Vestibular manifestations of mTBI: Diagnostics and Therapeutics in the Outpatient Setting

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SLC VAMC
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Objectives

- Understand the role of out-patient based vestibular/balance therapy.

- Familiarize other HCPs regarding components of a thorough physical therapy balance evaluation.
Objectives

- Develop a better understanding of Sensory Organization Test (SOT) and the Functional Gait Assessment (FGA) to test postural stability as part of the PT balance evaluation.

- Develop a better understanding of VPT treatment specifically related to sensory integration dysfunction and static/dynamic postural instability.
Most patients with mTBI recover completely within weeks to months.

Small subset experience persistent symptoms and difficulty in rehab, most commonly due to co-occurring disorders (i.e. PTSD, chronic pain, etc.)

Dizziness is a common symptom following TBI and can have a significant impact on QOL.

(DCoE Clinical Recommendation September 2012 p 1)
Post-Blast Symptoms and Complaints

- Positional dizziness
- Migraine associated dizziness (MAD)
- Episodic vertigo (while others experience no TRUE vertigo)
- Exercise induced dizziness

**Unsteadiness** *(with some this is a constant feeling or one that worsens in challenging balance environments.)*

- Spatial disorientation
- Headache
- Fluctuating hearing loss
- Tinnitus
- Ear Pressure

(Hoffer et al., 2010, p 233-235)
OUTPATIENT ROLE in PT

Address chief complaint of dizziness/vertigo and/or imbalance as related to function through a wide variety of therapeutic techniques.
OUTPATIENT ROLE of Physical Therapy

- Address secondary issues of:
  - pain limiting function
  - coordination
  - safety awareness
  - deficits in strength or ROM
  - equipment needs
  - caregiver education and training

(Dayna Geiger, DPT)
Discovering what Dizziness Means

- Defining Dizziness as part of patient History
  - Lightheadedness
  - Vertigo
  - Dysequilibrium, Unbalanced
  - Pre-Syncope
  - Confusion
**PHYSICAL THERAPY EXAM:**

<table>
<thead>
<tr>
<th>Central Screening</th>
<th>Neurologic/Coordination Screening</th>
<th>Musculoskeletal Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Observation for spontaneous nystagmus</td>
<td>• Rapid Alternating Movements</td>
<td>• A/PROM</td>
</tr>
<tr>
<td>• Smooth pursuit</td>
<td>• Heel Taps</td>
<td>• Strength (i.e MMT, Repeated Sit to Stands/30 secs)</td>
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<tr>
<td>• Saccades</td>
<td>• Nose to Finger</td>
<td>• Joint mobility as needed</td>
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<tr>
<td>• VOR Cancellation</td>
<td>• Vibration/Sensation</td>
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<td></td>
<td>• Proprioception</td>
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<td>• Reflexes</td>
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# PHYSICAL THERAPY EXAM:

<table>
<thead>
<tr>
<th>BPPV Testing</th>
<th>Peripheral VOR Testing</th>
<th>Standardized Functional Tests</th>
<th>Cervicogenic Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBI Clearance</td>
<td>Head shake</td>
<td>DGI/FGA</td>
<td>Smooth Pursuit Neck Torsion Test (SPNT)</td>
</tr>
<tr>
<td>Dix- Hallpike</td>
<td>Head Thrust</td>
<td>Gait Velocity</td>
<td>Head/Neck Differentiation Test</td>
</tr>
<tr>
<td>Head Roll</td>
<td>Dynamic Visual Acuity Test (DVAT)</td>
<td>Berg</td>
<td>Joint Position Error Testing (JPE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TUG</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>ABC</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Dizziness Inventory</td>
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<td></td>
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<td>Motion Sensitivity Test</td>
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<tr>
<td></td>
<td></td>
<td><strong>Balance Master</strong> (SOT/ADT) or CTSIB</td>
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</table>
Assessing Postural Stability and Unsteadiness

Sensory Organization Test (SOT)

(www.resourceonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 5-52)
Sensory System Function

- Sensory Organization/Integration
  1. Helps to determine body position
  2. Compares, selects, and combines senses
     - Visual system
     - Vestibular system
     - Somatosensory system
  3. Recognizes Environmental Interaction

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 5-52)
Computerized Dynamic Posturography (CDP)

- CDP = SOT + MCT
  - Sensory Organization Test (SOT)
    - Sensory portion of CDP
  - Motor Control Test (MCT)
    - Involuntary motor portion of CDP
  - Adaptation Test (ADT)
    - Is often used as a substitute for MCT when MCT is not available.

[www.resourcesonbalance.com](http://www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide, p 5-52)
Overview of Sensory Organization
## Overview of Sensory Organization:

<table>
<thead>
<tr>
<th>Condition</th>
<th>ENVIRONMENT</th>
<th>SYSTEM RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision</td>
<td>Surface</td>
<td>Disadvantaged</td>
</tr>
<tr>
<td>1</td>
<td>Stable (EO)</td>
<td>Stable</td>
</tr>
<tr>
<td>2</td>
<td>Absent (EC)</td>
<td>Stable</td>
</tr>
<tr>
<td>3</td>
<td>Unstable</td>
<td>Stable</td>
</tr>
<tr>
<td>4</td>
<td>Stable (EO)</td>
<td>Unstable</td>
</tr>
<tr>
<td>5</td>
<td>Absent (EC)</td>
<td>Unstable</td>
</tr>
<tr>
<td>6</td>
<td>Unstable</td>
<td>Unstable</td>
</tr>
</tbody>
</table>

* If motor status is within functional limits (i.e. LOS)

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 5-52)
Sensory Organization Test Results:

- EQUILIBRIUM SCORE
- COMPOSITE SCORE
- SENSORY ANALYSIS
- STRATEGY ANALYSIS
- COG ANALYSIS

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 5-52)
SOT: Interpreting Test Results

- EQUILIBRIUM (E) Score:

This is a stability measurement. How well does the patient’s sway remain within the theoretical limits of stability (12.5 degrees) during each sensory condition?

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide, p 5-52)
SOT: Interpreting Test Results

- **Composite Score**: Represents the weighted average of all scores
- Composite Score is $>15$ pts below that of age-matched norms are also at fall risk.
  - 20-59 y/o n=112: Composite: 79.8 (< 65)
  - 60-69 y/o n=54: Composite: 77.6 (< 63)
  - 70-79 y/o n=29: Composite: 72.9 (< 57)
- **Meaningful improvement**
SENSORY ANALYSIS:

- **SOM (Bar 1):** How well does my patient use somatosensory cues for balance?
  - Ratio score of A/P sway of cond 2 to cond 1.
- **VIS (Bar 2):** How well does my patient use visual cues for balance?
  - Ratio score of A/P sway of cond 4 to cond 1
- **VEST (Bar 3):** How well does my patient use vestibular cues for balance?
  - Ratio score of A/P sway of cond 5 to cond 1
- **PREF:** Can patient ignore inaccurate visual cues in a situation of visual conflict?
  - Ratio score of A/P sway of cond 3+6 to cond 2+5

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide, p 5-52)
**STRATEGY ANALYSIS**

- **Hip Strategy:** typically used when patient perceives they are less stable.

- **Ankle Strategy:** typically used when patient perceives they are more stable. Strategy patient utilizes should be appropriate for amount of sway exhibited.

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 5-52)
Center of Gravity (COG) Alignment Interpretation.

- COG alignment also must be considered when interpreting sensory and motor tests and for treatment planning.

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 5-52)
What if you don’t have access to a Balance Master?

Try the “Low-Tech” version:

- Clinical Test of Sensory Interaction on Balance (CTSIB)

- Need a two volunteers!
Starting Position:
- Remove shoes
- Standing with feet together
- Hands crossed and touching shoulders

Grading the Sway
1 = minimal
2 = mild
3 = moderate
4 = Fall

STOP the Task:
- Arms moved from original position
- Foot moved from original position
- Opened their eyes during EC condition
SOT Impairment Patterns

GROUP BREAKOUT TIME!

- **Somatosensory Dependence Pattern**
  - Difficulty balancing on unstable surfaces (4,5,6)

- **Visual Dependence Pattern**
  - Difficulty balancing when visual cues are absent or conflicting (2,3,5,6)

- **Visual Preference Pattern**
  - Difficulty balancing when visual cues are conflicting (3,6)

- **Vestibular Pattern**
  - Difficulty balancing on unstable surfaces with absent or conflicting visual cues (5,6)

[www.resourcesonbalance.com](http://www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 5-52)
SOT Impairment Patterns

- Central, Anxiety Component, or Aphysiologic Presentation
  - Difficulty balancing all conditions 1-6
“...Occasionally, however, particularly in cases of head trauma, the mechanism and severity of injury are out of proportion to the physical or laboratory findings of posture and gait control.”

Hamid et al. reported that CDP “could detect inconsistencies that implied voluntary exaggeration of anterior-posterior sway.”

Gianolie et al “found non-organic sway patterns were identifiable and distinguishable from normal performance patterns in 76% of patients who have the potential for secondary gain.”

(www.resourceonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 93-100)
Better performance on harder vs. easier SOT conditions
Regular oscillations without falls
Sway patterns
Mallinson-Longridge Aphysiologic Determination Criteria (9-part)
- 0-2/9: No suspicion of aphysiologic behavior
- 3/9: Possible
- 4/9: Probable
- 5-9/9 Definite

(Balance Manager Systems: Clinical Interpretation Guide., p 93-100)
Mallinson-Longridge Aphyshiologic Determination Criteria (9-part)

1. High inter trial variability seen throughout
2. Conditions 1 and 2 markedly below normal
3. Better performance on 1 and 2, when pt is unaware of performance recording
4. Cond 5,6 relatively better than 1,2
5. Circular sway (SOT COG XY Plot)
6. Repeated, suspiciously consistent sway patterns throughout SOT trials (SOT Sway Shear and Alignment)
7. Exaggerated motor responses to even small forward and backward translations (MCT/ADT)
8. Inconsistent, non reproducible motor response (MCT/ADT)
9. Clinical Judgment “gut feeling” (Clinical Impression)

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide, p 93-100)
Be Careful!

Must exercise caution when assigning a motive to malingering cases to such patterns.

“Beside secondary gain, excessive voluntary sway can be seen (usually to a limited extent) in anxious patients or patients with real pathology who are eager to ‘show’ their deficits on platform posturgraphy testing.”

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide., p 93-100)
Assessing Postural Stability during Gait

- Dynamic Gait Index (8 items)
- Functional Gait Assessment (10 items)

(Wristley et al. 2004)
Description of FGA

- 10-item test that comprises 7 of the 8 items from the original DGI
- Each item is scored on a scale from 0 - 3, with
  - 0 = severe impairment
  - 1 = moderate impairment
  - 2 = mild impairment
  - 3 = normal ambulation
- Assessment may be performed with or without an assistive device
Description of FGA

- Length of Test: 5-15 min
- Items Needed:
  - Marked area for walking (20ft)
  - Set of Steps
  - Shoeboxes for obstacles
  - Stopwatch
- High Score: 30, Fall Risk 22/30
- MCID: 8 points
Functional Gait Assessment (FGA)

1. Normal Gait
2. Gait with changes in velocity
3. Gait with Head Turns
4. Gait with Head Nods
5. Gait with Pivot and Turn
6. Gait with Obstacles
7. Backwards Gait
8. Gait with eyes closed
9. Tandem Gait
10. Stairs

Volunteers!
Primary Treatment:

**Vestibular Therapy**
- Repositioning Maneuvers
- Adaptation/Gaze Stabilization
- Habituation
  - *Enhancing Postural Stability*
- Gait training
- Functional Balance training
Secondary Treatment

Address secondary issues of:

- pain limiting function
- coordination
- safety awareness
- deficits in strength or ROM
- Cervicogenic treatment when appropriate
- equipment needs and assistive devices
- caregiver education and training
Enhancing Postural Stability

1. Learn to use **stable visual references and somatosensory info** for their primary postural sensory system
2. Encourage use of **remaining vestibular function**
3. Identify efficient and effective **alternative strategies**
4. Recover normal postural strategies

(In Han et al., 2011, p187)
## Enhancing Postural Stability (3)

<table>
<thead>
<tr>
<th>Exercises for specific SOT Patterns</th>
<th>Did poorly on conditions...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Visual Dependency</td>
<td>2,3,5,6</td>
</tr>
<tr>
<td>2. Somatosensory Dependency</td>
<td>4,5,6</td>
</tr>
<tr>
<td>3. Vestibular Dysfunction</td>
<td>5,6</td>
</tr>
</tbody>
</table>

(www.resourcesonbalance.com)

(Balance Manager Systems: Clinical Interpretation Guide., p 5-52)

(In Han et al., 2011, p187)
Repeated exposure to appropriately challenging sensory environments improves overall balance control.

It will also improve motor output and function
- ROM, strength, balance, and gait
- With or without specific training of these motor elements.

(www.resourcesonbalance.com)
(Balance Manager Systems: Clinical Interpretation Guide, p 5-52)
Gait Training and Functional Training to Improve Daily Living

- Define impairments
- Set goals
- Start with skill-breakdown and habituation
- Combine skills
- Turn skills into functional tasks
Physical therapy CAN HELP ADDRESS IMPAIRMENTS and IMPROVE FUNCTIONAL ABILITY due to dizziness and unsteadiness in those that have suffered mTBI.
Disciplines must work together...must communicate well....take a wholistic approach.

Show Compassion

Understand that pt may be suffering from other co-morbidities (i.e. pain and nightmares) that can affect performance at therapy, so provider may need to adapt to how patient feels that day.

“I like to see progress to feed my motivation.”
References and Resources

1. Dayna Geiger, DPT
2. DCoE Clinical Recommendation September 2012. Assessment and Management of Dizziness Associated with Mild TBI
4. Website: www.resourceonbalance.com
Questions?