Implementation of a Multi-disciplinary Concussion Care Path

Jay L. Alberts, Ph.D.  
Cleveland Clinic  
VA FES Center  
albertj@ccf.org

Susan Linder, PT, DPT, NCS  
Cleveland Clinic  
linders@ccf.org

Scott Euype, PT, DPT, OCS  
Cleveland Clinic  
euypes@ccf.org
Learning Objectives

At the end of the presentation, the participant will be able to:

1. Describe the role of the physical therapist as part of a multi-disciplinary team in the management of individuals with concussion.

2. Identify outcome measures utilized to track the recovery of function in individuals with concussion.

3. Appreciate the benefits of utilizing technology and mobile devices in monitoring outcomes in individuals with concussion.

4. Describe interventions used by physical therapists to manage concussion-related symptoms and impairments.

5. Define the rationale behind and components of a progressive 6-phase return to an activity concussion rehabilitation program.
Concussion in the News
Definition of Concussion & mTBI

• An injury affecting the brain induced by direct or indirect biomechanical forces

• Common Features
  – Rapid onset of usually short-lived neurological impairment, which resolves quickly
  – Acute clinical symptoms that usually reflect a functional disturbance rather than structural
  – A range of clinical symptoms that may or may not involve loss of consciousness
  – Routine neuroimaging (MRI, CT) typically normal
Concussion Biomechanics & Pathophysiology

- Deceleration-Linear
- Rotational acceleration to the brain
- No current known threshold for concussive injury
- Metabolic changes occur at the cellular level
Neurochemical & Neurometabolic Cascade

- Axonal Stretching & Disruption of Cellular Membrane

http://www.healio.com/pediatrics/journals/pedann/%7Bc125fe55-4b08-4b15-94cb-cfa80fc69584%7D/concussion-pathophysiology-rationale-for-physical-and-cognitive-rest#
Increased risk if not properly identified and managed properly

- Symptoms can take significantly longer to recover
- Player is more likely to be re-injured.
- Second/third injuries:
  - Are more likely to be more severe
  - Could cause permanent brain damage
  - Can take longer to recover
  - Increase risk of retirement from sport
Concussion Prevalence

- 1.6 to 3.8 million sport-related concussions per year
- Higher incidence in games compared to practice
- Only 47% of football players sustaining a concussion actually report injury (McCrea et al., 2004)
- 400,000 mTBI in deployed US Troops

<table>
<thead>
<tr>
<th>TABLE 1 Concussion Rates in High School Sports</th>
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<tbody>
<tr>
<td>Sport</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>Football</td>
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<tr>
<td>Girls’ soccer</td>
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<td>Boys’ lacrosse</td>
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<td>Boys’ soccer</td>
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<tr>
<td>Girls’ basketball</td>
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<td>Girls’ lacrosse</td>
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<td>Softball</td>
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<tr>
<td>Boys’ basketball</td>
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<tr>
<td>Boys’ and girls’ volleyball</td>
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<tr>
<td>Baseball</td>
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</tbody>
</table>

Halstead et al., 2010
Annual Incidence in the United States

- Multiple Sclerosis (11,000)
- Spinal Cord Injuries (12,000)
- HIV (47,000)
- ACL Tears (200,000)
- Breast Cancer (232,000)
- Alzheimer's (500,000)
- Stroke (795,000)
- Concussion (3,800,000)
Continuum of Care in Concussion Management

**Acute mgmt (physician)**

On-field mgmt (ATC)

**Symptom mgmt (PT, physician)**

**Clearance (Physician, PT, ATC)**

Return to Play

Neurological Testing (PT, ATC)

RTP Rehab (PT, ATC)
The American Physical Therapy Association recognizes that physical therapists are part of the multidisciplinary team of licensed health care providers that provides concussion management, which includes:

• **Education and prevention** to minimize risk and increase awareness

• Examination and evaluation to *establish a diagnosis, treatment* through implementation of a plan of care, *monitoring of progress, and making return to participation decisions* by using best available evidence and standards of care.
The individual should not return to:

- Organized activity until he or she receives written clearance for return to participation from a physical therapist or other licensed health care provider who is trained in the evaluation and management of concussion.

- Selected activities involving physical or cognitive exertion unless a physical therapist or other licensed health care provider who is trained in the management of concussion has determined he or she should return to such activities.
The Disconnect

• Physical Therapist often not involved in the acute management of individuals with concussion
  — On-field management administered by ATC
  — Lack of evidence that PT interventions can improve concussion-related symptoms in acute phase
  — Prescribed treatment → Rest
  — Rehabilitation / Return-to-Play Program often overseen by ATC in the school environment
The Disconnect

• Role of PT within the multi-disciplinary team is poorly defined
  — Skilled need?
  — Cost-effective?
    — RTP administered within school environment
    — RTP administered by parent/coach
The Disconnect

• Determining readiness for Return to Play
  – Approach / Philosophy congruent with team?

• Management of athlete with chronic symptoms
  – Post-Concussion Syndrome?
  – Chronic Post-traumatic headache
  – Risk of re-injury?
  – Learning to manage chronic symptoms

• Legal considerations
The Disconnect - Evidence-Based Management?

• PubMed search (Jan 5, 2014)
  – Stroke and Physical Therapy – 6856 results
  – Back Pain and Physical Therapy – 4456 results
  – Concussion and Physical Therapy – 128 results

• Scientific Investigation of Concussion Management with Physical Therapy needs development
Continuity of Care Challenge: Large Multi-Provider, Multi-Site Enterprise

60 ATCs in NEO High Schools and Colleges

Patients treated at >25 Cleveland Clinic locations
Continuity of Care Challenge: Patients seen by Multiple Providers

• 2011
  – 292 physicians
    – neurology, pediatrics, internal medicine, cardiology(?)
    – 1048 concussion dx
  – 7 Primary Care Sports Medicine – 2.4%
    – 377 concussion dx – 35.9%

• 2012
  – 371 physicians
    – 1745 concussion dx (66.5% increase)
  – 10 Primary Care Sports Medicine – 2.7%
    – 821 concussion dx – 46.8%
Previous Model of Concussion Management

Electronic Medical Record

Return to Play?
Solutions to Improve Continuity of Concussion Management

• **Development of a multi-disciplinary Concussion CarePath**
  − Physicians
    − Sports medicine
    − Pediatrics
    − Neurology
    − PM&R
    − ED
  − Rehabilitation
    − PT, Speech, ATC

• **Integrate Technology across Providers**
  − Development of Cleveland Clinic Concussion (C3) App
Concussion CarePath Developed to Unify Care and Gather Outcomes

- **Red flags**
  - Yes: Refer to ED
  - No: Follow-up in x days based on symptoms and patient needs

- **Head injury suggestive of concussion**
  - Yes: Education and symptom management
  - No: Follow-up in x days based on symptoms and patient needs

- **Hypersensitive/Acute**
  - 0-7 days post-injury
  - Yes: Refer to ED
  - No: Follow-up in x days based on symptoms and patient needs

- **Subacute**
  - 8-21 days post-injury
  - Yes: Education and symptom management
  - No: Follow-up in x days based on symptoms and patient needs

- **Post-Concussive**
  - > 21 days post-injury
  - Yes: Education and symptom-based referral to specialist

- **Is there a lack of progress toward recovery?**
  - Yes: Physical Therapy, PM&R, Otolaryngology
  - No: Education and symptom-based referral to specialist

- **Does the patient have any modifiers or comorbidities that may prolong recovery?**
  - Yes: Education and symptom-based referral to specialist
  - No: Follow-up in x days based on symptoms and patient needs

- **1. Symptom-free at rest**
  - Yes: Unrestricted return to activity
  - No: Education and symptom-based referral to specialist

- **2. Symptom-free with exertion**
  - Yes: Sport 6-phase RTP protocol
  - No: Education and symptom-based referral to specialist

- **3. Normal clinical exam**
  - Yes: Unrestricted return to activity
  - No: Education and symptom-based referral to specialist

- **4. Normal cognitive and motor testing**
  - Yes: Sport 6-phase RTP protocol
  - No: Education and symptom-based referral to specialist

- **Balance and vestibular issues**
  - Yes: Physical Therapy, Sports Health PM&R
  - No: Education and symptom-based referral to specialist

- **Neck issues**
  - Yes: Physical Therapy, Sports Health PM&R
  - No: Education and symptom-based referral to specialist

- **Cognitive issues**
  - Yes: Speech Therapy, Neuropsych
  - No: Education and symptom-based referral to specialist

- **Headache**
  - Yes: Neurology
  - No: Education and symptom-based referral to specialist

- **Sleep issues**
  - Yes: Sleep Medicine
  - No: Education and symptom-based referral to specialist

*Physical Medicine & Rehabilitation*
iPad As a Powerful Data Collection Tool

• Advanced sensors in a compact package
  – 3D Accelerometer and Gyrometer
  – High resolution multi-point touch screen

• Wireless communication to cloud

• On-board processing power for data analysis

• Portable, affordable & widespread
The call for comprehensive and objective measures of concussion-related impairment

• “Concussion often presents with varying symptomatology and most experts think it should be evaluated using a multifactorial approach… Although neuropsychological testing has proven to be a valuable tool in concussion management, it is most useful when administered as part of a comprehensive assessment battery that includes grading of symptoms and clinical balance tests” – Guskiewicz, 2011

• "Concussion is increasingly recognized as a very complicated and complex injury that is best dealt with using multiple modalities. ImPACT is not designed to be used 'in and of itself,' but rather as part of an overall strategy that includes a clinical evaluation by an expert, a vestibular evaluation (including visual processing and balance) and neurocognitive assessment (ImPACT)." Mark Lovell, CEO, ImPACT Applications, Inc (8-26-12 ESPN The Magazine)
Cleveland Clinic Concussion (C3) App

Postural sway
Accelerometer and gyroscopic data collection
Visual Acuity
Symptom Assessment

Prolonged recovery predisposition
Symptom management
Graded RTP Program

Executive Function
Working memory
Set-switching
Substitution and Coding
Symptom Assessment

Simple Reaction Time
Choice Reaction Time
Trail Making Test
Psychomotor Speed
Fine Motor Control
Symptom Assessment

Detection Evaluation Management
Integrated Concussion Management Model

Pre-Season Assessment

Incident Report

Follow Up Assessment

Return to Play

Sports Medicine Review & Decision Support

Baseline

Incident

Follow-up

Follow-up
Continuity of Care Achieved Through Modules Serving Each Phase of Management

• Athlete Demographics

• Assessment Modules
  – Portions of SCAT3 - Graded Symptom Checklist, SAC
  – Information processing (Simple and Choice reaction time)
  – Attention and Working Memory (Trail Making Test and PST)
  – Balance (Instrumented BESS)
  – Static and Dynamic Visual Acuity Test

• Concussion Incident Report

• Emergency Department Module

• Return-to-play Protocol
Symptom Checklist & Enhanced SAC

- 27-item symptom severity score
- Physical Signs / Red Flags
- Glasgow Coma Scale
- Maddock’s Score
- Upper Limb Coordination
- Enhanced Standardized Assessment of Concussion
Balance Error Scoring System

• Six 20-second trials
  • 3 Stances
    • Firm Ground and Foam
  • Eyes closed, Hands on hips
  • Administrator counts errors (10 max per trial)
• Limitations
  • Poor reliability
  • High MDC
  • Floor effect (1st stance)
  • Ceiling effect (5th stance)
BESS Trial Scoring
Using standardized BESS scoring criteria, how many errors did this person commit?
iPad-SOT Balance Validation

• High correlation with “gold standard” NeuroCom SOT
Significant Correlations between iPad & NeuroCom Equilibrium Scores

SOT 1  
r = 0.45

SOT 2  
r = 0.53

SOT 3  
r = 0.67

SOT 4  
r = 0.74

SOT 5  
r = 0.70

SOT 6  
r = 0.83
Quantification of Balance with iPad Sensors

- Utilizes IMU in iPad to objectively quantify postural stability
- Developed with “Gold Standard” biomechanical tools
- Adds sensitivity to stances where errors are infrequent
Sensitivity of BESS Improved with Objective Measures

![Graph demonstrating sensitivity of BESS with different leg configurations.

- Error Count
- log_e (Ellipse Volume)
- Double-Leg
- Single-Leg
- Tandem

- Blue line represents Firm condition
- Red dotted line represents Foam condition

Significance levels:
- **:** p < 0.001
<table>
<thead>
<tr>
<th>Volume data during BESS</th>
<th>Baseline BESS Test (8/10/12)</th>
<th>1 day post-injury (9/16/12)</th>
<th>4 days post-injury (9/19/12)</th>
<th>9 days post-injury (9/24/12)</th>
<th>11 days post-injury (9/26/12)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image" alt="Baseline BESS Test" /></td>
<td><img src="image" alt="1 day post-injury" /></td>
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<td><img src="image" alt="9 days post-injury" /></td>
<td><img src="image" alt="11 days post-injury" /></td>
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</table>
BESS Visualization – Front View

Quantification of BESS using iPad2 data

<table>
<thead>
<tr>
<th>2D SWAY</th>
<th>AREA (SQ. IN.)</th>
</tr>
</thead>
</table>

Baseline

Plumb  | Baseline  | Assessment

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Visual Acuity

• Measures static and dynamic visual acuity
• Evaluate relative performance for assessment of vestibulo-ocular reflex integrity

Subject should be seated, sitting tall with shoulders back, and wearing glasses or contacts, if necessary and available. iPad should be held or placed 5 feet from subject at eye level.

In time with the sound of the metronome, the subject should smoothly shake his or her head side-to-side 'from 10 to 2' while maintaining focus on the screen.

Subject should read letters left to right in order without stopping head shake. If the subject stops shaking head, there is an option to redo the trial. Number of letters correctly identified is recorded for each trial.
Processing Speed Test

- Measures processing speed, short-term memory and visuo-spatial scanning
- Provides evaluation of attention and rate of learning
Simple Reaction Time

- 1 Stimulus, 1 Response
- Variable Wait Time controls anticipation
- Touch and Release minimizes influence of motor time on reaction time
- Lower bound at 100 msec. eliminates well-timed pure anticipation trials
- Upper bound at 500 msec. eliminates distraction trials

Begin by placing your index finger on the bottom button that reads “Touch and Hold”
Choice Reaction Time

- 2 Stimuli, 1 Response
  - Distractor (not color-blind pair)
- Increase in Task Complexity
  - Response Selection
- Variable Wait Time controls anticipation
- Touch and Release minimizes influence of motor time on reaction time
- Lower bound at 100 msec.
- Upper bound at 800 msec.

Begin by placing your index fingers on each of the buttons that read “Touch and Hold”
iPad Provides Measures of Movement Time & Accuracy

Baseline

Movement Time: 139ms
Choice RT: 456ms

48h post-concussion

Movement Time: 378ms
Choice RT: 696ms

• Concussion diminishes Information Processing, Movement Speed and Accuracy
Trail Making Test A & B

- Measures processing speed, attention, and set switching
- Discriminate between cognitive and motor time

Trails A: 1-2-3-4...

Trails B: 1-A-2-B...
Trail Making Test B Animation
Performance Polygon: “Normal” Recovery

- Graded Symptom Checklist
- Processing Speed
- Balance
- Simple RT
- Trails B-A
- Choice RT

Follow Up:
- May 20, 2013
- May 13, 2013
- May 10, 2013
- April 1, 2013

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Performance Polygon: Lingering Balance Deficits May Dictate Referral to Therapy

- Graded Symptom Checklist
- Processing Speed
- Balance
- Trails B-A
- Simple RT
- Choice RT

- Follow Up: May 20, 2013
- Follow Up: May 13, 2013
- Follow Up: May 10, 2013
- BASELINE: Apr 1, 2013
Performance Polygon: Identify “Stalled” Cases to Treat More Appropriately & Sooner

Graded Symptom Checklist

Processing Speed

Balance

Trails B-A

Simple RT

Choice RT

Follow Up: May 20, 2013
Follow Up: May 13, 2013
Follow Up: May 10, 2013
BASELINE: Apr 1, 2013
Improving Outcomes & Utilization of Services

- 2000 concussions in 2011
- 9 referrals to PT (~48 days) in 2011
- 78* referrals to PT* (~11 days) from Aug to Dec 2012
- Cost analysis and number of visits for each approach ongoing

\[
\text{Value} = \frac{\text{Outcomes}}{\text{Cost}}
\]

*Visit # pending reporting from S.E. and M.L.
Solutions for our Physical Therapy Team

• Identification & Development of core PT team
• Standardization of outcome measures
• Standardized PT Exam Template
• Educating the PT team
• Promoting active participation in multi-disciplinary meetings & symposium
• Monitoring & reporting outcomes
**Symptom Based Indications to Refer to PT**

- Headache
- Pressure in the head
- Neck pain
- Dizziness
- Balance problems
- Numbness/tingling
- Ringing in ears

- Presents with >2/5 of the following migraine cluster symptoms
  - Nausea and vomiting
  - Light sensitivity
  - Sound sensitivity
  - Noise sensitivity
  - Difficulty concentrating
**Exam Based Indications to refer to PT**

- **BESS** - Significant balance deficit at 7+ days post injury
- Abnormal balance exam on C3
- Vestibular screen indicates and complaints of dizziness present
- Abnormal vestibular testing on C3
- Any nystagmus present, smooth pursuit deficits or symptoms of blurry vision
- Jaw tenderness, pain, popping, clicking, or deviations noted with opening
- Neck pain and limited range of motion
PHYSICAL EXAMINATION
Systems Review

• Cardiovascular

• Integumentary

• Neuromuscular

• Musculoskeletal
PT EXAMINATION

Posture

• Done in both sitting and standing

• Look most specifically for:
  – Cervical spine rotation
  – Lateral head tilt
  – Thoracic / pelvic girdle rotation
  – Uneven weight-bearing

• Lateral head tilt and correction giving patient the perception of “leaning to the right” supported by concept of “Joint Position Error” (Treleaven et al 2003)
POSTURAL STRESSES

- Sitting in Class
- Surfing the Net/ Emailing Friends
- Carrying Backpacks
- Texting / Cell
- Watching TV/Movies
- I-Pad / Kindle
- Doing Homework/Reading
- Playing Video Games

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PT EXAMINATION
Range of Motion

• Cervical Spine
  – Cervical Range of Motion Device (CROM)
  – ICC were found to be greater than 0.80 for intra and inter-tester reliability (Youdas et al 1992)

  – Standard Errors of Measurement was found to be 4° for flexion, 3° for extension, 2° for lateral flexion, 3° for right rotation, and 2° for left rotation (Olsen et al 2000)

  – Universal Goniometer: ICC was > 0.80 (Youdas et al 1991)
PHYSICAL EXAMINATION
Passive Segmental Spinal Mobility

- **Inter**-rater agreement of PIVM for the cervical spine has been found to be poor (Huijbregts 2002)

- Excellent **intra**-examiner reliability has been found for segmental mobility assessment of the cervical spine (Hanten et al 2002)

- **Flexion Rotation Test**
  - Was found to have 100% inter-tester reliability in assessing the specific mobility of the C1-2 spinal segment

 UPPER CERVICAL SPINE and HEADACHES

• **Flexion Rotation** test showed average unilateral rotation of 27.6 degrees for headache patients, and 44.7 degrees for non-symptomatic controls.

• Flexion rotation test has **Sensitivity** of 91%, and **Specificity** of 90%.

• Severity of headache is not correlated to degree of ROM restriction.

• Side of C1 C2 restriction correlated with side of headache.

  *Hall and Robinson (2004)*
PHYSICAL EXAMINATION
Passive Segmental Spinal Mobility

- O-A Joint Lateral flexion
- Axis of motion through the nose
- Measure amount of lateral flexion
PHYSICAL EXAMINATION
Passive Segmental Spinal Mobility

• CO-C2 Flexion
• “Nodding”
PHYSICAL EXAMINATION
Passive Segmental Spinal Mobility

• Lower Cervical Spine
  – Down Glide Segmental Mobility
  – Up Glide Segmental Mobility
PHYSICAL EXAMINATION
Tempomandibular Joint

— Jaw opening
— Lateral Excursion
— Protrusion
— Clicking/Popping
— Facial Pain
— Clenching teeth
— Posture
PT EXAMINATION

Strength

• Strength testing for the cervical spine, upper extremities was performed according to manual muscle testing methods as described by Kendall.

• Lower Abdominal strength assessment performed (McDonnell, Sahrmann, J Orthop Phys Ther. 2005)

• Intra-tester reliability has been found to range from .80 to .99 for manual muscle testing (Florence, Phys Ther. 1992)
PT EXAMINATION
Strength

• Cranio-cervical Flexion Test
  – On wedge, OA nodding
  – Jull: Pressure sensor under neck. Cervical spine retraction: flattening out lordosis, increasing pressure 10 mmHg
    – Activation Score is that which patient can hold increase of 10 mmHg for 10 seconds, for 10 repetitions
      – Spine.2002;27:1835-1843
      – Cephalgia.1999;19:179-
PHYSICAL EXAMINATION
Balance Tests

- **Romberg** and **Sharp Romberg** tests
  - Eyes open
  - Eyes Closed

- **Unilateral Stance**
  - Both balance tests have been found to have good inter-tester reliability (Franchignoni et al 1998)
  - Sustaining at least 30 seconds is normal for the 4th decade (Vereeck et al 2008)

- **Clinical Test of Sensory Integration and Balance (CTSIB)**
  - Romberg and Sharp Romberg with Foam
PHYSICAL EXAMINATION

Balance Tests

• Romberg

• BESS Test
  – Errors
  – Volumes
PHYSICAL EXAMINATION
Balance Tests

• B.E.S.S. Types of Errors
  – Hands lifted off iliac crest
  – Opening eyes
  – Step, stumble or fall
  – Moving hip into > 30 degrees abduction
  – Lifting forefoot or heel
  – Remaining out of test position > 5 seconds

• Hold each position for 20 seconds

• Add the error for all 3 tests for both Firm / Foam
  and this will give you the TOTAL #.
Research: balance

• Balance impairments are common after concussion and mTBI

• Historically balance was tested with computerized posturography
  — To ID: somatosensory, vision, vestibular system dysfunction

• Other forms of balance testing for application in the clinic
  — Clinical test of sensory integration of balance (CTSIB)
  — mCTSIB (modified- without lantern)
  — BESS test
PHYSICAL EXAMINATION

Special Tests

• Transverse Ligament Test
  – *Sharp-Purser*
    – Patient: Sitting
    – PT: Hand on forehead, and other hand Thumb on SP of C2
    – Patient flexes head, with while PT presses backward on forehead
    – (+) Test
      – Reduction in symptoms
      – Clunk
    – Sensitivity of 69%, and a specificity of 96% for laxity >3mm


http://www.physio-pedia.com/index.php5?title=Sharp%E2%80%90Purser_Test
PHYSICAL EXAMINATION
Special Tests

• Alar Ligament Stress Test
  – Rotation
  – Patient sitting, neutral head
  – PT: Hold C2 SP with thumb, passively rotate head left and right.
  – Should not have > 30 degrees rotation without C2 segment moving
PHYSICAL EXAMINATION
Special Tests

Neck Torsion Nystagmus Test
PHYSICAL EXAMINATION
Special Tests

• Neck Torsion Nystagmus Test
  – 50% of patients without cervical trauma tested positive for nystagmus (Norre 1987)
  
  – 47% of patients with cervical trauma demonstrated subjective findings of vertigo (Fitz-Ritson 1991)
  
  – Does not rule out proprioceptive versus vascular cause (Oosterveld et al 1991)
PHYSICAL EXAMINATION
Special Tests

• Vertebral Artery Test

• Positive
  – Blurred vision, dizziness, nystagmus, slurred speech
  – Partial or complete blockage of opposite vertebral artery

PHYSICAL EXAMINATION
Special Tests

• OCULOMOTOR
  – Ocular alignment
    – Eye opposite of lesion elevated
  – Spontaneous Nystagmus
    – Often seen in acute stage of peripheral vestibular lesion
  – Smooth Pursuit
    – Look for eye movement and nystagmus
  – Saccades
  – Convergence
    – < 6 cm normal

• VESTIBULO-OCULAR
  – Maintain stable vision during head movements
  – Head Thrust
  – Head Shaking
    – Not done with concussion patients
  – Dynamic visual acuity test
    – Read eye chart with stationary head
    – Read eye chart with head moving
Dizziness and Concussion

• Consider ruling out positional vertigo (Post traumatic BPPV)
  – Episodic spinning with positional changes
    – Rolling over
    – Bending down
    – Looking up
  – Nystagmus present
    – Torsional, vertical or horizontal

• Incidence is low at 5%
  Alsalaheen et al 2010

How much Cervical Spine movement is needed?
Dizziness and Concussion

• Consider ruling out positional vertigo (Post traumatic BPPV)
  – Episodic spinning with positional changes
    – Rolling over
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    – Looking up
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  Alsalaheen et al 2010
PHYSICAL EXAMINATION
Special Tests

• Kinesthetic Awareness
  — Literature supports that those with neck pain and dizziness have a decrease in repositioning accuracy

OUTCOME TOOLS

Numeric Rating Scale

Neck Disability Index

Dizziness Handicap Index

Headache Disability Index

Activities Specific Balance “ABC”

Function:
  Balance
  Gait
OUTCOME TOOLS

Numeric Rating Scale

– Has been shown to be a valid and reliable measurement, which can be used easily in the clinical setting (Williamson 2005)

– Has been shown that only a 2-point change in score is needed to indicate a minimum clinically important difference (MCID) in patients with low back pain (Childs et al 2005)

– MCID of the NRS was found to be 1.3 in patients with neck pain (Cleland et al 2008)
OUTCOME TOOLS

Numeric Rating Scale

- Asked per symptoms reported by patient
  - Light headedness
  - Dizziness
  - Headache
  - Neck pain / stiffness

- No research found using NRS for dizziness/light headedness
OUTCOME TOOLS

Neck Disability Index (NDI)

- Developed from a modification of the Oswestry Low Back Pain Index (Vernon and Mior 1991)
- Test-retest reliability of 0.89
  - Minimal detectable change (MDC) of 4.2 percentage points
- Several studies have looked at Minimal detectable change (MDC) and MCID scores, with the best being a MDC of 10.2, and MCID of 7.0 percentage points (Westaway et al 1998, Cleland et al 2006)
OUTCOME TOOLS

Dizziness Handicap Inventory

- Has 3 separate subscales to distinguish between the patient’s perception of physical, functional, and emotional disability

- Test-reliability to be 0.97
- Statistically significant correlation coefficient with the functional (r=0.94), emotional (r=0.97), and physical (r=0.92) components
- MDC = 18 points

(Jacobsen and Newman, 1990)
OUTCOME TOOLS

Headache Disability Inventory (HDI)

- 25-item scale
- Determines impact of headache on daily living
- Good test-retest reliability
  - Total score
  - Functional
  - Emotional
- MDC: 29 points

OUTCOME TOOLS

• **Activities Specific Balance Scale (ABC)**
  - Targeted to “elderly” and individuals with stroke and balance disorders
  - Test-Retest reliability:
    - 0.92 (p<0.001)
  - Score < 67% identifies “fallers” from non fallers
    - 84% sensitivity / 87% specificity
  - **Scoring**
    - > 80-100: high functioning
    - 50-80: moderate level of functioning
    - < 50: homebound
    - MCID: 20 points per Alsalaheen 2010

— Is this valid to use with post concussion patients?
Dizziness Outcomes

• ABC Scoring
  – > 80-100: high functioning
  – 50-80: moderate level of functioning
  – < 50: homebound
  – MCID: 20 points per Alsalaheen 2010

  – Appropriate for younger concussion population?
BALANCE OUTCOMES

• Balance Error Scoring System (BESS)
  —“For most athletes performance is returned to baseline in 3-7 days post-injury”
  —Low inter-rater, intra-rater reliability
  —MCID: between 7-9 points

Harmon et al 2013
GAIT OUTCOMES

• **Dynamic Gait Index**
  – 8 functional tasks
  – ≥ 60 years old with risk of falling
  – Maximum score of 24 points
  – < 19 points
    – Risk for falling

• Has been found that younger people with vestibular disorders often show normal or close to normal DGI scores

MCID 3 per Alsalaheen et al 2010
GAIT OUTCOMES

Dynamic Gait Index

• In individuals with vestibular dysfunction and found to correlate with fall history
  Whitney et al. 2000, Badke et al. 2004, Hall et al. 2006, Bishop et al. 2010

• Ceiling effect with high functioning patients with balance / vestibular disorder
  Dye et al 2013

• Minimal evidence in concussion population

• Is this challenging enough for athletes?
GAIT OUTCOMES

• Functional Gait Assessment
  – 10 item test
  – 7 of the 8 items of DGI
  – Including:
    – Gait with narrow BOS
    – Walk backwards
    – Gait with eyes closed

• Study found:
  – Inter rater ICC of 0.86
  – Intra rater ICC of 0.74
  – Demonstrated acceptable reliability, and concurrent validity with other balance measures used for patients with vestibular disorders

GAIT OUTCOMES

• FGA Scoring

• A score of < or = to 22/30 indicates that patients are 4-6 times more likely to have increased risk of falling

Wrisley DM et al.2010

• MCID: 6 per Alsalaheen 2010

• Better for athletes?

• Used now for TBI, but starting to see use in concussion research
Oculomotor Outcomes

- Static and Dynamic Visual Acuity
  - Have the patient sit in front of an (ETDRS) eye chart approximately 2-4 meters (6.5-13 feet depending on type of chart used)
    - Note the lowest level that the patient is able to read while seated still
    - Then tilt their head down 30 degrees and gently turn their head side to side at 2 Hz (2 complete cycles side to side per sec)
    - Note the lowest line the patient is able to read with the head moving
      - Abnormal DVA is 3 or more lines

Herdman 2000
Oculomotor Outcomes

• Dynamic visual acuity
  — Sensitive to acute changes after a concussion
  — Patients show recovery in dynamic visual acuity to baseline levels in 4 weeks
  — Evidence that a deficit is present after concussion

Gottshall et al 2003
Cleveland Clinic Rehab Findings

- Sport / Non sport Concussion patients August-December 2012

Retrospective Chart Review (78 patients)

- Male: n = 45 (mean age = 18.6 y/o)
- Female: n = 33 (mean age = 21.9 y/o)
<table>
<thead>
<tr>
<th></th>
<th>Female (n=33)</th>
<th>Male (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dizziness</strong></td>
<td>79% (26/33)</td>
<td>53% (24/45)</td>
</tr>
<tr>
<td><strong>Imbalance</strong></td>
<td>39% (13/33)</td>
<td>40% (18/45)</td>
</tr>
<tr>
<td><strong>Neck pain</strong></td>
<td>61% (20/33)</td>
<td>51% (23/45)</td>
</tr>
<tr>
<td><strong>Headache</strong></td>
<td>100% (33/33)</td>
<td>89% (40/45)</td>
</tr>
</tbody>
</table>
Cleveland Clinic Rehab Findings

Headache 73/78

- Dizzy with HA 47/73
- Imbalance with HA 28/73
- Neck pain with HA 41/73
- Difficulty concentrating with HA 36/73
Cleveland Clinic Rehab Findings

Headache Disability Index
- 73/78 reported HA (93%)
- Completed HDI 38/78

![Graph showing the Headache Disability Index (HDI) for those with and without headaches (HA). The average HDI for those with HA is 35.13, while those without HA have an average HDI of 0.](attachment:graph.png)
Cleveland Clinic Rehab Findings

Dizziness Handicap Inventory

- **Dizziness** (64%)
  - Average DHI = 30.71 (n= 28)
- **Imbalance** (40%)
  - Average DHI = 35.2 (n= 15)
- **Both** (32%)
  - Average DHI without dizziness = 19.71 (n=7)
  - Average DHI without imbalance = 23.5 (n=20)
Cleveland Clinic Rehab Findings

Neck Disability Index

- 43/78 reported neck pain (55%)
- Completed NDI 36/78
# Cleveland Clinic Rehab Findings

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Description</th>
<th>N=71</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical ex.</td>
<td>ROM, repeated movements</td>
<td>65/71</td>
</tr>
<tr>
<td>Oculomotor ex.</td>
<td>X1, X2 smooth / saccades, vergence</td>
<td>51/71</td>
</tr>
<tr>
<td>Balance ex.</td>
<td>Balance or gait exercises</td>
<td>52/71</td>
</tr>
<tr>
<td>Manual</td>
<td>Massage, mobs</td>
<td>37/71</td>
</tr>
<tr>
<td>Posture</td>
<td>Scapular training etc</td>
<td>43/71</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>Treadmill, bike, etc.</td>
<td>37/71</td>
</tr>
<tr>
<td>Other</td>
<td>Repositioning</td>
<td>5/71</td>
</tr>
</tbody>
</table>
Comparative Findings

• Cleveland Clinic
  – 78 pts
  – Top 3 exercises:
    – Cervical
    – Balance
    – Oculomotor

• Alsalaheen et al 2010
  – 114 pts
  – Top 3 exercises:
    – Oculomotor
    – Balance
    – Gait
Return to Play / Function
A Collaborative Approach

- MD – Family and / or Team
- Physical Therapist
- Athletic Trainer
- Clinical Team
  - Evaluating MD, Clinical ATC, PT, Neuro-Psych
- Parent
- Coach – School Administration, if needed
- Athlete
RETURN TO PLAY

• **Symptom-free**
  — At rest
  — During all mental activities (full day of school)

• **Normal neurophysiological exam**
  — MD
  — C³ Testing

• **Normal neurocognitive exam**
  — MD
  — C³ Testing
  — ImPACT
RETURN TO PLAY
Monitoring Symptoms

• **Graded symptom checklist**
  — Pre and post-exercise

• **Borg Rating**
  — Perceived Exertion (RPE)
  — During each phase and cycle

• **Heart Rate**
  — During each phase and cycle for clinic-based interventions

• **Symptoms**
  — During each cycle
BORG Scale

- 6 No exertion at all
- 7 Extremely light
- 8
- 9 Very light
- 10
- 11 Light
- 12
- 13 Somewhat hard
- 14
- 15 Hard (heavy)
- 16
- 17 Very hard
- 18
- 19 Extremely hard
- 20 Maximal exertion
RETURN TO PLAY

- Criteria to advance to next phase
  - Asymptomatic with activities in current phase
    - No greater than 2 points on NRS?
  - $C^3$ performance remains baseline
    - Phase 2
    - Phase 5

- Duration of each phase ~ 1 day

- Must be evaluated and cleared by MD prior to full contact practice (Phase 5)
RETURN TO PLAY
Phase 1: Rest

• Physical and Cognitive **Rest**

• Criteria to advance to phase 2:
  – Asymptomatic with daily activities
  – Asymptomatic with full day of school and all mental activity
  – Impact / C-3 at baseline levels
  – MD clearance if complicated recovery or significant co-morbidities
RETURN TO PLAY

Phase 2: Exertional

• Light Aerobic Activity
  – Exercise 15-30 min
  – 8-11 on Borg Scale and/or
  – HR-based training (30-40% of max exertion)

\[ (\text{Max HR-Resting HR}) \times \text{Target } \% \] + Resting HR
RETURN TO PLAY
Phase 3: Exertional

• **Moderate Aerobic Activity**
  — Circuit-based exercise 30-45 min including warm-up
  — 11-14 RPE Scale
  — HR-based training (40-60% of max exertion)

• Criteria to advance to phase 4
  — Asymptomatic before, during and after activity
## RETURN TO PLAY
### Phase 3 Example

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Cardio Interval</th>
<th>Lower Extremity</th>
<th>Cardio Interval</th>
<th>Upper Extremity</th>
<th>Cardio Interval</th>
<th>Core</th>
<th>Cardio Interval</th>
<th>Balance</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle 1</td>
<td>Jog</td>
<td>Squats</td>
<td>Jog</td>
<td>Push-Up</td>
<td>Jog</td>
<td>Plank</td>
<td>Jog</td>
<td>SLS- Right</td>
<td>2 min</td>
</tr>
<tr>
<td>Cycle 2</td>
<td>Jog</td>
<td>Walking Lunge</td>
<td>Jog</td>
<td>T-Band Row</td>
<td>Jog</td>
<td>R Side Plank</td>
<td>Jog</td>
<td>SLS- Left</td>
<td>2 min</td>
</tr>
<tr>
<td>Cycle 3</td>
<td>Jog</td>
<td>Calf Raise</td>
<td>Jog</td>
<td>T- Band Curl</td>
<td>Jog</td>
<td>L Side Plank</td>
<td>Jog</td>
<td>R Steamboat</td>
<td>2 min</td>
</tr>
<tr>
<td>Cycle 4</td>
<td>Jog</td>
<td>Jumping Jacks</td>
<td>Jog</td>
<td>T-Band Front Raise</td>
<td>Jog</td>
<td>Bridge</td>
<td>Jog</td>
<td>L Steamboat</td>
<td>2 min</td>
</tr>
</tbody>
</table>
RETURN TO PLAY
Phase 4

- Higher Intensity Sport-Specific Aerobic Activity
  - Circuit-based exercise 45-60 min including warm-up
    - Cardio
    - Strength
    - Core
    - Balance
    - Change of Direction
    - Plyometrics
  - Non-contact practice drills
  - 14-18 RPE Scale
  - HR-based training (60-80% of max exertion)
# RETURN TO PLAY
## Phase 4 Sample

<table>
<thead>
<tr>
<th>Cycle 1</th>
<th>Cardio</th>
<th>Strength</th>
<th>Cardio</th>
<th>Plyometric</th>
<th>Cardio</th>
<th>Balance</th>
<th>Cardio</th>
<th>Change of direction</th>
<th>Cardio</th>
<th>Core</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jog</td>
<td>Jog</td>
<td>Squats</td>
<td>Jog</td>
<td>Med-ball Slams</td>
<td>Jog</td>
<td>SLS-R</td>
<td>Jog</td>
<td>Pro-agility</td>
<td>Jog</td>
<td>Plank</td>
<td>2 min</td>
</tr>
<tr>
<td>Cycle 2</td>
<td>Jog</td>
<td>Band Row</td>
<td>Jog</td>
<td>Power Skips</td>
<td>Jog</td>
<td>SLS-L</td>
<td>Jog</td>
<td>Box Drill</td>
<td>Jog</td>
<td>R-side Plank</td>
<td>2 min</td>
</tr>
<tr>
<td>Cycle 3</td>
<td>Jog</td>
<td>Walking Lunges</td>
<td>Jog</td>
<td>Med-ball Chest Pass</td>
<td>Jog</td>
<td>SLS-R w/Ball Toss</td>
<td>Jog</td>
<td>3 Cone Drill</td>
<td>Jog</td>
<td>L-side Plank</td>
<td>2 min</td>
</tr>
<tr>
<td>Cycle 4</td>
<td>Jog</td>
<td>Band Pull-apart</td>
<td>Jog</td>
<td>Lunge Hops</td>
<td>Jog</td>
<td>SLS-L w/Ball Toss</td>
<td>Jog</td>
<td>T-Test</td>
<td>Jog</td>
<td>Bridge</td>
<td>2 min</td>
</tr>
</tbody>
</table>
RETURN TO PLAY
Phases 5 & 6

• Phase 5
  — Return to FULL Contact Practice
  — Criteria to advance to phase 6
    — Asymptomatic before, during and after practice

• Phase 6
  — Return to Game Play
SUMMARY

• Concussion presents in a multitude of ways
  – Dizziness
  – Migraines / Headaches
  – Impaired Balance/gait

• The Neck is a part of Concussion Rehabilitation

• Combine concepts from Neurology and Orthopaedics

• Successful Rehabilitation is Collaborative
CASE REPORT

Subjective

• 14 year old male
  – 8th grade Wrestler

• Was wrestling, and had “head slammed to mat”. Kept wrestling

• 2 days later, hit head on bed post and per mother, this “ramped up symptoms”

• Symptoms
  – Neck pain 4/10
  – HA 7/10 “global”
  – Feels “off centered”, “Tired”
  – Ears “Full”

• Mom present during exam

• Goal: Get back to wrestling for HS tryouts
CASE REPORT
Initial Physical Examination

• Posture:
  – Forward head,
  – R lateral head tilt: Correction feels “off”

• ROM
  – C spine: ROT L 74 deg R 71 deg (+) on L
    SB L 20 deg (+) , R 45 deg
    BB 55 deg
    FB 42 deg, (+)

• PIVM
  • OA Lateral Flexion L 50% (+), R 25% (+)
  • C0-2 flexion (+)
  • C1,2 ROT L < 50% WNL (++), R 75% WNL (-)
  • Lower C spine: C 5-7 Stiff with down glide
CASE REPORT
Initial Physical Examination

• **Balance:**
  – Unable to test fully, secondary to unsafe with eyes closed, when on foam

• **Special tests**
  – All negative except:
    – Saccades: “dizzy”
    – Visual Pursuit: Lateral movements “dizzy”

• **Outcomes**
  – DHI: 44/100 (Moderate impairment)
  – NDI: 66% (Severe Disability)
CASE REPORT
Assessment

• Preferred Practice Pattern(s):
  – Musculoskeletal Practice Pattern(s) Impaired Jt Mobility, Motor Function, Muscle Performance, and ROM Associated With SPINAL DISORDERS
  – Neuromuscular Practice Pattern(s) Impaired Motor Function and Sensory Integrity Associated with Non-progressive Disorders of the Central Nervous System-Acquired In Adolescence or Adulthood
CASE REPORT

Treatment

• **Postural supportive strategies**
  – Sitting: Arm support
  – Supine/Side-lying: Towel roll support

• **Manual Therapy**
  – STM to SCM, Upper Traps, Pec Minor, Subcranial region
  – OA, C1,2 joint mobilization

• **Home Instruction**
CASE REPORT

Treatment

• Progressed patient weekly with exercise
  — Visit 4: Performed Phase 3 of RTP
  — Visit 5: Performed Phase 4 of RTP

• Cervical Kinesthetic Test
  — Proprioception
    — R Rotation: 6.0 cm error
    — L Rotation: 3.0 cm error
  — Instructed on Sitting / standing VOR, and eye tracking exercises
CASE REPORT
Outcomes

- Total of 6 visits (27 days)
- Symptoms:
  - Neck pain 0/10
  - HA 0/10
- Posture: Forward, No Lateral head tilt
- C spine ROM:
  - ROT L 84 deg R 81 deg
  - SB > 45 deg bilat
  - C1,2 L WNL bilat
  - C0-2 Flexion Minimal tightness
  - OA Lateral Flexion WNL
  - C1,2 ROT WNL
CASE REPORT

Outcomes

• Balance:
  – BESS testing: DATE: December 28, 2012
    – Total Firm: 0
    – Total Foam: 6
    – Total Score: 6
  – BESS testing: DATE: January 10, 2013
    – Total Firm: 0
    – Total Foam: 3
    – Total Score: 3
CASE REPORT

Outcomes

• **Special Tests**
  – Saccades and Visual pursuit: No dizziness

• **Outcomes**
  – DHI: 15/100
  – NDI: 0/10

• Still having some symptoms when reading after moving neck “fast”

• Able to run, but didn’t make back in time for wrestling
THANK YOU

- Thank you!!

- Thank you Kay Cherian, PT, MPT, Cert. MDT

- Thank you APTA

- Thank you Neuro Section