function</td>
</tr>
<tr>
<td>VIII Vestibulocochlear</td>
<td>Examine tympanic membrane for tears, test eye movement for nystagmus, postural responses, and hearing</td>
</tr>
<tr>
<td>IX Glossopharyngeal</td>
<td>Test sensation of posterior tongue and gag reflex</td>
</tr>
<tr>
<td>X Vagus</td>
<td>Test palate elevation and gag reflex</td>
</tr>
<tr>
<td>XI Spinal Accessory</td>
<td>Test resisted head rotation to opposite side and ipsilateral shoulder shrug</td>
</tr>
<tr>
<td>XII Hypoglossal</td>
<td>Look for ipsilateral atrophy, tongue deviation with protrusion</td>
</tr>
</tbody>
</table>

### Physical Examination

<table>
<thead>
<tr>
<th>Part</th>
<th>#</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ear</td>
<td>VIII</td>
<td>Hearing / postural responses</td>
</tr>
<tr>
<td>Head</td>
<td>V</td>
<td>Sensation → 3 locations → temporal, maxillay, mandibular → sharp, soft &amp; temp (hand and tuning fork)</td>
</tr>
<tr>
<td>Head</td>
<td>VII</td>
<td>Facial expression</td>
</tr>
<tr>
<td>Eye</td>
<td>II</td>
<td>Snellen chart exam, direct eye reflex</td>
</tr>
<tr>
<td>Eye</td>
<td>III, IV &amp; VI</td>
<td>6 positions of gaze</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IV → look down and out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VI → look out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>III → all other positions</td>
</tr>
<tr>
<td>Eye</td>
<td>III</td>
<td>PERRLA</td>
</tr>
<tr>
<td>Nose</td>
<td>I</td>
<td>Sense of smell</td>
</tr>
<tr>
<td>Mouth</td>
<td>IX, X</td>
<td>Soft palate moves with “ahhh” &amp; uvula is centered</td>
</tr>
<tr>
<td>Mouth</td>
<td>XII</td>
<td>Tongue in cheek</td>
</tr>
<tr>
<td>Neck</td>
<td>XI</td>
<td>Cervical ROM</td>
</tr>
</tbody>
</table>
Pupillary Signs

- Size
- Response to light
  - Should briskly contract to light
- Movement (nystagmus)
- Signs of intracranial pressure increase
  - Asymmetric pupils
  - Pupils that remain dilated

<table>
<thead>
<tr>
<th></th>
<th>Normal</th>
<th>Abnormal</th>
<th>Not Documented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>95.6 (1008)</td>
<td>3.8 (40)</td>
<td>0.6 (6)</td>
</tr>
<tr>
<td>Response</td>
<td>96.6 (1008)</td>
<td>2.8 (30)</td>
<td>0.6 (6)</td>
</tr>
<tr>
<td>Movement</td>
<td>83.7 (882)</td>
<td>15.7 (166)</td>
<td>0.6 (6)</td>
</tr>
</tbody>
</table>

Valovich McLeod, CJSM, In press
Ocular Innervations

- SR
- LR
- IR
- IO
- MR

= OM or III
= T or IV
= A or VI

Oculomotor Screening

- Smooth pursuit and ocular ROM
- Saccades
- Gaze stability
- Vergence
- Eye alignment
Smooth Pursuit

• This system moves the eyes in space to keep a single target on the fovea
  – Calculates how fast the target is moving and then moves the eyes accordingly
  – Voluntary function under cortical control
  – Requires attention to the moving target
  – Does not operate in the dark

Smooth Pursuits

• Follow finger or object in an H or X pattern
• Head is kept still
• Eye movement should be smooth with no corrective saccades
Saccade

- Responsible for rapid repositioning the fovea from 1 target to another in the visual field
  - Conjugate, ballistic movement of the eyes
  - Extremely fast and accurate.
  - Under voluntary control and do NOT require input from the peripheral vestibular apparatus

Saccades

- Look at nose then finger to left, back to nose, finger to right
- Repeat looking up and down
- Movement should be smooth
- No over/undershoot or corrective saccades
Gaze Stability

- Focus on stationary object while moving head side to side or up and down
  - Vertical/Horizontal: any observable nystagmus, dizziness, blurriness, slowed movements
- Convergence
  - Near point <6-8cm

Vergence system

- Aligns the eyes to look @ targets at different depths of field
- The eyes will move in opposite directions (disconjugate) when they converge or diverge to focus @ different distances
- Vergence is CENTRAL in nature
Eye Alignment and Symmetry

- Ask patient to look at target 6-8 feet away
- Observe eye alignment
- Should be symmetrical at center
- Left-right
- Up-down

Vestibular Ocular Motor Screening (VOMS)

Systematic method to evaluate oculomotor function

- Ages 9-40
- Abnormal findings or provocation of symptoms may indicate dysfunction and result in referral

- Equipment
  - Tape measures
  - Metronome
  - Target with 14 point font

Mucha, AJSM, 2014
<table>
<thead>
<tr>
<th>Vestibular/Ocular-Motor Test:</th>
<th>Not Tested</th>
<th>Headache 0-10</th>
<th>Dizziness 0-10</th>
<th>Nausea 0-10</th>
<th>Fogginess 0-10</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASELINE SYMPTOMS:</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth Pursuits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saccades – Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saccades – Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convergence (Near Point)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____</td>
</tr>
<tr>
<td>VOR – Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOR – Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Motion Sensitivity Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mucha, AJSM, 2014
ROM / Strength

• Cervical ROM
  – Flexion
  – Extension
  – Lateral flexion
  – Rotation

• Assess UE myotomes
  – C1-C2: cervical flexion
  – C3: lateral cervical flexion
  – C4: shoulder shrug
  – C5: shoulder abduction
  – C6: elbow flex, wrist ext
  – C7: elbow ext, wrist flex
  – C8: ulnar deviation, thumb ext, finger flex and abduction

STEP 4: NEUROLOGICAL SCREEN

See the instruction sheet (page 7) for details of test administration and scoring of the tests.

- Can the patient read aloud (e.g., symptom check list) and follow instructions without difficulty? Y N
- Does the patient have a full range of pain-free PASSIVE cervical spine movement? Y N
- Without moving their head or neck, can the patient look side-to-side and up-and-down without double vision? Y N
- Can the patient perform the finger nose coordination test normally? Y N
- Can the patient perform tandem gait normally? Y N
Symptom Reporting & Interview

Self- Reported Symptoms

- Largest effect immediately post-concussion
- Effect was greater than the effect on neurocognitive performance
- Inexpensive, easy to administer tools
- Should be used in conjunction with other assessments in a concussion battery

Symptom Checklists and Scales

• Symptom Checklist
  – Check whether a symptom is present (Y/N)

• Symptom Scale
  – Allows athlete to describe the extent to which they are experiencing the symptom
  – Athlete ranks the severity of the symptom using a Likert scale
  – Overall score of injury severity
    • # symptoms rated
    • Summed symptom score

Symptom Checklist

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Initial Symptoms</th>
<th>Symptoms Today</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drowsiness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess sleep</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Fatigue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel “in fog”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel “slowed down”</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Irritability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory problems</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nervousness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numbness/tingling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor balance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor concentration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ringing in ears</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Sickness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitive to light</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cantu RC. J Athl Train. 2001
### Graded Symptom Scale

#### Pittsburgh Steelers Post-Concussion Scale

Mark Lovell, Ph.D.  Joseph Maroon, M.D.  John Norwig, A.T.C.  Julian Bailes, M.D.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nausea</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Vomiting</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Fatigue</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sleeping more than usual</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Depression</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to light/haze</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sadness, feelings of depression</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Menopausal symptoms</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Numbness or tingling</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling like you are &quot;in a fog&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Other (describe)</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Symptom Score Calculation

- **3 Symptoms endorsed**
- **Symptom score of 6**

---

**STEP 2: SYMPTOM EVALUATION**

The athlete should be given the symptom form and asked to read the instruction paragraph aloud then complete the symptom scale. For the baseline assessment, the athlete should rate his symptoms based on how he/she typically feels and for the post-injury assessment the athlete should rate his symptoms at this point in time.

**Please Check:** [ ] Baseline  [ ] Post-Injury

*Please hand the form to the athlete*

<table>
<thead>
<tr>
<th>Symptom</th>
<th>None</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&quot;Pressure in head&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Neck Pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Nasal or sinus</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Feeling like &quot;in a fog&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>&quot;Don’t feel right&quot;</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Difficulty concentrating:**
- 0 1 2 3 4 5 6

**Difficulty remembering:**
- 0 1 2 3 4 5 6

**Fatigue or low energy:**
- 0 1 2 3 4 5 6

**Confusion:**
- 0 1 2 3 4 5 6

**Drowsiness:**
- 0 1 2 3 4 5 6

**More emotional:**
- 0 1 2 3 4 5 6

**Irritability:**
- 0 1 2 3 4 5 6

**Sadness:**
- 0 1 2 3 4 5 6

**Nervous or Anxious:**
- 0 1 2 3 4 5 6

**Trouble falling asleep:**
- 0 1 2 3 4 5 6

**Total number of symptoms:**
- 0 of 22

**Symptom severity score:**
- 0 of 192

**Do your symptoms get worse with physical activity?**  Y  N

**Do your symptoms get worse with mental activity?**  Y  N

**If 100% is feeling perfectly normal, what percent of normal do you feel?**

**If not 100%, why?**

---

Confidential. Do not copy  without permission
• Drowsiness
• Fatigue
• Difficulty concentrating
• Feeling foggy
• Feeling slowed
• Difficulty remembering

• Visual problems
• Dizziness
• Balance problems
• Headache
• Photophobia
• Phonophobia
• Nausea
• Numbness/tingling

• Sleeping more/less than usual
• Trouble falling asleep

• Sadness
• Feeling more emotional
• Nervousness
• Irritability

Pardini et al, 2007 (abstract)
Cognitive Functioning
(Mental Status Tests)

- Repeat digits backwards or forwards
- Serial 3’s or 7’s
- Months of year in reverse (MOYR)
- Days of week in reverse (DOWR)
- Standardized Assessment of Concussion (SAC)
- Acute Concussion Evaluation (ACE)
- Sport Concussion Assessment Tool-5 (SCAT5)

Serial 3’s or 7’s

- Start at 100 and have the athlete serially subtract either 3 or 7
- Good idea to vary the starting number between 95-105 to avoid learning effects
- Serial 3’s
  - 100, 97, 94, 91, 88, 85, …
- Serial 7’s
  - 100, 93, 86, 79, 72, 65, …
• Ask the athlete to recite the months of the year in reverse
  – December, November, October, September, …
  – Alter the starting month to reduce practice effects

• Ask the athlete to recite the days of the week in reverse
  – Friday, Thursday, Wednesday …
  – Alter the starting day to reduce practice effects

### ORIENTATION

| What month is it? | 0 | 1 |
| What is the date today? | 0 | 1 |
| What is the day of the week? | 0 | 1 |
| What year is it? | 0 | 1 |
| What time is it right now? (within 1 hour) | 0 | 1 |

**Orientation score:** 0 of 5

---

**Continued...**
IMMEDIATE MEMORY

The Immediate Memory component can be completed using traditional 5-word trial list or optionally using 10-word lists to minimize any ceiling effects. All 3 trials must be administered at the initial test. Administer a of one word per second.

Please choose EITHER the 5 or 10 word list groups and circle the specific word for this test.

I am going to test your memory. I will read you a list of words and when I am done, I will repeat the list again. Repeat back as many words as you can remember in any order you said the words before.

<table>
<thead>
<tr>
<th>List</th>
<th>Alternate 5 word lists</th>
<th>Score of 15</th>
<th>Immediate Memory Score</th>
<th>Time that last trial was completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Finger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Candle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Baby</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Elbow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Jacket</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Dollar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Penny</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Paper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>SunSet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>Iron</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Score: 3 of 4

MONTHS IN REVERSE ORDER

Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November, October...

Dec = Nov • Oct • Sept • Aug • Jul • Jun • May • Apr • Mar • Feb • Jan

Total Score: 1 of 3

DIGITS BACKWARDS

Please circle the Digit list chosen (A, B, C, D, E, F). Admixture of one digit per second reading DOWN the digits.

I am going to read a string of numbers and when I am done, you repeat in reverse order of how I read them to you. For example, I say 7-1-9, you...

<table>
<thead>
<tr>
<th>Concentration Number Lists (circle one)</th>
<th>List A</th>
<th>List B</th>
<th>List C</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-9-1</td>
<td>Y</td>
<td>N</td>
<td>0</td>
</tr>
<tr>
<td>6-2-1</td>
<td>Y</td>
<td>N</td>
<td>0</td>
</tr>
<tr>
<td>3-8-1</td>
<td>N</td>
<td>N</td>
<td>0</td>
</tr>
<tr>
<td>3-2-7</td>
<td>Y</td>
<td>N</td>
<td>0</td>
</tr>
<tr>
<td>6-2-9-1</td>
<td>Y</td>
<td>N</td>
<td>0</td>
</tr>
<tr>
<td>3-5-2-6</td>
<td>Y</td>
<td>N</td>
<td>0</td>
</tr>
<tr>
<td>7-1-8-4-6</td>
<td>Y</td>
<td>N</td>
<td>0</td>
</tr>
<tr>
<td>5-3-9-1-4</td>
<td>Y</td>
<td>N</td>
<td>0</td>
</tr>
</tbody>
</table>

Digits Score: 3 of 4
### SCAT2

**Baseline**
- Adolescent baseline = 88.3±6.8 (range=58-100)
- Females scored significantly ↑ than males
- Hx of at least one prior concussion scored significantly ↓ than no hx
- 9th graders significantly ↓ than 11th & 12th

**Post-Injury**

Utility questionable after 5-7 days

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Valovich McLeod, *AJSM* 2012; Mayfield, *ATSHC* 2013

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**STEP 5: DELAYED RECALL:**

The delayed recall should be performed after 5 minutes have elapsed since the end of the Immediate Recall section. Score 1 pt. for each correct response.

Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order.

<table>
<thead>
<tr>
<th>Time Started</th>
<th>3:37p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of words recalled accurately</td>
<td>4 of 5</td>
</tr>
</tbody>
</table>
Mental Status Evidence

- Mental status testing should be used in the sideline assessment
  - SAC, Serial 3’s, MOYR, Recent memory questions are appropriate (McCrea, 1998, 2001, 2002; Maddocks, 1995; Young, 1997)
- Deficits in mental status as measured by the SAC until about 48 hours post injury (McCrea, 1998, 2001, 2002)
- Orientation questions not sensitive enough to detect deficits following MHI (Maddocks, 1995)
- Serial 7’s unlikely to be sufficient in for MHI HS athletes (Young, 1997)

Balance Evaluation
**Balance & Coordination**

- Heel to opposite knee
- Finger to nose
- Romberg test
- Balance apps
- Tandem gait
- Balance Error Scoring System (BESS)

Difficult to quantify and use in serial assessments

<table>
<thead>
<tr>
<th>Coordination task</th>
<th>Abnormal</th>
<th>Normal</th>
<th>Not Tested</th>
<th>Not documented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heel-to-Knee</td>
<td>2.6 (27)</td>
<td>32.1 (338)</td>
<td>64.1 (679)</td>
<td>0.9 (10)</td>
</tr>
<tr>
<td>Finger-to-Nose</td>
<td>4.8 (51)</td>
<td>63.8 (672)</td>
<td>30.6 (322)</td>
<td>0.9 (9)</td>
</tr>
<tr>
<td>Rhomberg</td>
<td>12.7 (134)</td>
<td>45.2 (475)</td>
<td>41.3% (435)</td>
<td>0.9 (9)</td>
</tr>
</tbody>
</table>

Valovich McLeod, CJSM, In press

**BESS**

- Clinical balance assessment
- 20-second trials
- Hands on hips
- Eyes closed
- Attempt to remain stable

Continued
**BESS Errors**

- Lifting hands off iliac crests
- Opening the eyes
- Stepping, stumbling, falling
- Moving the hip into >30° flexion or abduction
- Lifting forefoot or heel
- Remaining out of test position for >5 seconds

Score is calculated by adding 1 point for each error.

---

**mBESS**

**BALANCE EXAMINATION**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double leg stance</td>
<td>0      of 10</td>
</tr>
<tr>
<td>Single leg stance (non-dominant foot)</td>
<td>3      of 10</td>
</tr>
<tr>
<td>Tandem stance (non-dominant foot at the back)</td>
<td>2      of 10</td>
</tr>
<tr>
<td>Total Errors</td>
<td>5      of 10</td>
</tr>
</tbody>
</table>
On-field screen
Modified SCAT in locker room
Neuro exam

Assessed in a distraction free environment
Only player, AT, physician present

Quiet environment
Neuro exam
AT or physician

AT screen
If + remove and evaluate in clubhouse

SCAT 2-3-5

Professional Sports League Protocols

Head impact + S&S or Medical initiation of protocol (AT, booth AT, team physician, UNC)

Sideline Survey (Team physician & UNC)
No go, Hx, S&S, Maddock’s, Video review, Focused neurological exam

 Locker Room Exam (Team physician, UNC, AT)
NFL SCAT
Complete neurological exam

RTP decision based on assessment findings

No Go
• LOC
• Confusion
• Amnesia

NFL Concussion Protocol, 2017

Cochrane, 2017
### step 6: decision

<table>
<thead>
<tr>
<th>Domain</th>
<th>Date &amp; time of assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom number (of 23)</td>
<td></td>
</tr>
<tr>
<td>Symptom severity score (of 10)</td>
<td></td>
</tr>
<tr>
<td>Orientation (of 9)</td>
<td></td>
</tr>
<tr>
<td>Immediate memory</td>
<td>15</td>
</tr>
<tr>
<td>Concentration (of 5)</td>
<td>15</td>
</tr>
<tr>
<td>Reaction time</td>
<td>Normal</td>
</tr>
<tr>
<td>Balance scores (of 10)</td>
<td>Normal</td>
</tr>
<tr>
<td>Delayed recall</td>
<td>5</td>
</tr>
</tbody>
</table>

**Date and time of injury:**

- If the athlete is known to you prior to their injury, are they different from their usual self? (Yes/No/Reassure/Not Applicable)
- If different, describe why in the clinical notes section.

**Concussion Diagnosed?**

- Yes
- No
- Reassure
- Not Applicable

**Has testing, has the athlete improved?**

- Yes
- No
- Reassure
- Not Applicable

I am a physician or licensed healthcare professional and have personally administered or supervised the administration of this SCAT5.

**Signature:**

**Name:**

**Title:**

**Registration number (if applicable):**

**Date:**

---

### concussion injury advice

(To be given to the person monitoring the concussed athlete)

This patient has received an injury to the head. A careful medical examination has been carried out and no sign of any serious complications has been found. Recovery time is variable across individuals and the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

If you notice any change in behaviour, vomiting, worsening headache, double vision or excessive drowsiness, please telephone your doctor or the nearest hospital emergency department immediately.

Other important points:

- **Initial rest:** Limit physical activity to routine daily activities (avoid exercise, training, sports) and limit activities such as school, work, and screen time to a level that does not worsen symptoms.

1) Avoid alcohol

2) Avoid prescription or non-prescription drugs without medical supervision. Specifically:
   a) Avoid sleeping tablets
   b) Do not use aspirin, anti-inflammatory medication or stronger pain medications such as narcotics
   c) Do not drive until cleared by a healthcare professional.

3) Return to play/sport requires clearance by a healthcare professional.

**Clinic phone number:**

**Patient’s name:**

**Date / time of injury:**

**Date / time of medical review:**

**Healthcare Provider:**

© Concussion in Sport Group 2017

Contact details or stamp
Concussion Management Team

On-Field / Sideline

- On-site medical provider
  - Initiates on-field examination
  - Determines need for emergent referral
  - Performs serial assessments
  - Patient/parent education
  - Recommendations for follow up care
### Secondary School

#### Team Members Roles

<table>
<thead>
<tr>
<th>Team</th>
<th>Team Members</th>
<th>Roles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Family</strong></td>
<td>Patient, parents, guardians, relatives, peers, teammates, family friends</td>
<td>Impose rest. Monitor and track symptoms at home including emotional and sleep-related symptoms daily. Communicate with school teams.</td>
</tr>
<tr>
<td><strong>Medical</strong></td>
<td>Primary care provider, team physician, emergency department, concussion specialist, neuropsychologist, other medical referrals</td>
<td>Rule out more serious injury. Evaluate patient periodically. Coordinate information from other teams. Encourage physical and cognitive rest.</td>
</tr>
<tr>
<td><strong>School Academic</strong></td>
<td>School nurse, school counselor, teachers, school psychologist, social worker, school administrator, school physician, school occupational or physical therapist</td>
<td>Reduce cognitive load. Meet with patient to create academic adjustments. Watch, monitor, and track academic and emotional issues.</td>
</tr>
<tr>
<td><strong>School Physical Activity</strong></td>
<td>Athletic trainer, school nurse, coach, physical education teacher, school physician, playground supervisor</td>
<td>Watch, monitor, and track physical symptoms. Athletic trainer should do daily follow-up examinations. Ensure no physical activity.</td>
</tr>
</tbody>
</table>

*Williams & Valovich McLeod, Quick Consult: Concussion, 2015*
Sideline Evaluation

Recovery Prognosis

Importance of Initial Evaluation in Prognosis

• 4+ symptoms were 2x more likely to have symptoms lasting >1 week (Chrisman, 2014)
  – History of prior concussion
  – Amnesia, dizzy, nausea, difficulty concentrating
• LOC, amnesia, increased symptom severity associated with 7+ days (McCrea, 2003)
• Subjective fogginess, dizziness, amnesia associated with symptom duration (Lau, 2011; Iverson, 2004)
Importance of Initial Evaluation in Prognosis

- Symptoms lasting longer than 28d, only **PCSS** was associated with duration ($OR_{stat}=1.037; 1.011-1.063$) (Meehan, 2015)
  - For a one point increase in score among adult patients
- **Dizziness** predictive $[OR=6.34 (1.34-29.91)]$ of a protracted recovery (Lau, 2011)

Take Home Points

- Rule out more serious injury
- Serves as a benchmark for follow-up assessments
  - Monitor vs. Refer
- Thorough clinical examination is critical
- Serial assessments during and after event
- Document on-field and sideline findings
- May aid patient prognosis
“Accurate assessment trumps expedience”
Anderson & Schnebel, 2016

“the clinical assessment and intuition of the sideline clinician remain the criterion standard and should take precedence over how an athlete performs on sideline testing”
Putukian, 2017

ATSU Concussion Program | Athletic Training
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