

# Neuro-Otology: Diagnosis and Management of Dizziness

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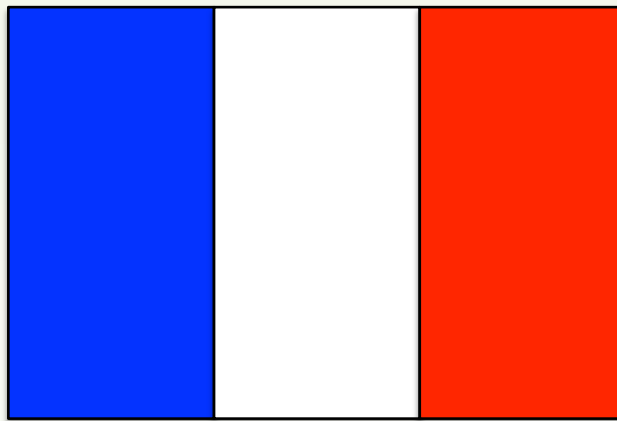
Reviewed by Dr. Suresh Subramaniam

CLINICAL  
**NEURO**  
SCIENCES  
CALGARY + CANADA



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Prosper Ménière  
(1799 - 1862)



# Objectives

- What is dizziness?
- Anatomy of hearing and balance
- Approach to history and physical examination
- Distinguishing central vs. peripheral causes
- Investigations and treatment



# Dizzy

*Adjective* | diz•zy | \ˈdi-zē\

:having a whirling sensation in the head with a tendency to fall

:mentally confused

# In medicine, dizziness can mean...

- Spinning
- Vertigo
- Lightheadedness
- Presyncope
- Imbalance
- Visual distortion
- Disorientation
- Anxiety
- Hearing loss
- Tinnitus



# Possible Etiologies

**Peripheral:** BPPV, Meniere's disease, vestibular neuritis, vestibular paroxysmia, perilymph fistula, superior canal dehiscence, otosclerosis, immune related (Cogan syndrome, sarcoidosis, lymphoma, carcinomatous meningitis), structural (acoustic neuroma, vestibular schwannoma), infectious (meningitis, bacterial/fungal, syphilitic labyrinthitis), trauma (labyrinth concussion), vestibular toxicity (gentamicin).

**Central:** stroke, TIA, MS, epilepsy, migraine, demyelinating disease, tumor, neurodegenerative disorders, rotational vertebral artery syndrome, familial ataxia syndromes, familial bilateral vestibulopathy, familial hemiplegic migraine, posterior fossa structural abnormalities (glioma, Chiari formation, AVM, cavernoma)

**Other:** orthostatic hypotension, irregular heart rhythm, OA, poor vision



# Common Etiologies

- Peripheral vestibular dysfunction (40%)
- Central brainstem vestibular lesion (10%)
- Psychiatric disorder (15%)
- Other i.e. presyncope, disequilibrium (25%)





# Epidemiology

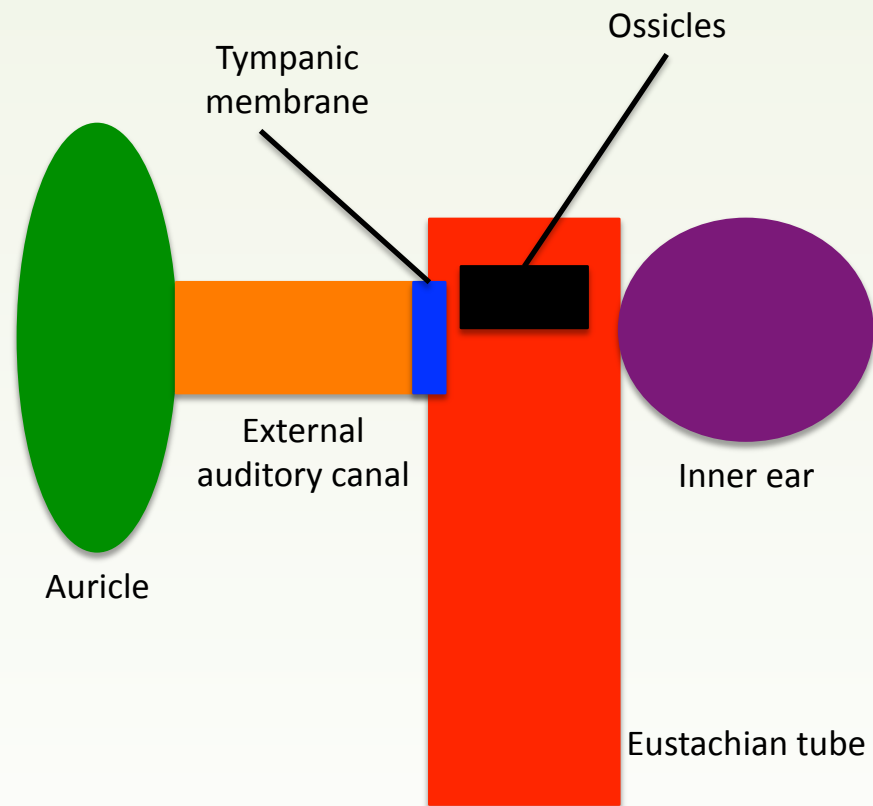
- 30% of population has experienced moderate to severe dizziness (Neuhaser et al. 2005)
  - 25% of these patients had true vertigo
- More common amongst elderly and females
- Large impact on healthcare!
  - 80% of dizzy patients seek medical care at some point



# Ear

- Organ of hearing and balance
- Three parts:
  1. External ear → auricle and external canal
  2. Middle ear → cavity in the petrous part of the temporal bone; connected to pharynx
  3. Internal ear → series of cavities in the petrous part of the temporal bone between middle ear and acoustic meatus





# Middle ear

- Transmits vibrations from the tympanic membrane to the inner ear
  - Tympanic membrane → malleus → incus → stapes
- Communicates with mastoid posteriorly and pharynx anteriorly



# Inner ear

- Bony labyrinth: lined with periosteum and contains perilymph fluid
  - Vestibule
  - 3 semicircular canals
  - Cochlea
- Membranous labyrinth: continuous system of ducts and sacs that is suspended within the bony labyrinth and contains endolymph
  - Semicircular ducts
  - Cochlear ducts
  - Utricle and saccule (sacs)



## Hearing:

- Cochlear duct
  - Auditory ossicles convert airborne waves from tympanic membrane to fluid waves in cochlea that stimulate receptor cells

## Balance:

### “Vestibular apparatus”

- Semicircular ducts respond to movement in the plane of their anatomical axis
  - Horizontal: “no-no”
  - Anterior: lateral tilting
  - Posterior: “yes-yes”
- Utricle → responds to centrifugal and vertical acceleration
- Sacculle → responds to linear acceleration



# Vestibulocochlear nerve [VIII]

- Special sensory afferent nerve
- Carries afferent fibers
  - Cochlear division → hearing
  - Vestibular division → balance
- Exits temporal bone via internal acoustic meatus  
→ crosses posterior cranial fossa → enters lateral brainstem between pons and medulla
- Fibers either synapse on the Vestibular nuclei or form the Vestibulocerebellar tract and directly enter the cerebellum



# Vestibular nuclei

- Located in the rostral medulla and caudal pons
  - Four nuclei:
    1. Lateral
    2. Inferior
    3. Medial
    4. Superior
- } Input: mainly utricle and saccule
- } Input: mainly semicircular canals
- Also receive afferent input from cerebellum, spinal cord, and reticular formation
  - Form connections with cerebellum, spinal cord, oculomotor system, and cortex





# Goals of our evaluation

**#1** Define dizziness

**#2** Rule out common peripheral vestibular causes

**#3** Consider neurological central causes



# History

## 1. Define the symptoms

If patient unable, then classify the symptoms as either:

1. Vertigo
2. Lightheadedness
3. Strictly imbalance (no head symptoms)

## 2. Complete a full history for the symptoms

## 3. Determine other details

1. Constant vs. episodic? If episodic, duration and frequency?
2. Accompanying symptoms?
3. How did it begin?
4. Aggravating and alleviating factors?
5. Triggers?



# Vestibular dysfunction

Manifestations include:

- Vertigo
- Oscillopsia
- Nausea/vomiting
- Nystagamus
- Past pointing
- Lateropulsion



# General Medical Exam

- Vitals
  - Especially orthostatic BP
- Cardiac
  - Rule out arrhythmia
- Pulmonary
- Abdominal
- MSK
  - Arthritis can impair gait



# Vestibular Physiology



# General Neurological Exam

- Mental Status and language
- Cranial nerves
  - Important to rule out central causes
  - Nystagamus
  - EOM
  - VA and dynamic VA
- Motor
  - Bulk, tone, strength, reflexes
- Sensation
  - Pinprick, temperature, vibration, proprioception
- Coordination
  - Finger-nose, heel-shin, RAMs looking for past-pointing and incoordination
- Gait and Romberg
  - Tandem gait, Fukuda stepping test



# Neuro-otological Exam

## 1. Vestibulospinal reflexes

- Past pointing
- Romberg
- Fukuda Stepping test

## 2. Vestibulo-ocular reflexes

- Oculocephalic (Doll's eyes) → performed slowly in a comatose patient
- Head impulse → performed quickly in an awake patient
- Dynamic VA
- Caloric testing (cold water stuns tonic activity from labyrinth on irrigated side)

## 3. Nystagamus



# Dix-Hallpike Maneuver

- Performed by turning head 45 degrees then moving patient from upright position to supine with head slightly extended
- Positive if up-beating and rotational nystagamus toward ear that is down
  - Diagnostic of posterior canal BPPV
  - Nystagamus usually lasts <60 seconds and can fatigue
  - Usually <15 second latency before nystagamus is seen
- Estimated sensitivity 79% and specificity 75%



Please refer to Youtube for videos  
demonstrating nystagamus and the Dix-  
Hallpike Maneuver

# HINTS EXAM

- **HINTS** includes:
  - Head Impulse
  - Nystagamus (direction changing in eccentric gaze)
  - Test of Skew (vertical ocular misalignment)
- Normal head impulse with presence of direction-changing nystagamus and skew deviation is suggestive of stroke with 100% sensitivity and 96% specificity
- Better than MRI with DWI for ruling out stroke in first 24-48 hours after symptom onset
- Early MRI was falsely negative in 12% of strokes when performed within 48 hours of symptom onset

# Physical Exam Review

Washington University recommends 6 specific tests for vestibular dysfunction on physical exam:

1. Spontaneous and gaze-evoked nystagamus
2. Extra-ocular movements
3. Vestibulo-ocular reflexes
4. Dix-Hallpike maneuver
5. Limb coordination
6. Gait and Romberg

# Investigations

- Tailor to the presumed underlying diagnosis
  - Electronystagmography
  - Rotary chair testing
  - Posturography
- Useful to identify central causes such as stroke
- Otherwise BPPV, Meniere's disease, and Vestibular neuritis do not have identifiable imaging characteristics



# Central vs. Peripheral

	Central	Peripheral
<b>Vertigo</b>	Less severe	Associated n/v
<b>Nystagamus</b>	Changes directions and NOT affected by fixation	Does NOT change directions, fatigable, latency to onset, affected by compensatory mechanisms
<b>Presentation</b>	Severe imbalance, other neurological or brainstem signs common	Associated hearing loss, aural symptoms, autonomic signs



# Treatment

## Specific

vs.

## Symptomatic

- a) BPPV → Dix-Hallpike to diagnosis and Epley to treat. Avoid head hanging activities.
- b) Meniere's → Low salt diet and diuretics. May try intratympanic gentamicin injection. May try labyrinth or vestibular nerve surgical ablation.
- c) Vestibular neuritis → Symptomatic treatment and vestibular rehabilitation.

<b>Antihistamines</b>	Dimenhydrinate 50 mg q4h Diphenhydramine 50 mg q4h Meclizine 50 mg q6h Betahistine 24 mg bid
<b>Anticholinergics</b>	Scopolamine patch or SC
<b>Benzodiazepines</b>	Lorazepam 1-2 mg q8h Diazepam 5-10 mg q12h
<b>Benzamide</b>	Metoclopramide 10 mg q6h
<b>Phenothiazine</b>	Prochlorperazine 10 mg q6h

# Case #1

86 yo F develops acute onset room spinning around her upon standing up out of bed in the morning. Symptoms last 30 seconds then resolved but continue to occur every morning when standing up out of bed.

**BPPV**



# Benign Paroxysmal Positional Vertigo

- Inner ear condition characterized by vertigo when head is moved relative to gravity
- Otoliths break free from saccule/utricle, settle in semicircular canals, then move and stimulate hair cells
- Diagnosis: Dix-Hallpike
- Treatment: Epley maneuver or vestibular rehabilitation
  - Medications recommended for use prior to using particle repositioning maneuvers such as antihistamine or anti-emetic
  - Betahistine 24 mg bid x 1 week





## Case #2

40 yo M develops warm, full sensation in the right ear. Also mentions ringing in his ears. Occasionally he has associated hearing loss vertigo lasting up to 1 day that can be triggered by salty foods.

## **Meniere's disease**



# Meniere's disease

- Estimated incidence 10-1500 per 100,000
- Bilateral disease can occur in up to half of patients
- Endolymphatic hydrops distend the membranes of the labyrinth
  - Unclear why this fluid build up occurs
- Audiometry important to assess for hearing loss
- Treatment
  - Lifestyle: avoid triggers (salt <2g per day, alcohol, caffeine, nicotine),
  - Medications: Antihistamines, anticholinergics, or benzodiazepines for symptomatic treatment
  - Rehabilitation
  - Interventional therapies for refractory cases: intratympanic gentamicin, labyrinthectomy, vestibular neurectomy, surgical endolymphatic decompression



# Fun Fact!

Individuals affected by Meniere's disease:

- Emily Dickinson
- Kristin Chenoweth
- Alan B. Shepard
- Jonathan Swift
- Dana White
- Vincent Van Gogh



## Case #3

72 yo M with HTN, T2DM, and dyslipidemia presents with acute onset vertigo that has not resolved since starting. Also limb ataxia and dysarthria.

**Stroke (central cause)**



# Stroke

- Likely vertebrobasilar stroke
- Perform HINTS exam
  - Would expect normal head impulse test but gaze-evoked nystagamus in all directions and skew deviation
- Obtain urgent CT/CTA!



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