Dizziness in the Older Adult
Part II: Vestibular Assessment and Rehabilitation

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Outline
- Introduction to the Vestibular System
- Common Etiologies of Dizziness
- Assessment of the Vestibular System
- Interpretation of Results
- Candidates for Vestibular Rehab
- Overview of Vestibular Rehab
- Treatment by Diagnoses
- Compensation and Outcomes to Vestibular Rehab
- Introduction to Case Studies

Statistics
- Approximately 7 million people see their physician per year for problems with balance and dizziness.
- 30% of the population will report problems with balance and dizziness before age 65.
- An estimated 45% of dizziness can be attributed to a vestibular disorder
- RISK FOR FALLS:
  - 25-35% of individuals aged 65-75 years old
  - 32-42% of individuals over 75 years old
  - Leading cause of death for those greater than 65 years of age.
Introduction to the Vestibular System

Otolith Organs
- Gravity
- Linear Acceleration

Semicircular Canals
- Angular Acceleration
- Shaking our Head “NO”
- Detects direction and speed

Vestibulo-ocular Reflex (VOR)

Vestibulo-ocular Reflex (VOR)

Introduction to the Vestibular System
- Unsteadiness
- Light headedness
- Imbalance
- “I’m Spinning!!”

Duration
- 30 seconds
- 30 minutes
- 30 hours
- 30 days???
**Case History**

- Vestibular
  - Sudden Onset
  - Room Spinning Dizziness
  - < 24 hours
  - Auditory Complaints

- Central
  - Gradual onset
  - Symptoms last 24/7
  - Include other symptoms such as
    - Diplopia (Double vision)
    - Dysarthria (difficulty speaking)
    - Dysphagia (Difficulty swallowing)

**Common Etiologies of Dizziness**

Peripheral
- BPPV
- Migraine
- Meniere’s disease
- Disequilibrium of aging
- Labyrinthitis
- Vestibular Neuritis

Low frequency hearing loss
- Room spinning dizziness
- Aural Fullness
- Buzzing tinnitus
- True room spinning dizziness
- Hearing Loss (labyrinthitis)

**So, when do you refer??**

- Videonystagmography (VNG)
- Rotary Chair
- Posturography
- Vestibular Evoked Myogenic Potential (VEMP)

**Examinations at BTNRH**

- Conductive hearing loss not of middle ear origin
- AUDIOGRAM!!
- VNG / ENG
- CASE HISTORY!!
- Bedside exam for postural control
- Bilateral Caloric weakness
- Tubes
- Perforation
- Malformed Canal
- CTSIB abnormal
- Major c/o unsteadiness
- Known or suggested pathology involving postural control pathways
- Rotary Chair
- Posturography
- Conductive hearing loss not of middle ear origin
- VEMP
Vestibular Testing

- Are symptoms central in nature?
- Does the patient have BPPV?
- Are symptoms vestibular in nature?

Videonystagmography: VNG

- Videonystagmography vs Electronystagmography
- Means for monitoring eye movements
- Looking for:
  - Ability to perform specific tasks
  - Nystagmus

Vestibular Testing

- Vestibular function
- Nystagmus
- Ocular Motor: Saccade
- Ocular Motor: Smooth Pursuit

Nystagmus

- Deflection up = rightward movements
- Deflection down = leftward movements

Left Beat: 41 degrees per second
Right Beat: 14 degrees per second

VNG: Ocular Motor: Saccade

- The ability to rapidly move the eyes and refixate on a target
- Latency: how long does it take to find the target
- Accuracy: how accurate are you?
- Velocity: how long does it take your eyes to get there?

VNG: Ocular Motor: Smooth Pursuit

- Smooth pursuit: ability to track
- Our ability to perform smooth pursuit arises from vestibulo-cerebellum
How is Gaze Testing Completed?
- Patient looks at a visual target:
  - Center position
  - Right
  - Left
  - Up
  - Down
- Take away Vision (close the goggles)
  - Center, right, left

Gaze Stability (Fixation)

Peripheral Origin
- Acute Lesion
- Direction fixed
- Enhanced with Fixation removed
- Linear Slow component
- Alexander’s Law

Central Origin
- Acute or Chronic
- Direction fixed or changing
- Rarely in primary
- Enhanced with Fixation present
- Decreasing speed of Slow Component

VNG: Positional Testing
- Monitor eye movements
  - Supine
  - Right Side
  - Left Side
  - Head Hanging
  - Head Right
  - Head Left

Dix Hallpike Maneuver
- Used to diagnosed BPPV
- What is BPPV?

What is BPPV?
- Symptoms: symptoms of room spinning dizziness when changing position of the head:
  - Top Shelf
  - Rolling over in bed
  - Lying down in bed
  - Bending over
  - Dentist visits
  - Hair Appointments

Diagnosing BPPV
- Characteristics:
  - Onset 1-10 seconds after movement
  - Symptoms last < 1 minute
  - Rotational eye movements which reverse upon sitting
  - Symptoms fatigue when repeat.
What is BPPV?
- #1 cause of dizziness in individuals over age 50.
- RARE in children
- Commonly follows head injury
- Often associated with other vestibular system insults
- AGE

Dix Hallpike Maneuver
- A: Dix Hallpike Right
  - Patient is seated with head turned 45 degrees to the right.
  - Gently lie down with head dropping slightly below level of the shoulders.
  - Monitor eye movements for 1 min.
- B: Dix Hallpike Left
  - Patient is seated with head turned 45 degrees to the left.
  - Gently lie down with head dropping slightly below level of the shoulders.
  - Monitor eye movements for 1 min.

Diagnosing BPPV

<table>
<thead>
<tr>
<th>Posterior/ Anterior Semicircular Canal BPPV</th>
<th>Right Torsion</th>
<th>Left Torsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up Beat</td>
<td>Right Posterior Canal</td>
<td>Left Posterior Canal</td>
</tr>
<tr>
<td>Down Beat</td>
<td>Right Anterior Canal</td>
<td>Left Anterior Canal</td>
</tr>
</tbody>
</table>

Horizontal Semicircular Canal BPPV Diagnosed by: Roll Test

<table>
<thead>
<tr>
<th>Head Right</th>
<th>Head Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canalolithiasis (geotropic)</td>
<td>Pure Horizontal Right Beat</td>
</tr>
<tr>
<td>Cupulolithiasis (ageotropic)</td>
<td>Pure Horizontal Left Beat</td>
</tr>
</tbody>
</table>

VNG: Caloric Testing
- This test is completed by delivering water irrigations to one ear at a time using either warm or cool water.
- Changes the temperature of the fluid within the vestibular system causing a change in pressure.
- This is the only exam that investigates one vestibular system at a time.

VNG: Caloric Testing
- The patient lies flat and water is delivered to one ear for 30 seconds.
- Eye movements are then monitored afterward.
- Direction of eye movement is dictated by the temperature of water.
- Pneumonic: COWS
- Cold Opposite / Warm Same
Rotary Chair
- Additional Exam of Peripheral Vestibular System
- Ear Canal Malformations
- Tubes
- Kids
- Adults

Posturography
- Functional Assessment: Not a Diagnosis
  - Vision
  - Vestibular
  - Somatosensory

Who is a candidate for VBRT?
- Symptoms vs Common Disorders
- Symptoms
  - Complaint of falls
  - Head motion provoked symptoms
  - Uncompensated
- Common Disorders
  - BPPV
  - Uncompensated stable lesion
  - Dysequilibrium of aging
  - Mild anxiety
  - Bilateral peripheral vestibular

Vestibular Rehabilitation Goals
- Exercise approach addressing motion sensitivity and postural stability
  - To decrease vertigo intensity or symptoms
  - To improve gaze stabilization and endurance to movement
  - To improve postural stability on multiple surfaces and visual situations
  - To improve overall function in multiple environments

Systems for Motion Sensitivity
- Vestibular
- Vision

Systems for Postural Stability
- Vestibular
- Vision
- Somatosensory
Diagnoses

Peripheral Vestibular Deficits
- Unilateral
- Bilateral
- Fluctuating
- Benign Paroxysmal Positional Vertigo (BPPV)

Central Deficits
- Vascular ischemia
- Diffuse damage
- Demyelinating disease
- Tumors
- Migraine

Exam - History
- Dizziness Handicap Inventory (DHI)
- Activities Specific Balance Confidence Scale (ABCs)
- Clear description of dizziness
- Identify any vestibular suppressant meds
- Activity level
- Home environment

Exam – System Screen
- Cardiopulmonary
- Musculoskeletal
- Neurological
- Vestibular
Systems Screen - Cardiopulmonary

- Differential diagnosis for lightheadedness
- Vertebral-basilar insufficiency

Systems Screen - Musculoskeletal

- Range of Motion
- Muscle Strength
- Pain
- Posture
  - Structural alignment and center of pressure
  - Muscle imbalance

Structural alignment

- Head forward
- Kyphosis
- Lumbar
- Hip flexion
- Knee flexion

Muscle Imbalance

- Cervical rotation (L)
- Shoulder abduction (A)
- Thoracic extension (B)
- Ant. humeral (C)

Systems Screen - Neurological

- Tactile and kinesthetic sensations
- Sensory organization
- Motor control strategies
- Postural Stability
  - Static
  - Dynamic (balance tests and LOS)

EquiTest (NeuroCom International)
Dynamic Posturography

1. Normal vision, Fixed support.
2. Absent vision, Fixed support.
3. Sway-referenced vision, Fixed support.
4. Normal vision, Sway-referenced support.
5. Absent vision, Sway-referenced support.
6. Sway-referenced vision & support.
Clinical Test of Sensory Interaction in Balance (CTSIB)

- Normal
- Normal
- Blindfold
- Dome

Foam

- Normal
- Blindfold
- Dome

Systems Screen - Vestibular

- Nystagmus check
- Oculomotor tracking
- Head Shake and head thrust
- Motion Sensitivity Test (MSQ)
- Dynamic visual acuity
- Dix-Hallpike
**Treatment by Diagnoses**

- Peripheral vestibular deficits
- Central deficits

**Peripheral Vestibular Deficits**

- Unilateral
- Bilateral
- Fluctuating
- Benign Paroxysmal Positional Vertigo (BPPV)
**Unilateral Vestibular Deficit Treatment**

- Habituation (head movement no target)
- Adaptation/Gaze stabilization (head and eye movements with target)
- Balance
- Conditioning

**Habituation Exercises**

- Repeated head or body movement in various planes of motion (H, V, Diagonal) without a visual target
- Encourage full range of head movement, vary speed, increase reps and sets for endurance
- Goal to fatigue out the response and encourage central compensation

**Adaptation Exercises**

- Use of head movement with a visual target to induce retinal slip to work VOR and encourage substitution strategies and vestibular adaptation
- Head movement with stationary visual target
- Head movement opposite dir of moving target
- Head movement at same speed and dir of target for VOR cancelation
- Vary distance of target, speed and complexity of background

**Bilateral Vestibular Deficits Treatment**

- Adaptation/Gaze stabilization
- Balance
- Sensory reorganization (optimize or compensate)
- Conditioning
- Patient education
- Compensatory needs

**Fluctuating Vestibular Deficits Treatment**

- Medical management
- Balance exercises
- Patient education
  - Self management for adaptation

**BPPV - Treatment**

- Canalith repositioning exercises
- Liberatory / Semont procedure
- Roll maneuver
- Brandt-Daroff exercises
Dix Hallpike Maneuver

A: Dix Hallpike Right
- Patient is seated with head turned 45 degrees to the right
- Gently lie down with head dropping slightly below level of the shoulders
- Monitor eye movements for 1 min.

B: Dix Hallpike Left
- Patient is seated with head turned 45 degrees to the left
- Gently lie down with head dropping slightly below level of the shoulders
- Monitor eye movements for 1 min.

Side Lying Maneuver

e11/2/2009

Epley - Left

Semont

Post Maneuver Instructions
- Don’t tip head down or bend at the waist for the rest of the day and night
- Sleep reclined at a 45 deg angle and do not lay on the affected side for 3-4 days
- Try movements or a hallpike the next morning to check for symptoms
- If symptoms persist further treatment may be necessary

Central Deficits
- Vascular ischemia
- Diffuse damage
- Demyelinating disease
- Tumors
Central Deficits Treatment

- Medical management
- Patient education
- Adaptation/Gaze stabilization
- Balance exercises
- Conditioning
- Compensatory measures

Outcomes

General conditioning speeds recovery!

- Most effective
  - Unilateral peripheral deficit
  - BPPV
- Functional improvement
  - Bilateral peripheral deficits
- Improved postural stability
  - Central deficits

Case #1 Case History

- 82 y.o. male
- Hx of fall from a ladder 1 year ago with resultant concussion and head injury
- Shuffling gait and dragging feet
- Back pain, bilateral knee replacements, hearing loss and broken right leg in 1980’s
- Macular degeneration with vision difficulties

Interpretation

- Does he have BPPV?
  - Yes, bilateral
- Any evidence of Peripheral Involvement?
  - No
- If so, is it compensated?
  - NO: disequilibrium
- Any evidence of Central Involvement?
  - No
- Any Recommendations?
  - VBRT

Musculoskeletal/Neurological

- Cervical rotation to right limited 50% all other extremities WFL for age
- Strength 5-to5/5 x 4
- Tactile WNL except radiating sciatic pain
- Sensory Organization with Mod CTSIB was WNL on all conditions, but nudge test showed 4-5 steps to free fall posterior on all conditions
Functional Testing
- Sitting balance on dynamic surface with significant difficulty drifting to left and inability to return to midline
- DGI 19/24 with difficulty with one leg stance activities, veering with head movement and inability to increase speed
- Was treated with Epley maneuver on left 2 days prior with no spinning or nystagmus now but imbalance

Home Program
- Amb with Horiz and Vertical Head movt with surface and lighting challenges
- Working on gradually larger and faster backward stepping 5-6 x on 1 leg at a time
- Work on the gym ball with supervision to increase ability to control hips and utilize trunk balance responses

2nd Visit 4 weeks later
- Has not performed maneuvers at home
- Patient c/o “faded and hazy vision”
- Persistent left BPPV subjective symptoms without nystagmus present
- Increased back pain which he may need to “go in for another injection”
- DGI up to 21/24 from 19/24 still min difficulty with head movt and stairs
- Computerized balance testing showed difficulty on RWS, LOS was WNL

Case #2 Case History
- 62 y/o female
- Acute onset room spinning dizziness worse with head movements
- Improving over the following 4-5 days
- Residual head motion sensitivity /imbalance
- No otologic or neurologic associations
- CT was completed and was WNL
Case #2
- Bedside: positive right head thrust
- All ocular motor testing was normal
- Left beating positional nystagmus

Case #2 Caloric

Musculoskeletal/Neurological
- Cervical ROM WNL but Motion symptoms with rotation bilaterally
- U/L extremities ROM WNL
- Hammer toes bilaterally with discomfort
- Gross mm strength 5/5 X4
- Tactile and Kinesthetic sensation WNL
- Sensory organization on Mod CTSIB Indep on all conditions and efficient stepping strategy within 1-3 steps

Functional Testing
- Balance in gait  DGI 18/24 with mild veer to right and difficulty with speed and head movement
- MST  MSQ=.88 in mild range with most difficulty with H and V head movement VOR x 1 5 reps 3/5 intensity
- Unable to perform DVA due to intensity of symptoms

Home Program
- H and V Habituation ex’s gradually increasing reps and speed
- VOR x 1 adaptation ex’s with increasing reps, speed and varying distance of target
- Heel and toe ex’s to improve A/P motor control
- Amb with H and V head movement for improved bal in gait with visual distraction
2\textsuperscript{nd} Visit 3 weeks later
- DGI up to 23/24 from 18/24
- Mod CTSIB with nudges with 1 step strategy instead of 3
- MSQ=0.1 down from .88
- VOR x1 less than 1/5 intensity from 3/5
- Tol comp GS test on the left at 131 deg/sec and 133 deg/sec the right
- Func feeling 95% better than last visit

Case #3: Case History
- 63 year old female
- Complaints of intermittent episodes of a sensation of swaying, described as a motion feeling with some difficulty going down stairs.
- Episodic: some days will be perfectly fine - other days she can tell in the morning when she gets up.
- Position change does not impact the dizziness.
- Mild left eustachian tube dysfunction

Case #3: Case History
- In 1995, she had an episode of dizziness that resolved in weeks.
- 2 years later: Complaint of chronic dizziness.
- She reports occasionally when leaning forward she has a sensation of imbalance.
- Seen by neurology and no reported diagnosis of problems found.

Case #3: Case History
- Bilateral aural fullness
- Normal MRI, normal carotid Doppler’s and neurology evaluation.
- Chronic dizziness with initial ENG 12 years ago showing right beating positional nystagmus
- VNG 3 years ago with no significant abnormalities
- Hearing within normal range
- Had laser surgery to right eye 5 weeks ago that started symptoms - Ophthalmologist states no eye problem
- Difficulty watching motion and reading

Case #3
- VNG: Normal
- Does she have BPPV?
  - NO
- Any evidence of Peripheral Involvement?
  - No
- Any evidence of Central Involvement?
  - No
- Any Recommendations?
  - VBRT
Musculoskeletal/Neurological
- ROM and extremity strength WNL
- Standing posture - BOS WNL, no sway and good alignment
- Tactile and kinesthetic sensation normal range
- Sensory Organization on mod CTSIB 3-4 steps on level self corrected and 3-4 steps to FF on uneven
- Computerized voluntary motor balance testing RWS was WNL, LOS with fall to back target and abnormal velocity scores

Functional Testing
- Balance in gait - DGI 22/24 with veering 1 ½ ft in path width with horizontal head movement
- Motion sensitivity test - MSQ = 0, VOR x 1 2/5
- Unable to perform DVA due to symptoms with repetition

Home Program
- Ambulation with horizontal and vertical head movement with surface and lighting challenges
- Gradually taking larger and faster steps backward
- Heel and toe standing on level and uneven surface
- Use of gym ball with progression of challenge
- VOR x 1 adaptation exercises for motion intolerance

Second visit 2 weeks later
- DGI up to 23/24
- Mod CTSIB independent on level and uneven surface within 2-3 steps on all conditions
- No fall on computerized LOS test, but still abnormal score on forward target range
- DVA at 85 degrees/second with static Snellen fraction of 20/15 and DVA at 20/20 bilaterally
- Symptoms due to increase speed, cervical range and repetition

Third visit 2 weeks later
- DGI 23/24
- Independent on mod CTSIB within 2 steps all conditions
- Computerized Gaze stabilization test found visual acuity accurate at 105 degrees/second on left and 75 degrees/second on the right
- VOR cancelation exercises started
Fourth visit 2 weeks later

- DGI 24/24
- LOS test within normal ranges
- Mod CTSIB within normal ranges
- Computerized Gaze stabilization accurate to 120 degrees/second bilaterally
- Significant change in motion tolerance and comfort in ADL's

Who is appropriate to refer for vestibular testing?

- Patients whose symptoms are:
  - Disruptive to daily life
  - Continuous
  - Peripheral/Central in nature

What are some common vestibular etiologies?

- BPPV
- Migraine
- Meniere’s disease
- Disequilibrium of aging
- Labyrinthitis
- Vestibular Neuritis
Symptoms
- Complaint of falls
- Head motion provoked symptoms
- Uncompensated

Common Disorders
- Bilateral peripheral vestibular
- BPPV
- Uncompensated stable lesion
- Dysequilibrium of aging
- Mild anxiety

Who is a good candidate for vestibular rehab?

What can you expect from vestibular rehab?
- To decrease vertigo intensity
- To improve gaze stabilization and endurance to movement
- To improve postural stability on multiple surfaces and visual situations
- To improve overall function in multiple environments

QUESTIONS??