Concussion Management: From Return to Learn to Return to Play
ACHA Annual Meeting
June 3, 2016
Jessica Higgs MD, Bradley University
Doug Meuser MD, University of Central Florida
Chris Nasin MD, University of Rhode Island
Learning Objectives

- Identify risk factors associated with prolonged concussive symptoms
- Describe current return to learn guidelines
- Define current return to play guidelines
- Discuss four components that may require medical intervention in prolonged concussions
Introduction

- Increase awareness
- Much of focus has been on repeated concussions or return to play
- Governing bodies are recommending or requiring concussion management protocols but what is in the program is dependent on individual institution
Prevalence

- Estimated 1.6-3.8 million occur in sports and recreational activities annually
- Approximately 9% of all reported injuries in high school are head injuries (lowers to 6-8% in college athletes)
- Sports with highest incidence of concussion in high school
  - Football, ice hockey, soccer, wrestling, basketball, baseball/softball, volleyball

Daneshaver, et al, 2011
Definition

Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces.

- Caused by either a direct blow to the head, face, neck, or elsewhere on the body with an “impulsive” force transmitted to the head.
- Results in rapid onset of short-lived impairment of neurological function that resolved spontaneously. However symptoms and signs may evolve over a number of minutes to hours.
- 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 imaging.
- Results in graded set of clinical symptoms. Resolution of the clinical and cognitive symptoms typically follow a sequential course.

Consensus statement, Zurich, 2012
College

- At collegiate level, age 17-23, the education experience is different than younger levels
- Student spend less time in classroom setting, more breaks throughout their day, and require more out of class work
- Including return to learn for practical management that is understood by all constituents
What is a concussion?
- A concussion is a brain injury
- that *may* be caused by a blow
- to the head, face, neck or elsewhere on the body

- An “impulsive” force
- transmitted to the head.
- Also can result from hitting
- A hard surface such as the ground, or hard surface.
Concussion Physiology

- Lots of stuff is happening.
- Standard imaging
- Laboratories
- Do not capture the physiology.
Concussion physiology
Rotational Forces
- Shearing
- Twisting

Coup ("blow")

Contrecoup ("counter-blow")
- Contusion
- Swelling
- Blood clots
 Neurometabolic cascade after traumatic injury. Cellular events: (1) nonspecific depolarization and initiation of action potentials; (2) release of excitatory neurotransmitters (EAAs); (3) massive efflux of potassium; (4) increased activity of membrane ionic pumps to restore homeostasis; (5) hyperglycolysis to generate more ATP; (6) lactate accumulation; (7) calcium influx and sequestration in mitochondria, leading to impaired oxidative metabolism; (8) decreased energy (ATP) production; (9) calpain activation and initiation of apoptosis. Axonal events: (A) axolemmal disruption and calcium influx, (B) neurofilament compaction via phosphorylation or sidearm cleavage, (C) microtubule disassembly and accumulation of axonally transported organelles, (D) axonal swelling and eventual axotomy. AMPA, d-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid; Glut, glutamate; NMDA, N-methyl-d-aspartate.

(From Giza CC, Hovda DA. The neurometabolic cascade of concussion. J Athl Train 2001;36(3):230.)
Concussion Physiology

- Biomarkers and more
- Ta; copeptin; galectin 3 (LGALS3);
- matrix metalloproteinase 9 (MMP9)
- occludin (OCLN).
- Glial fibrillary acidic protein
- NONE are ready for prime time

Concussion Physiology

- Wearable technology imperfect.
- CT scans miss it
- MRI scans miss it.
- It is a clinical syndrome
- Symptoms evolve over time.

- Measurements of neuronal malfunction
- Is done clinically
Concussion Physiology

• The brain moves slower than the skull
• Acceleration
• Deceleration

• https://www.youtube.com/watch?v=amcyZiH6Skk
• https://www.youtube.com/watch?v=QBTgaFd2Y_I#action
Physiology to Clinical Domains

- Clinical Domains that ARE measurable For an individual who has sustained a concussion.
  - Cognitive/Fatigue
  - Vestibular
  - Ocular
  - Post-concussive migraine (headaches)
  - Cervical
  - Anxiety/Mood disorders (unmasked or exacerbated)
Office Based Assessment of Concussion
Acute Concussion Evaluation (ACE)

- Downloaded from the CDC website
- Assessment of:
  - Concussion characteristics
  - Concussion symptoms
  - Risk factors for prolonged recovery
- Can be used to track symptoms recovery

Acute Concussion Evaluation (ACE)

A. Injury Characteristics

1. Injury Description

   - Is there evidence of a forceful blow to the head (direct or indirect)? Yes No Unknown
   - Is there evidence of intracranial injury or skull fracture? Yes No Unknown
   - Location of impact: Frontal Lateral Temporal Medial Occipital Neck
   - Force: Indirect Force
   - Causation: MVC Pedestrian MVC Fall Assault Sports (specify): Other
   - Amnesia Before (Retraction): Are there any events just BEFORE the injury that your person has no memory of (even briefly)? Yes No Duration
   - Amnesia After (Amnesia): Are there any events just AFTER the injury that your person has no memory of (even briefly)? Yes No Duration
   - Loss of Consciousness: Did your person lose consciousness? Yes No Duration
   - Early Signs: Are any signs or symptoms: (Answer questions only): Repeats Questions Forgetful (recent TBI)
   - Other: Were any other observed? Yes No Details

B. Symptom Check List:

- Since the injury, has the patient experienced any of these symptoms at any time: (Use Yes, No, Y which is today or in the past day? Note any other symptoms currently)

   - Physical:
     - Headache
     - Nausea
     - Vomiting
     - Sleep problems
     - Dizziness
     - Visual problems
     - Fatigue
     - Sensitivity to light
     - Sensitivity to noise
     - Balance problems
     - Memory problems

   - Cognitive:
     - Difficulty remembering
     - Difficulty concentrating
     - Difficulty seeing
     - Difficulty hearing

   - Sleep:
     - Sleep less than usual
     - Sleep more than usual

   - Total Symptom Score (0-20)

C. Risk Factors for Prolonged Recovery

   - Headache History: Yes No
   - Prior treatment for headaches
   - Seizure:
   - History of migraines in the family
   - Sleep disturbance
   - Depression
   - Anxiety
   - Other:
   - Hypersomnia
   - Sleep disorder
   - Depression
   - Other

D. RED FLAGS for acute emergency management: Refer to the emergency department with urgent onset of any of the following:

   - Persistent or worsening headache
   - Seizures
   - Persistent vomiting
   - Increasing confusion or irritability
   - Severe behavior change
   - Gross motor signs
   - Loss of consciousness
   - Unresponsiveness
   - Change in status of consciousness

E. Diagnoses CDR:

   - Concussion
   - LOC 5 on GCS
   - Unspecified
   - Other

F. Follow-Up Action Plan

ACE Completed by: ___________________________ 

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Title frame part of the Heads Up! Brain Injury in Your Practice set developed by the Centers for Disease Control and Prevention (CDC).
ACE Continued

- Concussion symptomatology can be grouped into:
  - Physical
  - Cognitive
  - Emotional
  - Sleep
ACE Continued

- Risk Factors for a protracted recovery:
  - Previous concussion
  - History of headaches
  - Developmental issues (ADD, learning disability)
  - Psychiatric history (anxiety, depression, sleep disorder, etc)

<table>
<thead>
<tr>
<th>Concussion History? Y ___ N ___</th>
<th>Headache History? Y ___ N ___</th>
<th>Developmental History</th>
<th>Psychiatric History</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous # 1 2 3 4 5 6+</td>
<td>Prior treatment for headache</td>
<td>Learning disabilities</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Longest symptom duration Days___ Weeks___ Months___ Years___</td>
<td>History of migraine headache</td>
<td>Attention-Deficit/ Hyperactivity Disorder</td>
<td>Depression</td>
</tr>
<tr>
<td>If multiple concussions, less force caused reinjury? Yes__ No__</td>
<td></td>
<td>Other developmental disorder</td>
<td>Sleep disorder</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other psychiatric disorder</td>
</tr>
</tbody>
</table>

List other comorbid medical disorders or medication usage (e.g., hypothyroid, seizures)
ACE Continued

- Red Flags
  - Worsening headache
  - Seizures
  - Focal neurological signs
  - Change in mental status
  - Repeated vomiting
  - Neck pain
  - Weakness/numbness in arms/legs
Standardized Assessment of Concussion (SAC)

- Provides immediate sideline mental status assessment of athletes with concussion. Assesses:
  - Orientation
  - Immediate memory
  - Concentration
  - Delayed Memory
Balance Error Scoring System (BESS)

- A quantifiable version of a modified Romberg test
- Measures postural stability or balance consisted of six stances
  - Double leg stance
  - One legged stance (non-dominant leg)
  - Tandem stance
- Good test-retest reliability
- Low to Mod sensitivity for diagnosis (0.34-0.64)
- High Specificity (0.91)
- Most useful within 2 days of injury
Post-Concussive Symptom Score (PCSS)

- 21 item self report symptom score
- 7-point Likert scale
- Moderate re-test reliability ($r=0.65$)
- Females score higher than males
- Higher scores in patients with multiple concussions
Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)

- Online computerized neuropsychological test battery
- Ideally a baseline test is completed prior to the athletic season
- Consists of six neuropsychological test modules:
  - Verbal recognition memory
  - Visual working memory
  - Visual processing speed
  - Reaction time
  - Numerical sequencing ability
  - Learning
ImPACT

- Sensitivity 81.9%
- Specificity 89.4%
- Initially validated in 2010 when compared to standard neuropsychological testing. Found to have good construct validity.

<table>
<thead>
<tr>
<th>Exam Type</th>
<th>Baseline</th>
<th>Post-Injury 1</th>
<th>Post-Injury 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date Tested</td>
<td>06/17/2012</td>
<td>10/13/2014</td>
<td>10/20/2014</td>
</tr>
<tr>
<td>Last Concussion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exam Language</td>
<td>English</td>
<td>English</td>
<td>English</td>
</tr>
<tr>
<td>Test Version</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composite Scores</th>
<th>Percentile scores if available are listed in small type.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory composite (verbal)</td>
<td>76 21% 71 9% 65 52%</td>
</tr>
<tr>
<td>Memory composite (visual)</td>
<td>81 70% 67 28% 89 87%</td>
</tr>
<tr>
<td>Visual motor speed composite</td>
<td>38.05 30% 45.47 72% 47.83 83%</td>
</tr>
<tr>
<td>Reaction time composite</td>
<td>0.65 15% 0.55 55% 0.49 86%</td>
</tr>
<tr>
<td>Impulse control composite</td>
<td>2 7 6</td>
</tr>
<tr>
<td>Total Symptom Score</td>
<td>21 4 0</td>
</tr>
</tbody>
</table>

Cognitive Efficiency Index: 0.17 0.23 0.4

The Cognitive efficiency Index measures the interaction between accuracy (percentage correct) and speed (reaction time) in seconds on the Symbol Match Test. This score was not developed to make return to play decisions but can be helpful in determining the extent to which the athlete tried to work very fast on symbol match (decreasing accuracy) or attempted to improve their accuracy by taking a more deliberate and slow approach (jeopardizing speed). The range of scores is from approximately zero to approximately .70 with a mean of .34. A higher score indicates that the athlete did well in both the speed and memory domains on the symbol match test. A low score (below .20) means that they performed poorly on both the speed and accuracy component. If this score is a negative number, the test taker performed very poorly on the reaction time component.

Scores in bold RED type exceed the Reliable Change Index (RCI) when compared to the baseline score. However, scores that do not exceed to RCI index may still be clinically significant. Percentile scores if available are listed in small type.

<table>
<thead>
<tr>
<th>Hours slept last night</th>
<th>Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>
Sport Concussion Assessment Tool (SCAT3)

- Comprised of several other combined tests (SAC, GSC, Modified BESS, PCSS)
- Takes 15-20 minutes to complete
- Ideally baseline testing should be accomplished. Although normative data on college aged adults exist.
Obsolete RTP

- At least 20 guidelines in last 30 years
- Graded concussions 1-3
- LOC key factor
- Based on clinical experience, not on evidence
Return to Play

- No activity
  - Symptom limited physical and cognitive rest

- Light aerobic exercise
  - Walking, swimming or stationary cycling

- Sport-specific exercise, resistance training
  - Skating drills, running drills

- Non-contact training drills
  - More complex training drills, progressive resistance training

- Full-contact practice
  - Following medical clearance participate in normal training activities

- Return to play
  - Normal game play

Consensus statement, Zurich, 2012
Return to Learn
What is the SCAT3?!

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used in athletes aged 13 years and older. It superseded the original SCAT and the SCAT2 published in 2005 and 2009, respectively. For younger persons, aged 12 and under, please use the Child SCAT3. The SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool. Progressive baseline testing with the SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, groups, and organizations. Any revision or any reproduction in a digital form requires approval by the Concussion in Sport Group.

NOTE: The diagnosis of a concussion is a clinical judgment, ideally made by a medical professional. The SCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgment. An athlete may have a concussion even if their SCAT3 is “normal.”

What is a concussion?

A concussion is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific signs, and/or symptoms (some examples listed below) and must often does not involve loss of consciousness. Concussion should be suspected in the presence of any one or more of the following:

- Symptoms (e.g., headache), or
- Physic signs (e.g., unsteadiness), or
- Impaired brain function (e.g., confusion) or
- Abnormal behavior (e.g., change in personality).

SIDELINE ASSESSMENT

Indications for Emergency Management

NOTE: A hit to the head can sometimes be associated with a more serious brain injury. The following warning signs of activating emergency procedures and urgent transportation to the nearest hospital:

- Glasgow Coma score less than 15
- Deteriorating mental status
- Potential spinal injury
- Progressive worsening symptoms or new neurologic signs

Potential signs of concussion?

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop participation, be evaluated by a medical professional and should not be permitted to return to sport the same day if a concussion is suspected.

Any loss of consciousness?

- If so, how long?
- Balance or motor incoordination (dizziness, sway, labored movement, etc.)
- Disorientation or confusion (ability to respond appropriately to questions)
- Loss of memory

- If so, how long?
- Before or after the injury?
- Blank or vacant look?
- Visible facial injury in combination with any of the above?

Glasgow coma scale (GCS)

<table>
<thead>
<tr>
<th>Best eye response (E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No eye opening</td>
</tr>
<tr>
<td>Eye opening in response to pain</td>
</tr>
<tr>
<td>Eye opening spontaneously</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best verbal response (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No verbal response</td>
</tr>
<tr>
<td>Incomprehensible sounds</td>
</tr>
<tr>
<td>Inappropriate words</td>
</tr>
<tr>
<td>Confused</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Best motor response (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No motor response</td>
</tr>
<tr>
<td>Extension to pain</td>
</tr>
<tr>
<td>Abnormal vision to pain</td>
</tr>
<tr>
<td>Flexion/Withdrawal to pain</td>
</tr>
<tr>
<td>Localizes to pain</td>
</tr>
<tr>
<td>Obeys commands</td>
</tr>
</tbody>
</table>

Glasgow Coma score (E + V + M)

Maddocks Score

“Are you going to ask me a few questions, please listen carefully and give your best effort”

- Maddocks questions (1 point each correct answer)
  - What venue are we at today?
  - Who’s here?
  - Who scored last in this match?
  - What team did you play last week?
  - What team won the last game?

Maddocks score

Maddocks score is validated for sideline diagnosis of concussion only and is not used for serial testing.

Notes: Mechanism of injury (“tell me what happened”):

Any athlete with a suspected concussion should be REMOVED FROM PLAY, medically assessed, monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle until cleared to do so by a medical professional. No athlete diagnosed with concussion should be returned to sports participation on the day of injury.
Symptom Evaluation

“You should score yourself on the following symptoms, based on how you feel now”.

none mild moderate severe

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>0</td>
</tr>
<tr>
<td>“Pressure in head”</td>
<td>0</td>
</tr>
<tr>
<td>Neck Pain</td>
<td>0</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>0</td>
</tr>
<tr>
<td>Dizziness</td>
<td>0</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>0</td>
</tr>
<tr>
<td>Balance problems</td>
<td>0</td>
</tr>
<tr>
<td>Sensitivity to light</td>
<td>0</td>
</tr>
<tr>
<td>Sensitivity to noise</td>
<td>0</td>
</tr>
<tr>
<td>Feeling slowed down</td>
<td>0</td>
</tr>
<tr>
<td>Feeling like “in a fog”</td>
<td>0</td>
</tr>
<tr>
<td>“Don’t feel right”</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty concentrating</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty remembering</td>
<td>0</td>
</tr>
<tr>
<td>Fatigue or low energy</td>
<td>0</td>
</tr>
<tr>
<td>Confusion</td>
<td>0</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>0</td>
</tr>
<tr>
<td>Trouble falling asleep</td>
<td>0</td>
</tr>
<tr>
<td>More emotional</td>
<td>0</td>
</tr>
<tr>
<td>Irritability</td>
<td>0</td>
</tr>
<tr>
<td>Sadness</td>
<td>0</td>
</tr>
<tr>
<td>Nervous or Anxious</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total number of symptoms** (Maximum possible 22)

**Symptom severity score** (Maximum possible 132)
Top Symptoms for Prolonged Recovery

- In decreasing order 3 days post injury:
  - Foggy
  - Difficulty concentrating
  - Vomiting
  - Dizziness
  - Nausea
  - Headache
  - Slowness
  - Balance
  - Sound and light sensitivity
  - Numbness
Top Symptoms for Prolonged Recovery

- In decreasing order 3 days post injury:
  - Foggy
  - Difficulty concentrating
  - Vomiting
  - Dizziness
  - Nausea
  - **Headache**
  - Slowness
  - Balance
  - Sound and light sensitivity
  - Numbness

Lau, et al. CJS, 2009
Concussion Recovery

- 2 major components
- Physical rest
  - Strict rest; does not hasten recovery
  - Adolescents report increased symptoms.

- Brain rest
  - Neurometabolic demands associated with longer recovery from concussion
Concussion Recovery

- Depends on the domains of concussion
- Affected by a particular individual.
- Gender,
- prior concussion,
- Baseline symptoms:
  - Motion sickness, migraine, learning challenges (attention deficit)
What is cognitive rest?

- Prescribed changes in behavior
- that allows the brain to recover
- Incrementally.
- Components of cognitive rest;
- Avoid any excess of
  - Noise,
  - Light
  - Exertion
  - Cognitive stress
What is cognitive rest?

- Home setting;
- Limited TV
- Limited computer
- Limited music
- Limited outdoor exposure during sunlight
- Non-strenuous activity

- Printed materials for RTL trials
What is cognitive rest?

- School setting;
- Excused absences
- Assignment deadline extensions
- Accommodation for excess light or noise
- Assignment reader

- Printed material
- Postpone testing
- Extended testing
- Smaller, quieter examination space
- Rest periods
- Notetaker

What is cognitive rest?

- School setting;
- Permission to leave class if symptoms return
- Reassessment
- Gradual return
- Incremental return.

Why cognitive rest?

- Our primary goals are
  - Recovery
  - Academic Success.
- Not to finish coursework on time.
Provide follow up appropriate Return to Learn

- There is a consensus standard.

**Concussion Management in Collegiate Student-Athletes: Return-To-Academics Recommendations**

Eric E. Hall, PhD,* Caroline J. Ketcham, PhD,* Cayce R. Crenshaw, PhD,† Martin H. Baker, MS, ATC,† Jodi M. McConnell, MS, ATC,† and Kirtida Patel, MD†

**Abstract:** Concussions in collegiate athletics can affect student-athletes both on the field and in the classroom. As policies are made to outline return-to-play decisions and timelines, this article will make the case that return-to-academics should also be included and follow a step-wise protocol. Complete cognitive rest is a cornerstone of concussion recovery and slow reintroduction to academics should precede return-to-play. The college structure allows for student-athletes to begin small doses of cognitive activity after the recommended complete cognitive rest. It is recommended that return-to-academics involves a team approach to help the student-athlete navigate the responsibilities of course work while healing from a brain injury.

**Key Words:** cognitive rest, brain injury, recovery

<table>
<thead>
<tr>
<th>Assessments</th>
<th>&lt;10 d: Gradual Return: If at any Point Symptoms Reappror with Increased Cognitive or Physical Load → Return to Cognitive and Physical Rest</th>
<th>&gt;10 d: Individualized Determination of Return to Class/Return-to-Play</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive/academic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessments</td>
<td>Symptom checklist (daily)</td>
<td>May consider referral to medical practitioner expert in management of concussion</td>
<td>When assessments return to baseline levels and athlete is asymptomatic</td>
</tr>
<tr>
<td>Assessments</td>
<td>When asymptomatic</td>
<td>Long-term modifications may be needed to continue learning in college-level course; may consider referral to neuropsychologist for more extensive testing</td>
<td>Return to class Some modifications to makeup missed work may be needed</td>
</tr>
<tr>
<td>Assessments</td>
<td>Gradual return to cognitive load → return to class</td>
<td>Moderate physical activity</td>
<td>Gradual return to physical exertion → return-to-play</td>
</tr>
<tr>
<td>Assessments</td>
<td>Increase reading time/class time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessments</td>
<td>Increase attention activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessments</td>
<td>Increase distractions in environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessments</td>
<td>No physical activity (no practice, weights, exertion)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Vestibular issues

- Dizziness and balance
- One of the most frequent symptoms

- 40% balance dysfunction
- 50% dizziness

Vestibular issues

- More than one type of post-concussive dizziness
- Primary blast injury
- Blunt head injury

- Blunt head injury is more potentially treatable.

- Identify, treat, and refer as needed.

Vestibular issues

- Why is it important?
- Documented vestibular deficits
- On initial evaluation
- Predict a longer recovery for concussion

- Documented vestibular deficits
- Are treatable for improved recovery
- With vestibular rehabilitation.

Vestibular Evaluation with Concussion

- What is a vestibular evaluation?
- Balance;
- Balance Error Scoring System (BESS);
- Currently a standard evaluation.
- Endorsed for use in SCAT 2 and SCAT 3
  - 3 stances
  - 2 separate surfaces
  - 20 second effort
  - Clear scoring rubric

Vestibular Evaluation with Concussion

- BESS
- Some issues;
  - High false positive rate
  - Limited retest reliability
  - Return to baseline occurs before neurocognitive recovery!
- Still worth using
- (as part of a more comprehensive assessment)


<table>
<thead>
<tr>
<th>Examination Domain</th>
<th>Recommended Elements (SORT)</th>
<th>Additional Elements (SORT)</th>
</tr>
</thead>
</table>
| Neurological                    | CNs (C)
MMT (C)
DTRs (C)                                                                 | UMN testing (C)                                                 |
| Musculoskeletal                 | Head and neck for trauma or tenderness (B)
ROM (B)
Spurling test (B)                                                             | Neck isometrics (B)
Cervical proprioception (B)
Jaw and TMJ (C)
Thoracic spine (C) |
| Balance/coordination            | Static and/or dynamic balance assessment (B)                                                | Coordination tests (B)                                         |
| Vestibulo-ocular/ophthalmologic | Screening ocular examination (A) consisting of:
- Evaluation of the eyes in 8 positions
- Nystagmus
- Saccades
- Smooth pursuits
- Near point of convergence/ accommodation                                             | Fundoscopic evaluation (C)
Pupillary reactivity (C)
Visual acuity (C)
If dizziness or imbalance present, consider:
- Orthostatic vital signs (B) via supine to stand stress test (B)
- Otoscopic evaluation, Dix-Hallpike maneuver, and assessment of dynamic visual acuity |
| Mental status                   | Orientation, immediate and delayed recall, concentration, mood, affect, insight, judgment (B) | Screening for depression and anxiety (B)
Preinjury psychiatric difficulties (A)
Substance use disorders (C)                                                   |

BESS, Balance Error Scoring System; CNs, cranial nerves; DTRs, deep tendon reflexes; MMT, manual muscle testing; ROM, range of motion; TMJ, temporomandibular joint; UMN, upper motor neuron; SORT, Strength of Recommendation Taxonomy (A, consistent, good-quality patient-oriented evidence; B, inconsistent or limited-quality patient-oriented evidence; C, consensus, disease-oriented evidence, usual practice, expert opinion, or case series).

*Options include BESS test, modified BESS, single-leg stance, tandem gait.
*Options include finger-to-nose test, rapidly alternating movements, or heel-to-shin test.

<table>
<thead>
<tr>
<th>Balance/coordination</th>
<th>Static and/or dynamic balance assessment(^a) (B)(^{33,38,40,79})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vestibulo-ocular/ophthalmologic</td>
<td>Screening ocular examination (A)(^{37,84}) consisting of:</td>
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<td>Smooth pursuits</td>
</tr>
<tr>
<td></td>
<td>Near point of convergence/ accommodation</td>
</tr>
</tbody>
</table>
Vestibular Evaluation with Concussion

- Saccades
  - https://www.youtube.com/watch?v=P6uTlnyNaTs
  - https://www.youtube.com/watch?v=h6pBbLqKfKI

- Smooth pursuits
  - Nl: https://www.youtube.com/watch?v=LasgmN4zwcs
  - Abn: https://www.youtube.com/watch?v=gqCgzSSwPLk

- Near Point convergence;
  - https://www.youtube.com/watch?v=6s291lpmIgo
Vestibular Ocular Reflex

http://cp.neurology.org/content/1/1/24/F1.large.jpg
Vestibular Evaluation with Concussion

- Vestibular/Ocular Motor Screening (VOMS)
  - Combines 7 oculomotor tests;
    - Smooth pursuits
    - Horizontal saccades
    - Vertical saccades
    - Horizontal vestibular ocular reflex
    - Vertical vestibular ocular reflex
    - Visual motion sensitivity
    - Near point convergence
  - Validated but not yet ready for routine use.


- https://www.youtube.com/watch?v=E2uF0lcyNps (14 min)
Vestibular Evaluation with Concussion

- Summary
- DO testing.
- Balance and OculoMotor abnormalities
  - predict a prolonged neurocognitive recovery.
- Refer for vestibular rehabilitation early.
- Adapt testing
  - more information is published.
Campus communication

#1 For moderate to severe symptoms:
- Student (name) has been diagnosed with a concussion. They have been instructed to remain out of class and will be unable to complete homework, due to symptoms, until further notice. The student will be re-evaluated on (date) and an update will be sent. Please take this into consideration.

#2 For mild symptoms or for a concussion that has improved to mild symptoms:
- Student (name) has been diagnosed with a concussion. Student will attempt to attend class but may need to miss due to symptoms or require accommodations for a brief period. Please take this into consideration. You may call Health Services if you have any additional questions.
Outside suggestions for RTL and RTP

- Consistent with modifications and accommodations for students with TBI in general, strategies useful in supporting the students’ return to school following a concussion:
  - Initial transition back to school
    - School personnel are alerted to injury.
    - School reintegration occurs gradually.
    - Student is not expected to do all work completed in absence.
    - Extra assistance is provided to facilitate completion of makeup work.
  - School-based support
    - Monitor student closely for two to three months.
    - Provide rest time and breaks as needed.
    - Reduce homework and class load.
    - Reduce cognitively demanding in-school tasks (e.g., no more than one test daily).
  - Classroom-based support
    - Delay tests.
    - Waive time constraints for tests.
    - Increase flexibility for assignment due dates.
    - Provide preferential seating for close monitoring and decreased distractions.
    - Be a part of individualized baseline testing.
Concussion Rx - Educational

- Patient Name: ___      DOB: ____        DOE: ____

- The above-named student has suffered a concussion and is currently under the care of this clinic. They are not permitted to participate in any contact sport activity until formally cleared by this clinic.

- Students recovering from a concussion have problems with memory, concentration, and thinking speed. In addition, engaging in cognitively demanding tasks can exacerbate symptoms and prolong recovery. The following academic accommodations and other recommendations will assist this student in minimizing post-concussive symptoms while continuing their academic work during the concussion recovery period:
Concussion Rx - School accommodation

- Patient Name: ___   DOB: ____   DOE: ____
- School attendance restrictions: ___ full day as tolerated; ___ half day as tolerated; ___ classes / hours per day; ___ no school until: _re-evaluation on ___, then attempt half / full days as tolerated
- Testing: ___ extra time to complete tests; ___ testing in a quiet environment; ___ eliminate or postpone tests when possible until the patient’s concussion symptoms clear.
- Note taking: ___ allow student to obtain class notes or outlines ahead of time to aid organization and reduce multitasking demands. Alternatively, copies of another student’s notes could be provided.
- Workload reduction: ___ reduce overall amount of make-up work, class work, and homework, by 50%; ____ allow student to have extended deadlines or turn in assignments late.
Concussion Rx – Permission to Rest

- Breaks: ___ take breaks as needed to control symptom levels. If headache worsens during class, the student should be excused from class.

- Physical activity: ___ no attendance at sports practices / P.E. class; ___ can attend but not participate in sports practices / P.E. class; ___ can leave practice early if symptoms develop; ___ no participation in other strenuous physical, aerobic, or weight training activities at school or home.

- Other: ___ limit exposure to T.V., computer, video games, movie theatres, and cell phone / texting.

- At the first sign of post-concussion symptoms such as headache, the student will need to discontinue the activity in which he/she is engaged. To help alleviate the symptom or decrease the headache pain, rest until the symptom or pain subsides. As noted above, over-exertion and recurrence of post-concussion symptoms can lead to a prolonged recovery.
Concussion Rx – Follow up

- Follow-up evaluation and
- Revision of recommendations to occur: ______
Management of Sleep and Mental Health in Concussion
Medications for Concussion

- Evidence of efficacy in many cases is equivocal and based on low quality studies
- Many studies include patients with severe injuries (not typical sporting concussion)
- Each therapy has side effects
- *All therapies are off label

*Halstead M. Pharmacologic Therapies for Pediatric Concussions. Sports Health. 2015*
Sleep and Concussion

- 35-70% of patients who sustain a concussion report sleep related disturbances
  - Trouble falling asleep
  - Sleeping more than usual
  - Sleeping less than usual
  - Excessive daytime sleepiness

- Collegiate athletes who reported disrupted sleep reported a greater number of total concussion symptoms on the PCSS consistently throughout the length of recovery from a concussion

Treatment of Sleep Disturbance in Concussion

- Upwards of 34% of adolescents receive inadequate sleep
- External factors that contribute to inadequate sleep include:
  - Poor sleep hygiene
  - Demanding schedules
  - Challenging collegiate dormitory environment
Pharmacologic Management of Sleep in Concussion

- **Melatonin:**
  - An endogenous hormone secreted by the pineal gland from serotonin.
  - Nontoxic and generally considered safe.
  - May be some data to support its role in recovery from traumatic brain injury.
  - A study protocol for a double-blind, placebo-controlled intervention trial of 3mg and 10mg sublingual melatonin for post-concussion syndrome in youths has been published (*Trials*. 2014; 15:271).
Pharmacologic Management of Sleep in Concussion

- Trazadone
  - a serotonin reuptake inhibitor
- Tri-Cyclic Antidepressants
- Benzodiazepines
  - Generally should be avoided for their affects on arousal and cognition
Emotional symptoms after Concussion

- Depression (10-77% of traumatic brain injuries)
- Anxiety
- Irritability/lability
- Rage
- Agitation
- Aggression
- Disinhibition
- Apathy

Silver J. Am J Psychiatry, 2009; 166: 653-661
Depression and Concussion

PRE-INJURY FACTORS

- Pre-morbid depression
- Substance abuse
- Psychosocial factors
  - School stress
  - Team stress
Depression and Concussion

- Increased number of and severity of other post-concussive symptoms
  - Headache
  - Dizziness
  - Blurred Vision
  - Anger
  - Aggression
  - Risk of suicidality
  - Cognitive dysfunction
Treatment of Post-Concussion Depression

- Best managed conservatively!
  - (symptoms are typically short lived)
- Reassurance
- Coping strategies
- Support of family, friends, teammates, coaches
- Counselling
- Improved sleep

Meehan W. Clin Sports Med. 2011; 30 (1)
Treatment of Post-Concussion Depression: SSRIs

- **Sertraline** (25-150mg QD) has been studied and showed to improve depression and likely offers cognitive improvement as well.

- **Citalopram** (>20mg QD) has been shown to be effective.

- **Fluoxetine**. Long half life of active metabolites and P450 enzyme inhibition make this a less favorable choice.

- **Paroxetine**. P450 inhibition and strong muscarinic effects may contribute to cognitive dysfunction.

Silver J. Am J Psychiatry, 2009; 166: 653-661
Treatment of Post-Concussion Depression: other meds

- **Bupropirion**: propensity of this medication to lower seizure threshold is a concern as a first-line agent. Avoidance of short acting formulations if to be considered for post-traumatic depression

- **Tricyclic Antidepressants**: may be less effective in treatment of depression following traumatic brain injury

Silver J. Am J Psychiatry, 2009; 166: 653-661
Headaches and Concussion

OTC Analgesics

- No studies evaluating the use of acetaminophen Vs. NSAIDs for treatment of sporting concussion
- No studies suggesting a harmful effect of NSAID use, such as an increased risk of subdural hematoma
- A retrospective chart review of adolescents seen in a headache clinic with chronic posttraumatic headaches found that 70% met criteria for medication overuse headaches
  - 68% had improvement of headaches with discontinuation of OTC pain relievers

Halstead M.  Sports Health.  2015.
Headaches and Concussion
Tricyclic Antidepressants

- Retrospective chart review of adolescents seen at a regional concussion clinic found 17% of patient’s were prescribed amitriptyline
  - 82% of these patients reported improvement in headaches
  - No controlled trials have looked at amitriptyline for treatment of concussion

Halstead M. Sports Health. 2015
Cognitive Dysfunction in Concussion

- Deficits in:
  - Memory
  - Concentration
  - Processing Speed

- Cognitive rehabilitation or medications are generally not necessary given the short duration of symptoms after a concussion.
Medications for Cognitive Dysfunction in Concussion

- In cases of **prolonged recovery**, for which main complaints are cognitive in nature, a trial of pharmacologic agents may be considered
  - **Methylphenidate** is the most studied stimulant and has been shown to have a positive effect on cognitive function in multiple studies
  - **Amantadine** (a dopaminergic agent with possible N-methyl-D-aspartate antagonist effect) may lead to improvements in executive function and is considered safe in the setting of concussion treatment.
Return to Learn
Return to Learn...

The Recent Literature

- Retrospective study of 49 high School/College aged athletes who suffered a sport related concussion (mean 15 yrs)
- Assigned to three groups based on time between concussion and onset of rest:
  - 1-7 days
  - 8-30 days
  - 31+ days
- Prescribed 1 week of cognitive and physical rest
- Participants showed significantly improved cognitive testing measures and symptoms scores after rest in all three groups (P<.001)
Return to Learn...

The Recent Literature

- Prospective cohort study of 355 patients, mean age 15yrs
- At each visit patient completed a scale that recorded their average level of cognitive activity
- Patients in the highest quartile of cognitive activity took longest to recover (95% CI 0.992-0.996)

*Pediatrics* Vol 133, No. 2, Feb 2014
Return to Learn...
The Recent Literature

- Cross-sectional questionnaire based study of 1033 High School Nurses (36% response rate)

- 53% of schools had guidelines to assist students with returning to school after concussion

- 58% nurses reported helping with academic and activity re-entry process
Initial Evaluation

Strict Cognitive Rest 24-48hrs

Improvement

Yes

Relative Cognitive Rest with graded RTL

No

Academic Adjustments

7-10 days

Recovery!

No

Yes

Improvement

Strict Cognitive Rest 24-48hrs
# Return to Academic Progression

<table>
<thead>
<tr>
<th>Stage</th>
<th>Activity</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>No activity</td>
<td>Complete rest</td>
<td>Recovery</td>
</tr>
<tr>
<td>Gradual cognitive activity</td>
<td>Gradually add cognitive activity for short periods</td>
<td>Increase cognitive activity at sub–symptoms threshold levels</td>
</tr>
<tr>
<td>Gradual reintegration into academics</td>
<td>Begin class attendance, slowly build up attendance to full days</td>
<td>Increase cognitive load at sub-symptom threshold; decrease accommodations</td>
</tr>
<tr>
<td>Resumption of full cognitive workload</td>
<td>Catch up with work, no restrictions</td>
<td>Full return to academics, commence RTP protocol</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Accommodation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Quiet, low light environment</td>
</tr>
<tr>
<td></td>
<td>Short periods of focus</td>
</tr>
<tr>
<td>Dizziness</td>
<td>Allow student to put head down when symptomatic, allow increased transition</td>
</tr>
<tr>
<td></td>
<td>time for engaged activities</td>
</tr>
<tr>
<td>Visual symptoms</td>
<td>Minimize computer/screen based tasks</td>
</tr>
<tr>
<td></td>
<td>Allow for a note taker</td>
</tr>
<tr>
<td>Noise sensitivity</td>
<td>Allow for quieter learning environment</td>
</tr>
<tr>
<td>Concentration/Memory problems</td>
<td>Provide new material in different manageable formats</td>
</tr>
<tr>
<td></td>
<td>Test/assignment accommodations (delay, more time, etc.)</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>Allow student to attend a later session of the class</td>
</tr>
</tbody>
</table>
Duration of symptoms

BEYOND 10 DAYS

- Engage Disability services
- Consider referral to concussion specialist (neurology, sports med, etc.)
- Academic Adjustments

BEYOND 3 WEEKS

- “Post-concussion syndrome”
- Consider referral to concussion specialist
- Consider neuroimaging and formal neuropsychological testing
- Academic accommodations
Concussion Management in Collegiate Student-Athletes: Return-To-Academics Recommendations

Eric E. Hall, PhD,* Caroline J. Ketcham, PhD,* Cayce R. Crenshaw, PhD,† Martin H. Baker, MS, ATC,† Jodi M. McConnell, MS, ATC,† and Kirtida Patel, MD†

Abstract: Concussions in collegiate athletics can affect student-athletes both on the field and in the classroom. As policies are made to outline return-to-play decisions and timelines, this article will make the case that return-to-academics should also be included and follow a step-wise protocol. Complete cognitive rest is a cornerstone of concussion recovery and slow reintroduction to academics should precede return-to-play. The college structure allows for student-athletes to begin small doses of cognitive activity after the recommended complete cognitive rest. It is recommended that return-to-academics involves a team approach to help the student-athlete navigate the responsibilities of course work while healing from a brain injury.

Key Words: cognitive rest, brain injury, recovery

While student-athletes have a rigorous schedule with classes, conditioning, practice, competition schedules, etc., there are opportunities to set up a return-to-academics plan that does not excessively impact their academic performance and may promote a faster recovery process. Most policies around concussion management have focused on return-to-play, and return to academics tends to follow a case-by-case need-based plan.7–9 The goals of concussion management policies are to protect student-athletes from multiple injuries and life-long consequences; however, the role of cognitive stress and impact on academics in the life of a student-athlete is often overlooked.

The goal of this article is to highlight the impact of concussions on cognitive function of student-athletes and outline a recommendation for collegiate institutions to include return-to-academics protocol in their concussion management policies. The inclusion of return-to-academics
Return to Learn Progression

- Gradual progression into cognitive activities (similar to progression into physical activities). One example would include:
  - Symptomatic – complete rest
  - Day 1 – home work 30 minutes at a time
  - Day 2 – Return to one 60 minute class
  - Day 3 – Return to two 60 minute classes not back to back
  - Day 4 – Return to 3 60 minute classes, two of which may be back to back
  - Day 5 – Return to all classes and labs
  - Day 6 – May resume test taking
Summary

- Most concussions should resolve in 7-10 days
- Physical exam should focus on vestibular/ocular assessment and cognitive ability
- Clinicians need to think about cognitive activity as well physical activity when managing
- Accommodations may be needed through disability services temporarily or long-term
- Step-wise progression should be followed in both resumption of cognitive and physical activity
Questions?