Defining Dizziness: An Acute Approach to Vestibular Dysfunction in the Hospital Setting

Friday, February 17, 2017 8:00 AM-10:00 AM

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Vestibular dysfunction can lead to dizziness, postural instability, and increased risk for falls. It is estimated that 1 in 3 adults over age 40 have experienced symptoms related to vestibular dysfunction and recent surveys indicate that most of these patients could see up to 4-5 doctors before receiving a diagnosis. The most common type of vestibular disorder, Benign Positional Paroxysmal Vertigo (BPPV) may account for up to 50% of vertigo in older adults; and can be easily treated in over 90% of cases by physical therapists in only 1-3 visits. Falls associated with dizziness is a common presentation in the hospital setting; but despite its prevalence, evidence suggests that less than 4% of patients will be tested for BPPV in the hospital. As a result, patients may incur medical costs over $5000 through an average of 8 hospital visits between onset of symptoms and receiving the diagnostic maneuver.

With such a large percentage of dizzy patients falling through the cracks of our medical system, it is imperative that the acute care physical therapist be able to provide appropriate differential diagnosis for vestibular dysfunction in the wake of a multitude of other medical, pharmaceutical, and cardiovascular sources for dizziness.

The purpose of this session will be to provide general clinical recommendations for the diagnosis and management of patients with vestibular dysfunction, while considering the added complexities of the acute care patient population.

Objectives

Upon completion of this course, participants will be able to...

1. Describe the basic pathophysiology involved with BPPV and discuss the key screening elements of BPPV to educate referral source.
2. Compare and contrast evidence based clinical balance assessment tools and functional outcome measures most appropriate for the hospital setting.
3. Identify subjective and objective findings in patient’s past medical history and PT examination consistent with BPPV or vestibular dysfunction, which require further clinical assessment.
4. Identify key clinical reasoning and red flag elements for management of vestibular dysfunction in the hospital setting to determine appropriate course of treatment or referral to most appropriate provider.

1. Introduction
   a. Why are we talking about vestibular dysfunction in the hospital setting?
      i. It is estimated that 1 in 3 adults over age 40 have experienced symptoms related to some form of vestibular disorder (Argawal Y., 2009)
      ii. Recent surveys indicate that most of these patients could see up to 4-5 doctors before receiving a diagnosis. (VEDA Survey, 2011)
      iii. As balance experts, physical therapists are often a key hospital based provider in assessing the unsteady, dizzy, or high fall risk patients to determine a safe and feasible discharge plan.
   b. Prevalence of vestibular dysfunction in hospital setting
      i. 80% of fallers (with no known cause) who presented to ED had symptoms of vestibular impairment
      ii. Despite its prevalence, evidence suggests that less than 4% of dizzy patients will be tested for BPPV in the hospital setting (Kerber K, 2013)
   c. Cost associated with unnecessary testing/hospital stay
i. Patients may incur medical costs over $5000 through more than 8 hospital visits between onset of symptoms and receiving the diagnostic maneuver. (Wang H, 2014)

2. Anatomy and Pathophysiology Review
   a. Vestibular system is designed as an accelerometer sensing both linear and angular movement
   b. 3 primary components make up the vestibular system
      i. Peripheral Sensory Apparatus
         1. Responsible for detecting and relaying information regarding head velocity (linear and angular).
         2. Located in the temporal bone of the skull. Consists of the bony labyrinth, membranous labyrinth, semi-circular canals, perilymphatic fluid and specialized hair cells which convert mechanical movement of into neural firing to signal changes in head movement.
         3. Semi-Circular Canals
            a. Loop shaped structures filled with fluid and hair-like sensors
            b. Anterior, Posterior, Horizontal canals detect angular acceleration
            c. Stimulation of the SCC will result in eye movement in the same plane
            d. detect higher frequency motion like walking
         4. Otoliths - Detect linear acceleration
            a. Saccule = linear vertical
            b. utricle = linear horizontal
            c. Positioned at the end of the canals and consist of calcium carbonate crystals called otoconia which help sense the head’s position relative to gravity.
            d. More sensitive to lower frequency movement like standing still
         5. Hair Cells
            a. Transduce mechanical movement/force into nerve action potentials. A lot of small cilia and one large kinocillium (otoconia in otoliths sit on top of hair cells)
               i. hairs displaced TOWARD kinocillium $\rightarrow$ increased firing $\rightarrow$ Excitation
               ii. hairs displaced AWAY kinocillium $\rightarrow$ decreased firing $\rightarrow$ inhibition
      ii. Central Processing System
         1. Vestibular nuclei and the cerebellum process information from peripheral sensory apparatus in order to provide information about where the head is in space.
         2. Each vestibular nucleus has a baseline neural firing rate and movement causes a change in the firing rate relative to the direction of movement.
            i. Head movement to right side will INCREASE firing on right side and DECREASE firing on the left side $\rightarrow$ brain interprets movement to the right
      iii. Motor Output System
         1. Processed information results in compensatory eye movements for gaze stabilization and body position for postural control during head or body movement and locomotion.
         2. Vestibulo-ocular reflex (VOR)
            a. Primary purpose is to maintain gaze stability during head motion.
            b. 3 neuron arch that links a set of extraocular eye muscles that are aligned with direction of pull in same spatial plane of horizontal, anterior, posterior semicircular canals.
         3. Vestibulo-spinal reflex (VSR)
            a. Series of reflexes which affect whole body equilibrium by facilitating and inhibiting skeletal extensor muscle activity.
      c. Defining Dizziness
         i. Vertigo – The illusion and perception of turning when stationary
         ii. Oscillopsia – Illusory back and forth movements of the visual environment
iii. Disequilibrium – A lack of equilibrium or stability
iv. Lightheaded – Feeling faint
d. Role of Vestibular System in Postural Control

<table>
<thead>
<tr>
<th>SENSORY INPUT</th>
<th>INTEGRATION OF INPUT</th>
<th>MOTOR OUTPUT</th>
<th>BALANCE</th>
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<tbody>
<tr>
<td>Vestibular</td>
<td>The cerebellum coordinates and regulates posture, movement, and balance.</td>
<td>Vestibuulo-ocular reflex</td>
<td></td>
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<tr>
<td>equilibrium</td>
<td>The cerebral cortex contributes higher level thinking and memory.</td>
<td>Motor impulses to control eye movements</td>
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<tr>
<td>spatial awareness</td>
<td>The brainstem integrates and sorts sensory information.</td>
<td>Motor impulses to make postural adjustments</td>
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<tr>
<td>rotation</td>
<td>&quot;reset&quot; the eye is always toward the side of increased activity</td>
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<td>linear movement</td>
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<td>Visual</td>
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<tr>
<td>sight</td>
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<td>Proprioceptive touch</td>
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i. Role of VOR in postural control
ii. Functional relationship of the vestibular system and balance
e. Generation of Nystagmus
   i. Involuntary rhythmic oscillation resulting in slow/fast phase of eye movement
   ii. Slow phase controlled by vestibular system
   iii. Fast phase = regulation to “reset” the eye is always toward the side of increased activity
   iv. Named for fast phase
f. Central vs. Peripheral Dysfunction
   i. Peripheral Dysfunction - direct damage to the Labyrinth, hair cells, or VII Cranial Nerve
   ii. Central Dysfunction - Lesion located in central nervous system i.e. vestibular cortex, thalamus, brainstem, vestibular cerebellum.

3. Evidence Based Approach to Balance/Vestibular Dysfunction in Hospital
   a. Screening vestibular dysfunction in hospital setting
      i. Differential Diagnosis - Important Subjective/Hospital Considerations before Objective assessment
         1. Think horses not zebras - review entire medical chart, discuss with other team members if red flags emerge
         2. Cardiac related causes for dizziness/light headedness
         3. Poly-pharmacy
         4. Trauma – concussion, falls, etc.
         5. Geriatric Syndrome
      ii. Subjective Exam
         1. Defining Dizziness
            a. Temporal, Type/Symptoms, Onset, Auditory involvement
            b. Ask patients to describe their symptoms using a word other than dizziness
            c. History of falls or near falls
            d. Self-perception of balance
iii. Objective Exam

1. Oculomotor Exam (room light) – Related to vestibular system
   a. Spontaneous Nystagmus
      i. Test – assessment of resting/spontaneous nystagmus with patient looking straight ahead
      ii. (+) = nystagmus at rest
   b. Gaze Holding Nystagmus
      i. Assess for nystagmus using a point target through a 20-30° range up/down/left/right
      ii. (+) = nystagmus
   c. Oculomotor Motility (ROM)
      i. 18-24 inches away from patient’s face using tip of pen to assess for conjugate eye movement or double vision at end range
      ii. (+) = disconjugate eye movement

2. VOR Testing
   a. Head Thrust Test (HIT) – diagnostic test for VOR
      i. 1) Tilt head at 30° angle (horizontal plane) 2) oscillate back/forth 3) patient focuses on your nose 4) keep pattern as random as possible
      ii. (+) = re-fixation saccades
   b. Static and Dynamic Visual Acuity – functional test for VOR
      i. Have patient read from Snellen chart at rest and repeat with 30° flexion at 15° range at approximately 2 Hz (240 per app)
      ii. (+) = ≥ 3 lines lost

3. Oculomotor Exam - Tests independent of vestibular system (central findings) RED FLAGS
   a. Vergence
      i. Have patient focus on single point - begin 2 feet away from patient’s face and move toward bridge of nose
      ii. (+) = double vision or eye jumps away from center >10 cm from bridge
   b. Smooth Pursuit
      i. Have patient follow point from 30° right to 30° left and back to center at approx. 20° /sec – repeat horizontal/vertical
      ii. (+) = saccadic intrusions
   c. Saccadic Eye Movement
      i. Have patient look at point object back/forth about 25° from midline – move object around your head to assess 1.) speed 2.) accuracy 3.) conjugate movement
      ii. (+) = overshoot, dysconjugate movement, slow movement
   d. VOR Cancellation
      i. Grasp patient head – tilt forward 30° (horizontal plane) move patients head with your outstretched arms (they focus on your nose)
      ii. (+) = nystagmus/saccadic eye movements

4. Positional Vestibular Testing
   a. Dix-Hallpike
   b. Sidelying Test
   c. Roll Test

b. Screening balance in the hospital environment
   i. Balance Assessment
      1. What is the underlying constraint?
a. Vestibular system  
b. Visual system  
c. Somatosensory system  

2. Anticipatory vs. Responsive balance systems  

ii. Objective Measures  
1. Body Structure/Function  
   a. Modified clinical test of sensory interaction and balance  
   b. Dynamic gait index  
   c. Timed up and go/Timed up and go - manual  
   d. 10 m walk test  
   e. 5x sit to stand  

2. Activity and Participation  
   a. Activities specific balance confidence scale  
   b. Dizziness handicap index  

c. Evaluation/Differential Diagnosis - Central vs. Peripheral Findings  
   i. Signs of Central Dysfunction → Referral  
      1. Subjective Findings  
         a. Sudden onset of vertigo w/ one of the 4 D’s (diplopia, dysphagia, dysarthria, dysmetria) or asymmetric muscle weakness  
         b. Slow onset imbalance with standing or walking  
         c. Dizziness without vertigo which results in generalized sensation of head movement that is constant – 24/7  

   2. Objective Findings  
      a. Oculomotor tests independent from vestibular system which can be used as markers for central involvement  
         i. Smooth pursuit  
         ii. VOR cancellation  
         iii. Saccade Testing  
         iv. Vergence  

   ii. Signs of Peripheral Dysfunction  
      1. Diagnostic Vestibular Findings  
         a. eye movements, nystagmus  
         b. head thrust, head shaking nystagmus  
         c. positional testing  

      2. Suggestive Vestibular Findings  
         a. mCTSIB – unstable when standing on foam with eyes closed  
         b. Impaired dynamic visual acuity  

      3. Functional Findings  
         a. Gait measures (DGI, gait speed etc.)
4. **Fundamentals of Dysfunction**
   a. Clinical considerations for other common presentations of vestibular dysfunction given the hospital setting

<table>
<thead>
<tr>
<th>Temporal</th>
<th>\textit{“Dizziness”}</th>
<th>Diagnosis</th>
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<tbody>
<tr>
<td>Episodic – Seconds</td>
<td>HM-HP provoked</td>
<td>• BPPV</td>
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<tr>
<td></td>
<td></td>
<td>• Uncompensated, stable Labrythitis</td>
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<tr>
<td></td>
<td></td>
<td>• VBI</td>
</tr>
<tr>
<td>Episodic - &lt; 60 seconds</td>
<td>Spontaneous</td>
<td>• Migraine;</td>
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<tr>
<td></td>
<td></td>
<td>• TIA</td>
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<td></td>
<td></td>
<td>• Anxiety</td>
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<td></td>
<td></td>
<td>• Meniere’s</td>
</tr>
<tr>
<td>Episodic - min/hrs. &lt; 24 hrs.</td>
<td>HM-HP provoked</td>
<td>• Uncompensated, stable Labrythitis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• migraine</td>
</tr>
<tr>
<td>Episodic - min/hrs. &lt; 24 hrs.</td>
<td>Spontaneous</td>
<td>• Labrythine disorders (i.e. Meniere’s, and autoimmune)</td>
</tr>
<tr>
<td>Episodic - min/hrs. &lt; 24 hrs.</td>
<td>Spontaneous</td>
<td>• Migraine</td>
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<td></td>
<td></td>
<td>• Anxiety</td>
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<tr>
<td></td>
<td></td>
<td>• Cardiovascular</td>
</tr>
<tr>
<td>Days</td>
<td>Spontaneous (\Rightarrow) HM – HP provoked</td>
<td>• Vestibular neuritis</td>
</tr>
<tr>
<td></td>
<td>1-3 days</td>
<td>• Vascular event</td>
</tr>
<tr>
<td>Days</td>
<td>Spontaneous (\Rightarrow) HM – HP provoked</td>
<td>• Labrythinitis</td>
</tr>
<tr>
<td></td>
<td>1-3 days</td>
<td>• PICA or AICA stroke</td>
</tr>
<tr>
<td>Days typically &lt;7</td>
<td>Spontaneous or HM – HP relatively constant</td>
<td>• Migraine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Vascular w/ other neuro symptoms</td>
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<tr>
<td>Continuous</td>
<td>Possibly exacerbated by HM - HP</td>
<td>• Central Vestibular</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Anxiety</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Non-vestibular (i.e. sensory motor neuropathy)</td>
</tr>
</tbody>
</table>

b. Clinical considerations for BPPV in hospital setting
   i. What is BPPV?
   ii. Anatomical Explanation
   iii. Assessment - Characteristic Presentation
   iv. Treatment
      1. More than 90% of cases of BPPV can be treated through a simple mechanical maneuver which uses gravity to resolve the mechanical displacement of crystals and decrease dizziness in 1-3 visits. (Parnes, 2003)
   v. Follow Up Recommendations
      1. No longer recommend Canalith Repositioning Maneuvers for HEP
      2. Be aware of outpatient follow up options in your area or use vestibular.org to search by zip code

c. Basic Treatment Interventions for Vestibular Dysfunction
   i. Vestibular intervention
      1. Adaptation
      2. Substitution
      3. Habituation
   ii. General balance intervention
1. Standing balance
2. Dynamic balance
3. General LE strengthening

5. **Education of Referral Source**
   a. Communication with the healthcare team
   b. Screening in multidisciplinary rounds
   c. Education of providers on scope of practice
   d. Resources available

6. **Key Clinical Reasoning Considerations - To treat or not to treat**
   a. Clinical Reasoning Algorithm
   b. Clinical exam findings
      i. Red flags
      ii. Reliable testing information
   c. Primary reason for admission to the hospital
      i. Surgical limitations
      ii. Precautions
      iii. Individual patient characteristics
   d. Access to follow up
   e. Participation
   f. Treatment environment
   g. Risk vs. Benefit

7. **Case Study Examples and Discussion**

**Works Cited**