HOW TO ASSESS THE NEED FOR THERAPY IN THE RECOVERY FROM CONCUSSION?

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DISCLOSURE

• I have no actual or potential conflict of interest in relation to this program/presentation

• I am an employee of the University of Utah and have no financial interests or relationships to disclose
OBJECTIVES

• Discuss the timeline and pathophysiology of concussion
• Discuss the common clinical trajectories after concussion
• Provide assessments of each clinical trajectory that can be performed during an evaluation
• Discuss the indications for referral to therapy specialties in the treatment of concussion
WHAT ARE WE MISSING?

• Athletes with a previous concussion are 50-70% more likely to experience a musculoskeletal injury compared to teammates without a recent concussion

Cross et al., 2016, Lynall et al., 2015, Lynall et al., 2017, Nordstrom et al., 2014, Fino et al., 2017
THE CONCUSSION TIMELINE

• Concussion is a functional disturbance rather than a macrostructural brain injury, the resolution of which requires 7 to 10 days in the typical athlete (80%–90% of cases)

• After a brief period (24–48 hours) of complete rest, patients can be encouraged to become gradually and progressively more active

Leddy et al., 2017, Giza & Hovda, 2001, Schneider et al., 2017
EDUCATION

• How Hard to Push Yourself

• Concussion as an Earthquake

• What Areas Do We Need to Assess
HOW HARD CAN I PUSH MYSELF?

1 MINUTE RULE

• Identify when an increase in symptoms occurs
• Stop activity and time how long it takes to return to baseline

• The goal is for a return to baseline within 45-60 seconds
• If it takes longer than 60 seconds to recover, take a break sooner or modify the task
• If it takes less than 45 seconds to recover, increase symptom intensity before taking a break
EDUCATION

• How Hard to Push Yourself

• Concussion as an Earthquake

• What Areas Do We Need to Assess
CONCUSSION AS AN EARTHQUAKE

CONCUSSION (earthquake)

- Dizziness (water/sewer)
- Memory (phone lines)
- Balance (roads)
- Headache (electrical)
EDUCATION

- How Hard to Push Yourself
- Concussion as an Earthquake
- What Areas Do We Need to Assess
PREVALENCE OF IMPAIRMENTS

- 47-60% visual changes
- 82.9% cervical dysfunction
- 26.8% cervicogenic dizziness
- 20-58% dizziness
- 47-95% headache
- 74% memory deficits
- 68% mood changes

• Identifying the **symptom generator(s)** in the athlete is essential to prescribing appropriate active therapy

• The clinical assessment of sport related concussion (SRC) should be symptom based and interdisciplinary. Whenever possible, the SRC assessment should incorporate neurological, vestibular, ocular motor, visual, neurocognitive, psychological and cervical aspects

Feddermann-Demont et al., 2017, Leddy et al., 2017
CLINICAL TRAJECTORIES

- Vestibular
- Migraine
- Cervical
- Cognitive
- Anxiety/Mood

Collins et al., 2014
CLINICAL TRAJECTORIES

Vestibular

Physiologic

Vision

Anxiety/Mood

Cervical

Cognitive

Migraine
CLINICAL TRAJECTORIES

- Physiologic
- Vestibular
- Vision
- Cervical
- Migraine
- Cognitive
- Anxiety/Mood

Collins et al., 2014
PHYSIOLOGIC

• Physiologic dysfunction after TBI is believed to represent some degree of uncoupling between the brain autonomic centers and the cardiovascular system.

• The patient with physiological dysfunction typically stops well short of the age-predicted maximum HR because he or she simply cannot continue to exercise for reasons other than physical exhaustion.

Goldstein et al., 1998, Clausen et al., 2016
BUFFALO CONCUSSION TREADMILL TEST

- The Buffalo Concussion Treadmill Test (BCTT) is based on the Balke cardiac treadmill stress test and imparts a very gradual increase in workload

- Start at speed of 3.3-3.6 mi/h
- Increase incline by 1% each minute
- Record HR each minute
- Record RPE each minute
- Record Symptom Level each minute

TEST SHOULD BE STOPPED IF:
- SYMPTOMS INCREASE 3 POINTS ABOVE INITIAL SYMPTOM SCORE
- RPE INCREASES TO 19/20
- AGE PREDICTED HR MAX IS REACHED

Leddy et al., 2010
MODIFIED ORTHOSTATIC VITALS

- Vitals performed after supine for 5min, then performed after transition to standing for 5min

Orthostatic Intolerance is indicated if:
- Increase in HR of >30bpm (40bpm for under 14)
- Standing HR >120bpm (130bpm for under 14)
- Decrease of >20 mm Hg in systolic BP
- Decrease of >10mm Hg in diastolic BP

Kizilbash et al., 2014
WHEN TO REFER TO THERAPY

• Buffalo Concussion Treadmill Test
  – Test is stopped due to symptoms and not due to RPE or HR Max

• Modified Orthostatic Vitals
  – If orthostatic intolerance is indicated by parameters

• Patient reports increased symptoms with any type of exercise
CLINICAL TRAJECTORIES

Vestibular

Physiologic

Vision

Anxiety/Mood

Cervical

Cognitive

Migraine

Collins et al., 2014
VESTIBULAR/VISION/BALANCE

- Vestibular rehabilitation should be considered in the management of individuals post concussion who have dizziness, gait and balance dysfunction that do not resolve with rest.
- Visual rehabilitation can be of benefit post-concussion for patient with blurring of vision, diplopia, photophobia/difficulty with glare, difficulty focusing, difficulty reading, difficulty with tracking objects.

Alsalaheen et al., 2010, Gottshall, 2011, Pillai & Gittinger, 2017
VESTIBULAR OCULAR MOTOR SCREEN (VOMS)

Vestibular/Ocular-Motor Screening (VOMS)

Smooth Pursuits (Horizontal & Vertical)
Tests ability to follow a slowly moving target
Both patient and clinician are seated
Patient follows finger with eyes
Do NOT move head, just eyes
2 reps at rate of 2 sec / rep
Rate symptoms (0-10)
Complete for both horizontal & vertical

Saccades (Horizontal & Vertical)
Tests ability of eyes to move quickly between targets
Both patient and clinician are seated
Clinician holds fingers 2 feet
Patient initially looks 0
Do NOT move head, just eyes
10 reps as quickly as possible
Rate symptoms (0-10)
Repeat with patient looking Up-Down

Convergence
Measures ability to view a near target without double vision
Patient holds target 14-point tool & arm length
Patient brings target toward eyes focusing on the “X”
Stop when they see double
Clinician measures distance from tip of nose to target (cm)
Repeat 3 x, record all 3
Rate symptoms (0-10)

Visual Motion Sensitivity
Tests visual motion sensitivity & ability to track vestibular-motor eye movements (Near Point)
Patient holds arm outstretched in front with thumb-up
Turn body as a single unit L-R 45 degrees
from initial focusing on thumb
Use metronome 50 bpm
Repeat 3 revolutions
Rate symptoms (0-10)

Vestibular-Ocular Reflex (Horizontal & Vertical)
Assesses ability to stabilize vision as head moves
Clinician holds target 2 feet from patient’s eye level
Patient initially turns head L-R 10x
Keep eyes focused on target
Use metronome 180 bpm
Wait 10 seconds
Rate symptoms (0-10)
Repeat with patient looking Up-Down

Visit natalfoundation.org/toethe-profession for more info including the NATA Foundation worksheet on VOMS


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Mucha et al., 2014
### Balance Error Scoring System (BESS) Test

**Balance Error Scoring System—Types of Errors**
1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of testing position > 5 seconds

The BESS is calculated by adding one error point for each error during the six 20-second tests.

<table>
<thead>
<tr>
<th>SCORE CARD (# errors):</th>
<th>FIRM Surface</th>
<th>FOAM Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double-Leg Stance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(narrow stance—feet together)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-Leg Stance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(nondominant foot)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tandem Stance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(nondominant foot in back)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Scores:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Score:
COBALT

FIRM SURFACE
1. Eyes open
2. Eyes closed
3. Head shaking
4. Visual motion sensitivity

FOAM SURFACE
5. Eyes open
6. Eyes closed
7. Head shaking
8. Visual motion sensitivity

• Error is counted if:
  – Step out of testing position
  – Eyes open during eyes closed task
  – Speed of head or shoulder rotation is not maintained
    • Head shaking = 180bpm
    • Visual motion sensitivity = 50bpm

Massingale et al., 2018
WHEN TO REFER TO THERAPY

• VOMS
  – Near Point Convergence ≥ 5cm
  – Symptom score ≥ 2pts on any item

• BESS
  – Greater than 10-12 errors

• COBALTL
  – Greater than 1 error on any item

Guskiewicz et al., 2001, McCrea et al., 2003, Iverson et al., 2008, Massingale et al., 2018, Mucha et al., 2014
CLINICAL TRAJECTORIES

Vestibular

Physiologic

Vision

Anxiety/Mood

Cervical

Cognitive

Migraine

Collins et al., 2014
CLINICAL TRAJECTORIES

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- Migraine

Collins et al., 2014
CERVICAL

- Neck injuries and concussion happen concurrently
- Treating cervical spine pain improves participation in vestibular and vision therapy
- Currently, there is no gold standard for the diagnosis of cervicogenic dizziness; therefore, it is a diagnosis of exclusion based on history, behaviors, and a clinically identified cluster of signs and symptoms."
CERVICAL ASSESSMENT

- Postural Assessment
- Cervical AROM
- Palpation/flexibility of upper quarter
  - Trigger points
  - Referred pain reproducing headache/dizziness
- Head Neck Differentiation Test
  - Patient sits on a chair that rotates
  - Chair and body rotated to left side then right side while examiner holds the head still

Cheever et al 2016
WHEN TO REFER TO THERAPY

- Neck pain
- Headache
- Dizziness
- Limited cervical ROM
- Painful cervical ROM
- Upper quarter muscular or myofascial pain
- Tingling/numbness in the UEs
- Symptoms with Head Neck Differentiation Test
CLINICAL TRAJECTORIES

- Vestibular
- Physiologic
- Vision
- Anxiety/Mood
- Cervical
- Migraine
- Cognitive

Collins et al., 2014
COGNITIVE/MEMORY

Receptive
LISTENING AND READING

Expressive
SPEAKING AND WRITING

Attention
Information Processing
Encoding
Thought Formulation
Organization
Word and Rule Retrieval
IMPACT

• ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing)
• Most commonly used, computer neurocognitive test to help evaluate and manage concussions
• Used by more than 7,400 high schools, 1,000 colleges and universities, 900 clinical centers, 200 professional teams and select military units.
• FDA cleared for ages 5-59, separate pediatric version
## STANDARD ASSESSMENT OF CONCUSSION (SAC)

1) **Orientation:**

<table>
<thead>
<tr>
<th>Month</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Day of week</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Year</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Time (within 1 hr)</td>
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<td>1</td>
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<tr>
<td>Orientation Total Score</td>
<td>/</td>
<td>5</td>
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</table>

2) **Immediate Memory:** (all 3 trials are completed regardless of score on trial 1 & 2; total score equals sum across all 3 trials)

<table>
<thead>
<tr>
<th>List</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word 1</td>
<td>0</td>
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</tr>
<tr>
<td>Word 2</td>
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<tr>
<td>Word 3</td>
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<td>1</td>
<td>0</td>
</tr>
<tr>
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<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
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<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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</tbody>
</table>

Immediate Memory Total Score __________ / 15

(Note: Subject is not informed of delayed recall testing of memory)

### Neurologic Screening:

- **Loss of Consciousness:** (occurrence, duration)
- **Retrograde & Posttraumatic Amnesia:** (recollection of events pre- and post-injury)
- **Strength:**
- **Sensation:**
- **Coordination:**

3) **Concentration:**

Digits *Backward* (If correct, go to next string length. If incorrect, read trial 2. Stop after incorrect on both trials.)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>4-9-3</td>
<td>6-2-9</td>
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</tr>
<tr>
<td>3-8-1-4</td>
<td>3-2-7-9</td>
<td>0</td>
</tr>
<tr>
<td>6-2-9-7-1</td>
<td>1-5-2-8-6</td>
<td>0</td>
</tr>
<tr>
<td>7-1-8-4-6-2</td>
<td>5-3-9-1-4-8</td>
<td>0</td>
</tr>
</tbody>
</table>

*Months in Reverse Order* (entire sequence correct for 1 point)

Dec-Nov-Oct-Sep-Aug-Jul
Jun-May-Apr-Mar-Feb-Jan

**Concentration Total Score** __________ / 5

### Exertional Maneuvers

(when appropriate):

- 5 jumping jacks
- 5 sit-ups
- 5 push-ups
- 5 knee bands

4) **Delayed Recall:**

<table>
<thead>
<tr>
<th>Word</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Word 1</td>
<td>0</td>
</tr>
<tr>
<td>Word 2</td>
<td>0</td>
</tr>
<tr>
<td>Word 3</td>
<td>0</td>
</tr>
<tr>
<td>Word 4</td>
<td>0</td>
</tr>
<tr>
<td>Word 5</td>
<td>0</td>
</tr>
</tbody>
</table>

Delayed Recall Total Score __________ / 5

### Summary of Total Scores:

- **Orientation** __________ / 5
- **Immediate Memory** __________ / 15
- **Concentration** __________ / 5
- **Delayed Recall** __________ / 5
- **Overall Total Score** __________ / 30

Valovich et al., 2006
POST CONCUSSION SYMPTOM SCALE (PCSS)

• Self report scale, a way to more objectively document subjective symptoms often reported by concussion patients.

• 22 questions, 0-6 Likert scale. Total out of 132.

• Subsections: Headache, Vestibular, Emotional, Cognitive, Sleep.
WHEN TO REFER TO THERAPY

• SAC
  – Less than 26pts

• PCSS
  – Men, greater than 12pts
  – Women, greater than 20pts

Valovich et al., 2006, Lovell et al. 2006
TESTING BATTERY

- Physiologic
  - Buffalo Concussion Treadmill Test
  - Modified Orthostatic Vitals
- Vestibular/Vision/Balance
  - VOMS
  - BESS
  - COBALT
- Cervical
  - Postural Assessment
  - Cervical AROM
  - Palpation/flexibility of upper quarter
  - Head Neck Differentiation Test
- Cognitive/Memory
  - ImPACT
  - SAC
  - PCSS
WHY IS A COMPREHENSIVE BATTERY IMPORTANT

• 60-70% have a musculoskeletal post-concussion compared to athletes without recent concussion

• Need to be more comprehensive in our approach to evaluation and use of therapy further evaluation and treatment
REFERENCES


