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The Dizzy and Imbalanced Patient
Part I: Differential Diagnosis
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Part I Objectives

Given a patient with a complaint of dizziness and imbalance,
• Discuss the differential diagnostic process.
• Develop a list of differential diagnoses.
• Distinguish between common causes of dizziness.
• Discuss the mechanisms of postural control.
• Design an assessment of fall risk.
Requirements

• Knowledge base
  – Postural control: multi-system
  – Peripheral systems used for maintaining upright posture.
    • Vestibular function
  – Central postural control mechanisms
  – Cervical anatomy and biomechanics

• Pathologies to these systems

Requirements

• Exam and intervention skill:
  – Vestibular system
  – Balance and postural control
  – Cervical spine

• Thought process

Considerations

• Prevalence of dizziness and imbalance
• Problems with imbalance
  – Function
  – Falls
  – Sequelae of falling

• Associated costs
What Do I Do...

You work in a:
- Small outpatient practice,
- Large institution, in-patient acute care,
- Rehab facility,
  
  ...wherever...

And your patient has a complaint of...
  
  ...DIZZINESS...

Your Next Patient

Mary Ground is a 35 year old female who complains of headaches and dizziness as of 2 months ago. She isn’t sure what started it, but she was showing her young daughter how to twirl the baton, threw it up in the air, looked up to watch it, and when she looked down again she was dizzy to the point of nausea and vomiting. The symptoms have subsided somewhat, but are still aggravated by looking upwards. Her least symptomatic position is sitting in an armchair with her head supported.

Questions

• What are your hypotheses as to the possible origin of this woman’s problems?
• What do you know about her condition?
• What do you need to know in order to begin your examination and intervention?
What Are the First Steps?

• Create a list of possible or potential diagnoses that fit the history.

• Organize, augment, edit, rearrange the order using information that you gather.

Possible Causes of Dizziness

• CNS disease, tumors
• Cerebral concussion/contusion
• Cranial nerve VIII neuroma
• Vestibular neuritis
• Otitis media
• Labyrinthine disease
• Iatrogenic causes (drugs, surgery)
• Postural hypotension

Possible Causes of Dizziness

• Toxins
• Migraine
• Disease processes: metabolic, hematologic, cardiovascular
• Cervical spine dysfunction
• TMJ dysfunction
• Anxiety disorder
• Vertebrobasilar insufficiency (VBI)
TIM VaDeTuCoNe

- Trauma: TBI, cervicogenic dizziness, fistula, BPPV
- Inflammation, septic or aseptic: labyrinthitis
- Metabolic: meds, toxin exposure
- Vascular: VBI; orthostatic hypotension
- Degenerative: BPPV; TMJ
- Tumor: acoustic neuroma, brain tumor
- Congenital: fistula
- Neurogenic: psychiatric disorders (anxiety), migraines

I’ve Begun a Diagnosis List...

- I’ve organized it:
  - It’s a wide list, encompassing all possible systems and processes.
  - It’s a deep list, with several diagnoses in each category.
- Now what do I do?

Narrow the List Down...

The Differential Diagnostic Process
Differential Diagnostic Process

**step one**

Decide if therapy is the appropriate management.

- Independent intervention appropriate
- Consult required
- Therapy is NOT appropriate, referral required
  - Call 911?

Differential Diagnosis: Red Flags

- Signs of
  - Systemic diseases
  - Infectious processes
  - Vascular causes
- Central nervous system
  - New onset or undiagnosed
  - Changing neurologic status

Red Flags

- Headache?
  - Unremitting, severe, first time
- Head is not firmly attached to neck
  - Ligamentous instability
  - Fractures ruled out
- Psychiatric: anxiety disorders
- Vestibular disorders not appropriate for therapy
  - Undiagnosed central causes
  - Peripheral causes
    - Tumor: acoustic neuroma
    - Fistula
Serious Cause of Dizziness?

**Benign**
- Vertigo or vomiting combined with (+) Hallpike
  - 85% PPV, 7.6 +LR
- Age ≤ 69, (-) neuro deficits, and/or vertigo
  - 88% NPV, -LR 0.3 for serious pathology

**Serious (refer)**
- Age > 69, (+) neuro deficits, and/or NO vertigo
  - 40% PPV, +LR 1.5 for serious pathology


---

Question:

I think the patient is appropriate for me...
Now what?

?  

---

Differential Diagnostic Process

step two

- Differentiate between **central** and **peripheral** vestibular disorders.
Central Vestibular Disorder Examples

- CVA
- TIA
- MS
- Head injury
- Tumor
- Migraine

If neurologic condition is undiagnosed (unexplained, new onset) or changing:

Refer Out!

Peripheral Vestibular Loss: Examples

- Trauma: fistula, BPPV
- Inflammation, septic or aseptic: labyrinthitis, acoustic neuronitis, episodic vertigo: Ménière's disease
- Metabolic: toxin exposure (ototoxicity), drug-induced
- Vascular
- Degenerative: BPPV
- Tumor: acoustic neuroma
- Congenital: fistula
- Neurogenic: neuritis

Types of Dizziness

- 65%
- 13%
- 9%
- 5%
- 8%

Dizziness Prevalence

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<tr>
<th>Diagnosis</th>
<th>Freq (%)</th>
<th>Source</th>
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<tr>
<td>BPPV</td>
<td>18.3</td>
<td>Brandt and Steddin, 1993</td>
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<td>Pseudobulbar vertigo (PVP)</td>
<td>15.0</td>
<td>Brandt, 1996</td>
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<td>Central vestibular disorders</td>
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<td>Brandt and Dieterich, 1994a</td>
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<td>Vestibular migraine</td>
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<td>Dieterich and Brandt, 1999; Neuhauser et al., 2001</td>
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<td>Vestibular neuritis</td>
<td>7.8</td>
<td>Brandt, 2002</td>
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<tr>
<td>Ménière’s disease</td>
<td>7.8</td>
<td>James and Thorp, 2001</td>
</tr>
<tr>
<td>Bilateral vestibulopathy</td>
<td>3.6</td>
<td>Finner et al, 1996</td>
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<tr>
<td>Psychogenic vertigo (w/o PVP)</td>
<td>3.6</td>
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<tr>
<td>Vestibular paroxysmia</td>
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<td>Jannetta et al, 1984; Brandt and Dieterich, 1994b</td>
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<tr>
<td>Perilymph fistula or superior canal dehiscence syndrome</td>
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<td>Minor et al, 1998</td>
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<tr>
<td>Various other disorders</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td>Unknown etiology</td>
<td>4.2</td>
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</tbody>
</table>

Brandt 2005.

Prevalence of Vestibular Disorders

Central vs. Peripheral: Why Make the Distinction?

**Central**
- Slower progress
- Perhaps smaller gains
- Sign of more significant problems

**Peripheral**
- Faster progress
- Good to full resolution
- Unilateral vs. bilateral
Differential Diagnosis

**central vestibular disorder**

- Nystagmus: resting, vertical, gaze-evoked
- Abnormal oculomotor tests
  - Smooth pursuit, saccades, VOR cancellation
- Signs of CNS disorder, e.g., UMN signs
- Constant vertigo

Differential Diagnosis

**peripheral vestibular disorder**

- No resting nystagmus (unless acute)
  - Position/movement provoked
- Good smooth pursuit
- No UMN signs
- Transient dizziness
- Positive passive head shake, head thrust, etc.

Videonystagmography (VNG)
Nystagmus

• Rapid eye movements
• Horizontal and vertical
  — Direction of nystagmus named by fast phase
• Generally, fast phase is away from affected side in peripheral vestibular loss of function or hypofunction.

Rotatory Nystagmus

• A.K.A., torsional
• Direction of nystagmus named by top of eye.

Contrast Nystagmus With Saccades

• Rapid eye movements to a target
• Allows us to fix gaze on a target
• Voluntary
• Normal
  — No overshoot of target
  — 2 or less eye movements to get to target
Abnormal Saccades

Rather than go directly to the object, eyes will:

- Overshoot
- > 2 eye movements

See the next two slides for video examples.
Smooth Pursuit

- Allows tracking
- Slower speed of movement
- Centrally driven
- Uses a different system than saccades.

Nystagmus

- Central
  - Pure vertical
  - Resting (spontaneous)
  - Gaze-evoked
- Peripheral
  - Vertical plus rotational (torsion)
  - Vertical canals
  - Pure horizontal
  - Horizontal canals

Differential Diagnosis

- If it isn’t central or peripheral, consider cervicogenic dizziness.

- Cervicogenic dizziness is a diagnosis of exclusion.
**Patient 1: Jim Nasium**

- History of cervical pain or trauma (e.g., whiplash injury)?
- Consider cervical origin of dizziness:
  - a.k.a., Cervical vertigo, whiplash vertigo
  - Common term in European literature and clinics.
- More recently: **cervicogenic dizziness**
  - Note: strictly speaking not a diagnosis, like low back pain, shoulder pain.

**History of Cervical Pain or Trauma (e.g., Whiplash Injury)?**

- These patients may come to you via:
  - PCP/GP/FP, orthopedist
  - Direct access
- If there is a concomitant complaint of dizziness...
  
  **Workup is required!**

**Patient 2: Ida Know**

- History of peripheral disorder?
- Cervical impairments are a common finding in vertigo, dizzy, dysequilibrium patients.
  - i.e., patients referred with a primary diagnosis of a vestibular problem often have C-spine impairments!
Summary of Thought Process for Patients Presenting With Dizziness

- Appropriate for therapy?
- Central: CNS disorders
- Peripheral: vestibular
  - Benign paroxysmal positional vertigo (BPPV)
  - Trauma to vestibular apparatus
  - Episodic vertigo (e.g., Ménière’s disease)
  - Unilateral, bilateral vestibular dysfunction
- Cervical: Cervicogenic dizziness

Postural Control

Mechanisms of Balance
Origins of Impairments
Common Diagnoses

Dynamic Equilibrium

Sensory organization
  - Determination of Body Position
    - Compare, Select & Combine Senses
      - Visual System
      - Vestibular System
      - Somatosensation
  - Interaction with the Environment

Motor coordination
  - Choice of Body Movement
    - Select & Adjust Muscle Contractile Patterns
      - Ankle Muscles
      - Thigh Muscles
      - Trunk Muscles
  - Generation of Body Movement

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Required for Postural Control

Input
sensory
information

Motor
response
output

Predict
process

Sensory Organization

Determination of Body Position

Compare, Select & Combine Senses

Visual System
Vestibular System
Somato-Sensation
Interaction with the Environment

Motor Coordination

Choice of Body Movement

Select & Adjust Muscle Contractile Patterns

Ankle Muscles
Thigh Muscles
Trunk Muscles

Generation of Body Movement
Sensory Environment

The conditions which exist (or are perceived to exist) in the real world around us which impact balance.

Interaction with the Environment

Visual System
Vestibular System
Somato-Sensation

Vestibular Input

- Provides information on head movement.
  - Speed
  - Direction
  - Acceleration
- Position of head in reference to gravity.
- Loss can be unilateral or bilateral.
- Examples: BPPV, Ménière’s disease, labyrinthitis, ototoxic vestibular loss.

Darkness, crowds
Gravity, linear and angular head movement
Sandy beach, woods, icy surface
**Benign Paroxysmal Positional Vertigo (BPPV)**

- Most common cause of peripheral vestibular vertigo (up to 66%).
- Loose crystals (otoconia) in the semicircular canals: canalithiasis.
  - Crystals move with change of position due to gravity: sensation of movement.
- Otoconia adhere to the cupula: cupulolithiasis.
  - Cupula becomes a gravity detector.
Typical Patient Presentation

- **Onset:**
  - Trauma to head knocks crystals loose.
  - Insidious: “I woke up one morning, sat up and got really dizzy. All I could do was lie down.”

- **Aggravating factors:**
  - “Every time I turn over in bed to the [left/right], I get dizzy.”

- **Short duration, although patient usually gets out of the provocative position.**
  - “The dizziness went away after a few minutes, but when I got up I got dizzy again.”
Nystagmus With Left Hallpike

- What do you see?
  - Duration
  - Direction
- What is your diagnosis?

Ménière’s Disease

- Recurrent episodes of vertigo, hearing loss, tinnitus or aural fullness.
- Caused by increased volume of endolymph.
- Time course: hours.
- Provoking factors: spontaneous.
- Repeated episodes differentiates from acute vestibular loss.

Labyrinthitis

- Acute onset of vertigo, tinnitus.
- Infection (viral) of labyrinth.
- Time course: hours.
- Provoking factors: spontaneous onset; changes in head position.
Ototoxic Vestibular Loss

- Side effect of certain medications (gentamicin).
- Bilateral loss of labyrinth function.
  - If equally affected, no complaint of dizziness.
- Loss of balance.
- Provoking factors: eyes closed, dark environment.

The Vestibular System

Normal Vestibular Function
Normal Vestibular Function

- Resting firing rate of ~100Hz.
- Left increased, right decreased firing rate; gaze fixed ahead.
- Right increased, left decreased firing rate; gaze fixed ahead.

Head-Eye Coordination: VOR

- Vestibulo-ocular reflex.
- Goal: stabilize image on retina.
  - Example: head movements while walking or chewing.
- Very fast system.
- Mediated by vestibular system.
- Abnormal VOR suggests vestibular system involvement.

VOR Cancellation

- If eyes are open and patient can fix his/her gaze, nystagmus can be suppressed.
- Rotate patient with gaze fixed: nystagmus should be suppressed.
  - If NOT: CENTRAL SIGN.
Oscillopsia

- Movement of the visual field.
- Caused by poor coordination between head and eye movements.
- Controlled by VOR.
- *If you hear the patient say “I see double,” suspect a poor VOR, and add peripheral vestibular problems to your diagnosis list.*

Vestibular Function Assessment:
Electronystagmography (ENG)

- Electronystagmography (ENG)
  - Tests which use electrodes to measure eye movements, relative to head movements.
- Videonystagmography
  - Uses infrared cameras to capture eye movements.
- Includes
  - Rotating chair
  - Calorics
  - Vestibular Autorotation Test (VAT)

Vestibular Function Assessment

- Electronystagmography (ENG)
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Rotary Chair Test

The Vestibular System

Ampulla
Normal Vestibular Function

- Resting firing rate of ~100Hz
- Left increased, right decreased firing rate; gaze fixed ahead
- Right increased, left decreased firing rate; gaze fixed ahead

Rotary Chair: Normal Vestibular Function

- Head turns, eyes stay on target (slow eye movement)
- Head turns further, eyes stay on target
- New target acquired (fast eye movement)

Vestibular Function Assessment

calorics

- How the test works:
  - Warm and cold applied into the external auditory meatus.
  - Stimulate the horizontal canal.
  - Measure resultant eye movements.
  - Look for asymmetry in response.

- Advantages
  - Test each ear separately, identify which side is problematic.

- Disadvantages
  - Only HSC.
  - Slow speeds.
  - Reliability issues.
Vestibular Function Assessment

vestibular autorotation test

• How the test works:
  – Head moves to metronome with eyes fixed on target
  – Speed increases from 2 to 6 Hz
  – Compare eye to head movements

• Advantages
  – Faster speeds
  – Vertical head movements

VAT Sample Tracing

VAT Graphs
Peripheral Input
visual
• Maintains visual stability.
• Maintains visual alignment.
• Strong inhibitor of other systems.
• Closing eyes releases inhibition.
• Examples
  – Standing by a bus and the bus moves.

Peripheral Input
somatosensory
• Proprioception, pressure, touch, stretch, etc.
• Provides information on body part position.
  – In space.
  – In relation to other body parts.
• Examples
Central Mechanisms

- Processing of information gathered peripherally.
- Decisions made on what information to use.
- Appropriate efferent responses made.
- Goal: maintain alignment.

Central Mechanisms

neural plasticity

- Allows for the capability to adapt.
- Distributed processing.
  - Key areas are vestibular nucleus, cerebellum.
- Therefore, other areas of brain can compensate for damage in CNS.
- Examples

Central Mechanisms

neural plasticity

- VOR Gain = eye velocity/head velocity.
  
  - Can be adapted up to 2.0, down to 0.5.
  - Occurs in the cerebellar flocculus.
Why Problems Occur

• Normal function
• We assume:
  – Surface (the earth) is stable.
  – Visual cues are more important.
  – Gravity is constant.
• Problems arise with conflicting input.

Why Problems Occur

• Assumptions typically made are not valid.
  – Surface is not stable.
  • On a boat.
  – Visual cues are invalid.
  • Standing next to a moving bus.
  – Acceleration due to gravity is not constant.
  • Carnival rides.

Why Problems Occur

• Information from periphery is not valid.
• Decreased proprioception.
  – Ankle sprain
  – Peripheral neuropathy
• Damage to the vestibular system.
  – Vestibular loss
  – Brain injury
Imbalance in the Elderly

Key Examinations
Significance of Findings

Topics of Discussion

• Postural control mechanisms
• The problem of imbalance in the elderly
• Are falls a normal part of aging?
• Evidence-based balance and fall risk assessment
• Risk factors for falling
Facts to Ponder (2007)

- 65+: Falls a leading cause of injury-related mortality.
- $43.8 million spent treating fall injuries.
- 20% of those who fall have moderate to severe injuries.
- 3 of 4 in nursing homes fall each year.
- 25% of falls attributed to weakness or gait problems.

Are Falls a Normal Part of Aging?

- Small proportion maintain good postural stability well into advanced age.
- Many different patterns of falls and postural control difficulties.
- Pathology, or “normal” aging?
- Result of sub-clinical pathology affecting multiple components.

Effects of Age on Postural Control

Effects of Age on Postural Control

- Normal
- Pathology 1
- Pathology 2
- Postural Instability
- Normal Age


Multifactorial Approach to Reducing Injurious Falls


- Falls are due to multiple risk factors.
- Intervening in each risk factor reduces the risk of falls.

Risk Factors for Falling

- Postural hypotension.
- Use of sedatives.
- Use of at least four prescription medications.
- Impairment in:
  - Arm or leg strength, or range of motion.
  - Balance
  - Transfer skills: bed to chair, bathtub or toilet.
  - Gait
Multifactorial Risk Factor Intervention

Assessment of Fall Risk

- Are there tests that can be used to identify those persons who may be at risk for a fall?
- If so, they should be:
  - Easy to administer
  - Reliable
  - Valid
  - Specific
  - Sensitive

Specificity and Sensitivity

- SpPIn
  - If the Specificity of a test is high, then if the test is Positive, you can rule the condition In.

- SnNOuT
  - If the Sensitivity of a test is high, then if the test is Negative, you can rule the condition Out.
Rhomberg Test

- Stand with your eyes closed, feet together.
- Identifies those who cannot stand with their feet together and their eyes closed.
- Reliable, but not functional.
- Does not accurately identify patients with vestibular deficits.
  - False negatives with vestibular disorders: Low specificity.
- Not age-sensitive: not all older adults have difficulty.

Sharpened Rhomberg Test

- Heel-toe position, eyes closed x 60 sec.
- Very difficult for older adults.
- Not predictive of falls.
- Distinguish normal from vestibular patient: r=0.837.
- Part of Berg Balance Scale.

Berg Balance Scale

- 14 item test, score from 0 (unable) to 4, total 56 points.
  - Each item’s scoring criteria well defined.
- Non-fallers ≥ 45, fallers < 45.
Berg Balance Scale

- **Function:**
  - Transfers, sit to stand, stand to sit, sit unsupported.

- **Stand:**
  - Unsupported, feet together, step stance, on one foot, eyes closed, add twist.

- **Mobility:**
  - Arm reach, pick up object off ground, turn 360°, stepping.

Berg Balance Scale usefulness

- Reliable intra-, inter-rater (Berg et al, 1995)
- Low sensitivity: Does not accurately identify those who fall (53%).
- High specificity: Accurately identifies those who have a low fall risk (96%).
- Probably more useful as an assessment of function than fall risk.

Single Leg Stance (SLS) and Falls Risk

- Used a SLS time of 30 sec to separate those who fell from those who did not.
- Yielded a sensitivity of 95% and a specificity of 58%.
- Thus can rule out fallers (SnNOut), but not rule in fallers (SpPIn).

**Timed “Up & Go”**

- Patient stands, walks 10 feet (3 meters), turns, walks back and sits down.
- < 20 sec: Independent ADL transfers, higher Berg balance scores, faster gait speed.
- > 30 sec: Patient will have significant difficulties in ADL and assisted mobility.
- Useful in predicting falls?

**Timed “Up & Go” and Falls**

- Community dwelling older adults, fallers and non-fallers.
- Sensitive (87%) and specific (87%) for identifying elderly prone to falls.
- Non-fallers: < 10 sec, fallers: > 22 sec.
- Fall prediction: >14 sec predicted 90% of fallers.


**Functional Reach Test**

- Forward Reach - Normal Reach = Functional Reach
- A functional reach score of less than 14 cm = high risk of falling

<table>
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<tr>
<th>Distance reached (cm)</th>
<th>Relative risk for falls</th>
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<tbody>
<tr>
<td>Unwilling to reach</td>
<td>8 times more likely</td>
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<tr>
<td>1-13</td>
<td>4 times more likely</td>
</tr>
<tr>
<td>14-24</td>
<td>2 times more likely</td>
</tr>
<tr>
<td>&gt; 25</td>
<td>Not likely to fall</td>
</tr>
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</table>

Duncan et al. / Gerontology, 1992;47/M93-7.
Dynamic Gait Index (DGI)

- Eight item test, four point scale.
- Level surface, change in speed, with head movements, with pivot-turn, step over and around obstacle, stairs.
- Moderate reliability (r=.6)
- Score of 19 or less (out of 24) were 2.6 times more likely to have at least one self-reported fall in past 6 months.

Assessment: CTSIB

- Classic test for sensory integration and balance.
- Utilizes six different sensory conditions to selectively test each of the three systems:
  - Vestibular
  - Visual
  - Somatosensory

Assessment: CTSIB

- Eyes open, firm surface.
- Eyes closed, firm surface.
- Eyes open, firm surface, sway referenced vision.
Assessment: CTSIB

• Eyes open, sway referenced surface.
• Eyes closed, sway referenced surface.
• Eyes open, sway referenced surface, sway referenced vision.

Assessment: CTSIB: Modified

• Usefulness of dome (conditions 3 and 6) in question.
• Therefore, only 1, 2, 4 and 5 are routinely done.
• Fall on 5: Vestibular dysfunction.
  – Vision and somatosensation are reduced.
• Fall on 4 and 5: Surface-dependent.

Assessment: CTSIB

• Which system(s) work well?
• Which system(s) are impaired?
• Under what functional conditions is the patient at risk?
• Provides direction for treatment.
• Screening tool to suggest further work-up.
• Portable.
Assessment: CTSIB

disadvantages

• Middle performances not well scored.
  – Fall or no fall.
  – How to document “increased sway?”
• Documentation of progress?
• Standing balance only.

Computerized Dynamic Posturography

• Sensory organization test
  – Measures balance performance under varying sensory conditions.
• Motor control test
  – Platform perturbations.
  – Measure motor response times, forces.

Identifying People at High Risk for Falls

5 questions to assess risk:
• Previous fall last year?
• On more than four medications?
• History or current stroke, or Parkinson’s disease?
• Unconfident in balance?
• Unable to rise from low chair without using arms?

Review of Thought Process for Patients Presenting With Dizziness

- Develop a differential diagnosis list.
- Appropriate for therapy?
- Central: CNS disorders.
- Peripheral: Vestibular
  - Benign paroxysmal positional vertigo (BPPV)
  - Unilateral, bilateral vestibular dysfunction (labyrinthitis, neuronitis, ototoxic vestibular loss)
  - Trauma to vestibular apparatus (fistula)
  - Episodic vertigo (e.g., Ménière's disease)
- Cervical: Cervicogenic dizziness

End of Part I

For more information on live hands-on courses on Vestibular Rehabilitation and Fall Prevention, visit www.skillworks.biz.