

# Vertigo In the Orthopedic Setting

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# Disclosure of Conflict of Interest

I have no conflicts of interest to disclose.

# Learning Objectives

1. Be able to explain anatomy and mechanisms of simple vertigo in patient friendly terminology
2. Review differential diagnosis of presentations of dizziness common in an orthopedic setting
3. Recognize when emergency referral is warranted
4. Review diagnostic tests and treatments for BPPV

# Key take-aways

- This course covers:
  - Basic background of BPPV
  - Vestibular anatomy review
  - Tips for DDx of Dizziness
  - Treatment interventions for simple types of BPPV
- Does not cover:
  - Extensive dive into central neuroanatomy involved with vestibular system
  - Discussion on cupulolithiasis / complex types of BPPV
  - Interventions for non-BPPV related dizziness diagnoses

# Defining terms

**Disequilibrium** – Feeling off balance, wobbly, “drunken”

**Vertigo** – Sensation or perception of movement / spinning

**Lightheadedness** – Vague symptoms of dizziness; may be related to the environment

**Pre-syncope** – Sensation of passing out or losing consciousness

**Labyrinth** – The structural inner ear

**Canalith / Otolith** - “Ear Rock” or “Ear Crystal”; fragments of calcium carbonate, which are anchored to a sticky membrane in your inner ear

**Nystagmus** – Hallmark sign of vestibular dysfunction; Rapid eye movements, may be spontaneous, or triggered by a change in position of the head

But I'm an Orthopedic provider, why does  
this matter to me?

# Dizziness is very common (Post et al. 2010)



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- Accounts for 3-5% of all primary care visits
- Approximately 3% of all ED visits
- 78-80% of head/neck trauma include dizziness

# BPPV Impact (Kim et al., 2021)

- 2.4% lifetime prevalence
- 24% of all hospital visits for dizziness
- 15-20% recurrence rate annually
- Cost \$2000 / diagnosis in the US
- Healthcare burden in USA approx. \$2 billion / year



# Impacts on quality of life (Liao et al., 2015)

- Impacts balance, increasing likelihood of falls
- Reduces confidence with balance, and increases movement-related fear/avoidance strategies
- Associated with higher rate of fractures in elderly after controlling for other co-morbidities



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# BPPV can be fixed, quickly

- “The only thing we can CURE with physical therapy”
- Posterior Canal BPPV
  - Epley Maneuver Efficacy: 75% - 92% resolved in 1-3 sessions (Bhattacharyya et al. 2017)
  - Similar efficacy found with Semont and Gans maneuvers (Kim et al., 2021)
- Horizontal Canal BPPV
  - Barbeque Roll Maneuver Efficacy: 75% resolved after 1 session 85% after 3 sessions (Escher et al. 2007)
  - Guffoni Maneuver Efficacy: 75-83% resolved after 1 session (Mandala et al. 2013)

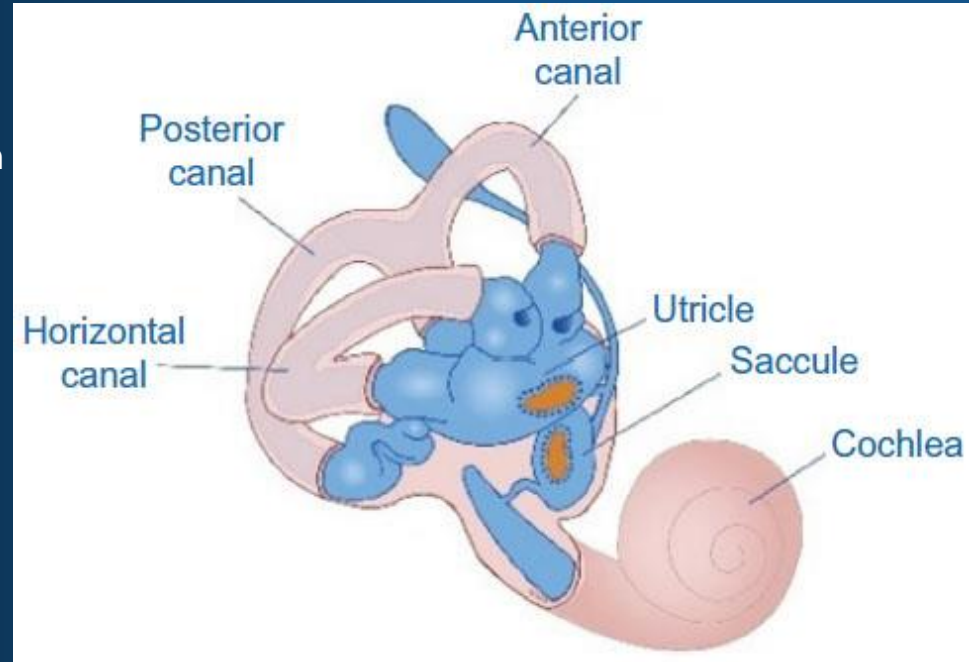
# Anatomy Review – peripheral system



- Outer Ear
  - catches sound
- Ear drum / middle ear
  - transmits vibrations
- Inner Ear
  - Cochlea
  - SSCs
  - Filled with a fluid called endolymph
  - Sends information to brain via CN8

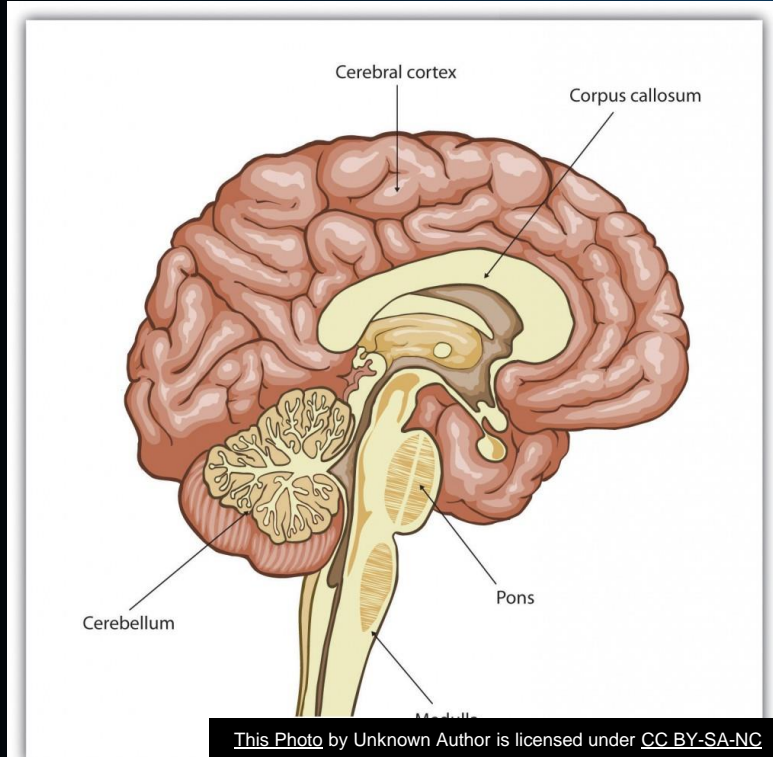
# Anatomy Review – peripheral system

- Cochlea
  - Vibrations in endolymph from sound waves trigger nerve signals to the brain
- Semi-circular canals (3)
  - Detect Angular Acceleration of the head
- Utricle and Saccule
  - Detect linear acceleration of the head, and give sense of verticality



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# Anatomy Review – central system



- Cerebellum
  - Contains arterial blood supply to the inner ear
- Temporal lobe
  - Location of vestibular nuclei
- 8<sup>th</sup> Cranial Nerve
  - Input from inner ear to the brain

# The “Umbrella” of Dizziness



*Lightheadedness*

*Vertigo*

*Pre-syncope*

*Dysequilibrium*

# What kind of “Dizzy” are they? (Post et al. 2010)

- Vertigo (45-54%)
  - BPPV
  - Vestibular neuritis
  - Meniere’s disease
  - Migraine
  - TIA / Stroke
- Dysequilibrium (16%)
  - Somatosensory related balance dysfunction
  - Cervicogenic dizziness
- Pre-syncope (14%)
  - Cardiac
  - Hypo/hypertensive
- Lightheadedness (10%)
  - Anxiety
  - Medication Side effects
  - Hypo/hyperglycemic

# Non-vestibular - Cardiac

(Newman-tokar & Carmango, 2006)

## Cardiovascular

- Orthostatic hypotension - common
  - Commonly positional in nature, intolerance to upright positions
  - Pallor, diaphoretic, “feeling faint”
  - Treatment – hydration, lie supine, teach patient pacing strategies until improves
- Orthostatic HTN - uncommon
- Reflexive bradycardia - rare
  - May be true vertigo, with syncope
  - Diagnosed with cardiac testing
  - Watch for yellow flags of PMH, age
  - May need cardiac pacing procedure



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# Non-Vestibular – Metabolic (Diabetes.org)

- Hypoglycemia - common
  - Diaphoretic
  - Pallor
  - Rapid HR
  - Feels “shaky”
  - Irritable / confused
  - Severely low can lead to seizures
  - Responds well to around 15 g carbohydrate snack
- Hyperglycemia - uncommon
  - Diabetic population
  - Weakness
  - SOB
  - Very Dry Mouth
  - Confusion
  - Nausea/vomiting
  - Coma
  - Fruity smelling breath
  - Can lead to Ketoacidosis – life threatening, needs immediate treatment

# Non-vestibular - Medications (Harun & Agrawal, 2015)



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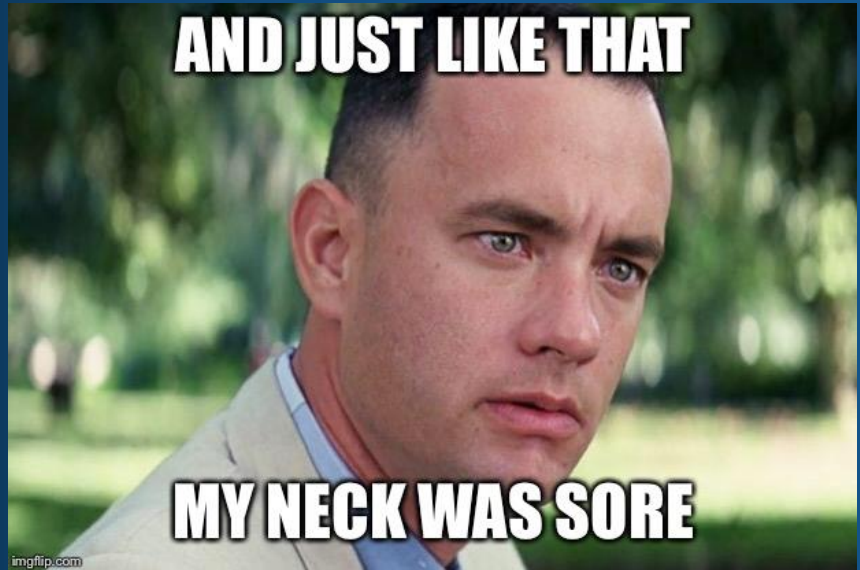
## Medications

- Nearly 40% of patients presenting to clinic with dizziness complaint
- Common types
  - Psychotropics (39%)
    - Sleeping pills
    - Anti-depressants
  - Antihypertensives (37%)
    - Beta blocker
    - Diuretics
  - Narcotics (8%)

# Non-vestibular – Cervicogenic (Riley et al., 2017)

## Cervicogenic Dizziness

- Dizziness related to changes in position of cervical spine
- Historically a diagnosis of exclusion
- Must have cervical pain / ROM loss / cervical injury in the absence of (+) vestibular test findings



# Cervicogenic Dizziness Tests (Riley et al., 2017)

- Neck Torsion Test
  - Positive if elicits nystagmus in any position
  - Patient sits on swivel chair, turns body under stabilized head 90 degrees
  - Hold 30 s each position: Left, Center, Right, Center



# Cervicogenic Dizziness Tests (Riley et al., 2017)

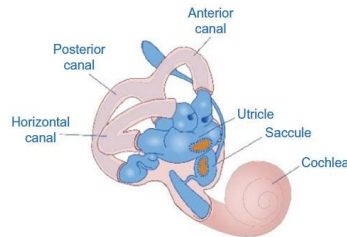
- Head Relocation Test (JPET)
  - Test of proprioceptive input of upper cervical spine musculature
  - Considered positive if 4.5° off from start position



# Vestibular Sources of Dizziness

## Peripheral Vestibular

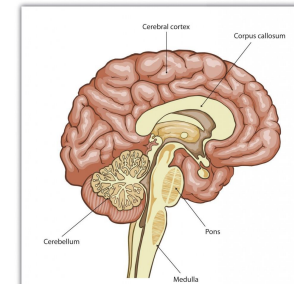
- BPPV
- Vestibular Neuritis
- Meneire's disease
- Labrynthine concussion



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## Central Vestibular

- Migraine
- Cerebellar / 8<sup>th</sup> CN / Brainstem lesion
- TIA / Stroke



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# Meniere's Disease (Gold, 2021)

- Episodic severe vertigo, lasts minutes to hours
- Cause: Increase in endolymph pressure in 1 or both of the inner ears, causing acute vestibular dysfunction
- Diagnosis: Referral to ENT/Audiology, comprehensive audiogram, characteristic Low-frequency hearing loss

# Meniere's Disease – Treatment

- Low-sodium diet, prescription of diuretics
  - Low evidence
- Vestibular rehab in between episodes to promote compensation
- Severe cases – surgery or gentamycin injection to essentially destroy vestibular portion of inner ear



# Vestibular Migraine (Lempert et al., 2012)

## Diagnostic Criteria

1. At least 5 previous episodes with vestibular symptoms, lasting 5 min – 72 hrs
2. Current or prior hx of migraine +/- aura
3. One or more migraine feature with 50+% of episodes:
  1. Headache (unilateral, pulsing quality, worse with physical activity)
  2. Photophobia / phonophobia
  3. Visual aura
4. Not better explained by another vestibular diagnosis

# Vestibular Migraine - Treatment

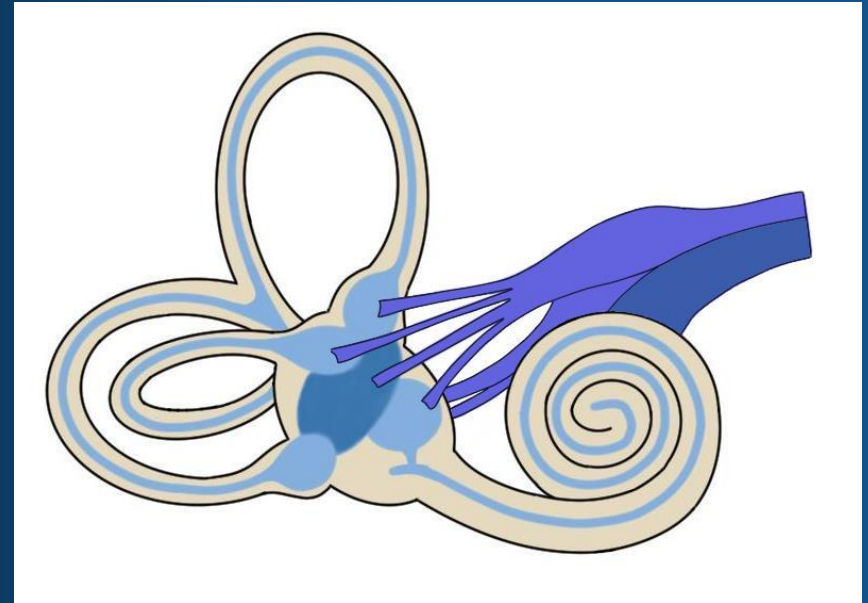
- Same as typical migraine
  - Recognize and mitigate triggers
    - Avoid caffeine, alcohol, odor triggers
    - Decrease stress, adequate sleep
  - May need routine maintenance medications
  - May need “rescue” medications
- Vestibular PT may be beneficial in between episodes

# Vestibular Neuritis - Presentation (Strupp & Brandt, 2009)

- Acute onset, usually violent episode of vertigo, lasts up to several days
- Sustained, horizontal nystagmus; may see a rotational component
- Significant dizziness and nausea
- Significant imbalance, and ataxic gait pattern tendency to fall towards affected side

# Vestibular Neuritis - Cause

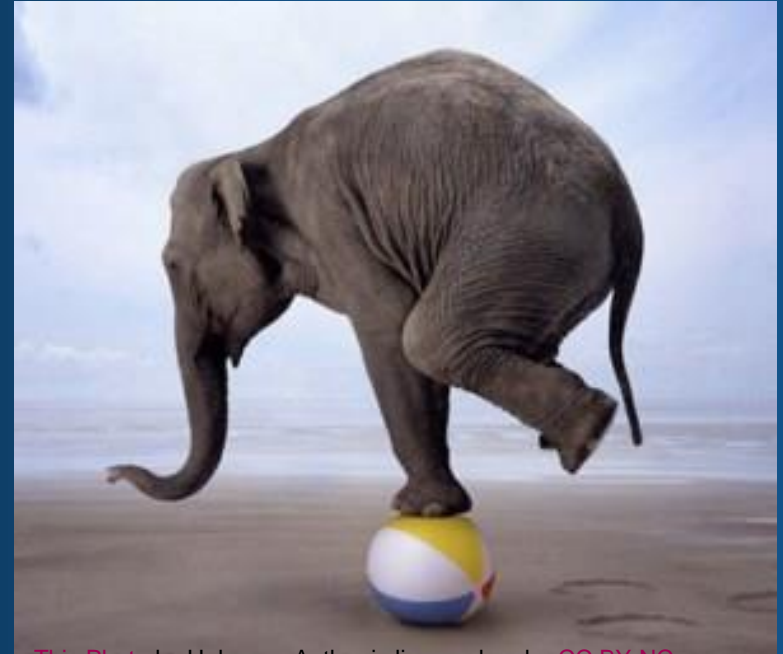
- Viral attack on Vestibular portion of 8<sup>th</sup> cranial nerve
- Inflammation causes eyes to be “pulled” towards affected ear, which “snap back” to middle, causing sustained nystagmus



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# Vestibular Neuritis - Treatment

- Corticosteroids to reduce inflammation on CN #8
- Symptom management with anti-nausea medications
- Vestibular rehab to address balance, VOR retraining

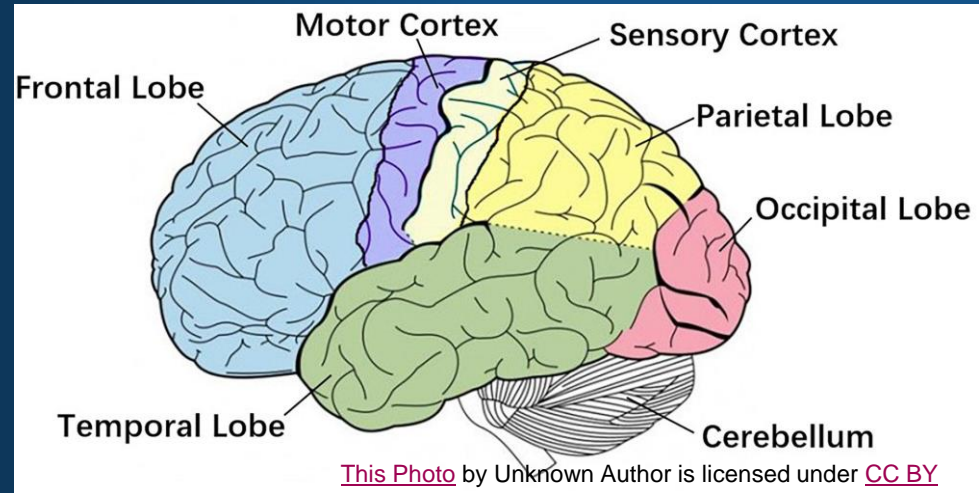


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# Posterior Circulation Stroke (POCS)

(Krishnan et al., 2018)

- POCS strokes account for 25% of strokes
- 35% are missed
- 8-fold increase in death if missed
- “FAST” not sensitive for POCS strokes



# Acute Vestibular Syndromes (Gold, 2021)

## Vestibular Neuritis (80%)

- Nystagmus
- Dizziness
- Nausea/vomiting
- Severe imbalance and difficulty walking
- May or may not have acute hearing loss (most do not)

## Posterior Circulation Stroke (20%)

- Nystagmus
- Dizziness
- Nausea/vomiting
- Severe imbalance and difficulty walking
- May or may not have acute hearing loss (most do)

# HINTS+ Exam > Early Imaging

- CT scan – may miss up to 60% when performed in first 24-48 hrs (Krishnan et al., 2018)
- MRI – more sensitive, may miss up to 20% of small posterior strokes in first 24-48 hrs (Gold, 2021)
- HINTS+ Bedside exam
  - 96.8% sensitive, 98.5% specific to detect central cause of symptoms



# HINTS+

HI – Head Impulse Test

N – Nystagmus Changing

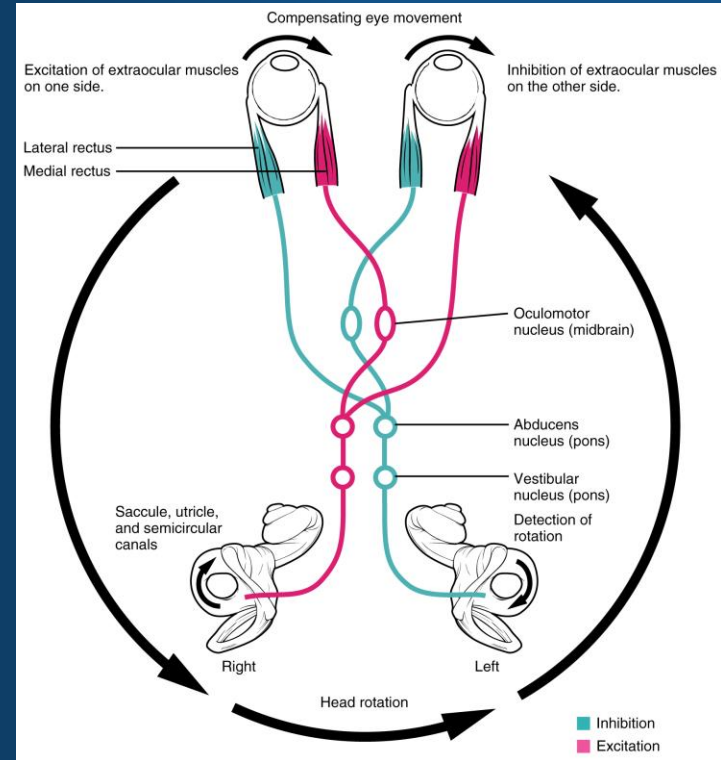
TS – Test of Ocular Skew

+ - New asymmetry in hearing

= HINTS+

# Head Impulse Test

- Assessment for the Vestibular Ocular Reflex
- Coordination between inner ears and your eyes
- Keeps your eyes on target when you turn your head



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# Head Impulse Test



# Head Impulse Test

## Acute Vestibular Neuritis

### Abnormal

- The peripheral VOR is not intact
- The eyes move with the head, and have to correct back, causing a corrective saccade

## Stroke

### Normal

- The peripheral VOR is intact, so eyes will stay fixed on the target with this test

# Nystagmus

## Acute Vestibular Neuritis

- Spontaneous horizontal nystagmus present
- Direction of nystagmus does not change
- Nystagmus will get stronger if you look in direction of the fast phase, weaker if you look away from fast phase

## Stroke

- Spontaneous nystagmus present
- Direction may change with gaze-evoked nystagmus testing
- Vertical spontaneous nystagmus may be present

# Nystagmus Type



# Test of Skew – Alternating Cover Test

## Acute Vestibular Neuritis

### Normal

- No vertical change in position of the eye you uncover
- Small horizontal correction is common, and normal

## Stroke

### Abnormal

- A vertical correction of the eye you uncover is observed

# Test of Skew – Alternating Cover Test





# + (asymmetrical hearing loss)

## Acute Vestibular Neuritis

### Normal

- Vestibular neuritis: No unilateral or bilateral hearing loss
- Labryrinthitis: May have unilateral or bilateral hearing loss

## Stroke

### Abnormal

- Acute unilateral or bilateral hearing loss is a central sign until proven otherwise



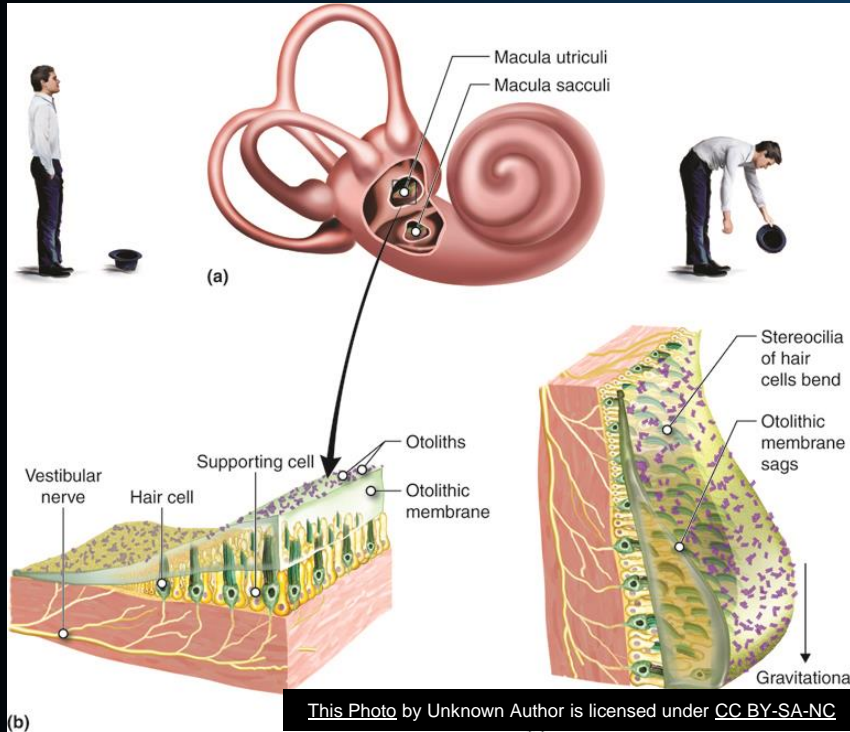
# HINTS+ Summary

- HINTS+ is useful to differentiate between central vs peripheral sources of severe acute vestibular syndrome, but takes practice
- Any one (+) finding on the exam is a POCS stroke until proven otherwise
- Most applicable in ED / Urgent Care setting

# BPPV - Diagnostic Criteria (Gold, 2021)

1. Recurrent positional attacks, provoked by head movement
2. Duration <1 minute, after brief latency
3. Positional Nystagmus, up-beating + torsion towards the affected ear in Dix-Hallpike test or Sidelying test
4. Not better explained by another vestibular disorder

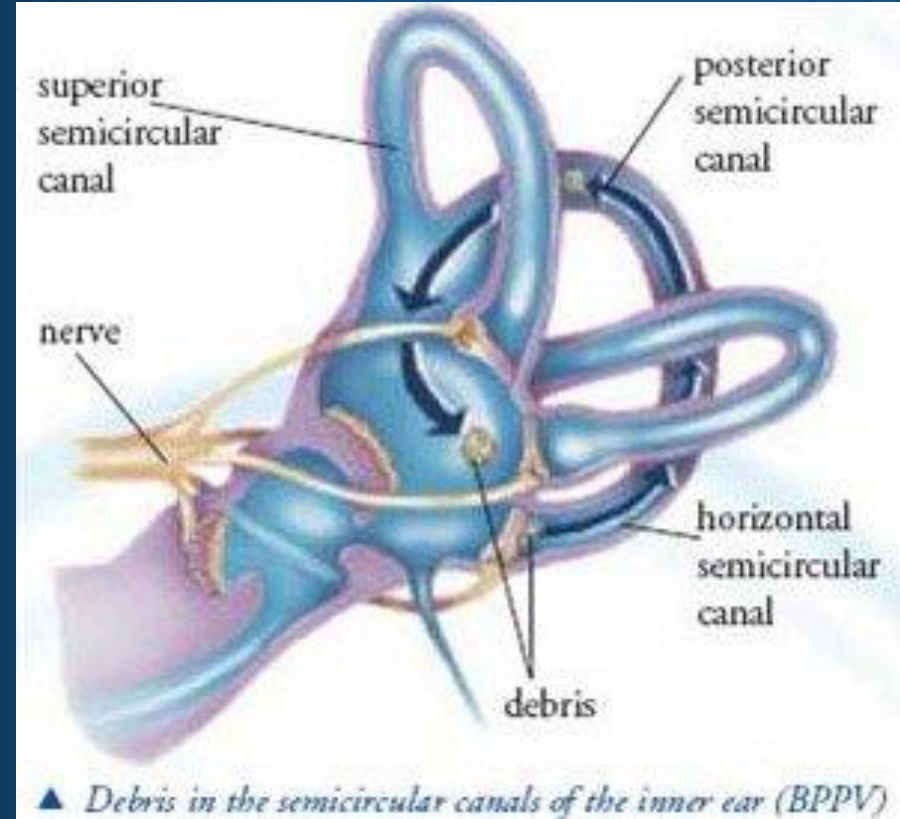
# Inner ear



- Utricle – static balance and horizontal tilt
- Saccule – static balance and vertical tilt
- Otoconia have mass; try to sink in endolymph; gives us sense of vertical

# BPPV

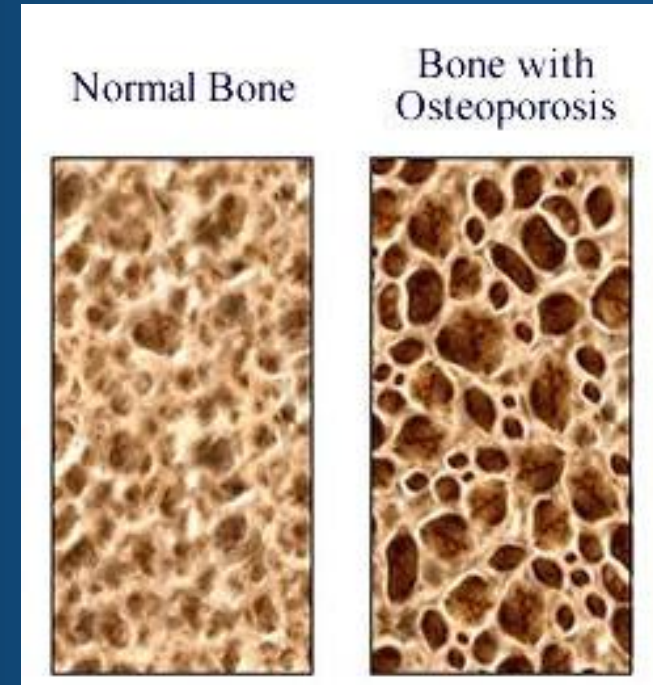
- Otoconia dislodge from lining of the utricle and saccule, float into SSC
- Debris floats through SSCs, triggering reflex with eyes leading to perception of spinning



# BPPV – Why does it happen?

(Kim et al., 2021)

- Factors that increase risk
  - Female gender; peaks in 60's
  - Osteoporosis
  - Low Vitamin D
  - Non-apnea sleep disorders
  - Head trauma
  - Seasonal allergies



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# BPPV – Treatment (Bhattacharyya et al. 2017)

- Gold Standard = Canalith Repositioning Maneuvers (CRMs)
  - Posterior Canal BPPV (PC-BPPV) (85%)
    - Epley Maneuver, Semont Maneuver, Gans Maneuver
  - Horizontal Canal BPPV (HC-BPPV) (15%)
    - BBQ Roll, Gufoni Maneuver
- Medications
  - Symptom management if severe / vomiting, otherwise medications generally discouraged



Okay, so I have a patient, and they're dizzy. Now what?

# Screen Medical History

- Medications
  - Any recent changes?
- Cardiac
  - Significant past history? New chest, shoulder or jaw pain, or shortness of breath?
- Neuro
  - Any new motor weakness, numbness, tingling?

# Non-vestibular causes?

- Hypertension
- Hypotension
- Medication side-effects
- Hypoglycemia
- Hyperglycemia
- Allergies
- Anxiety

# Ask about new symptoms

- Tinnitus / ringing in ears
- Recent hearing changes
- Aural pressure
- Nausea / vomiting
- Vision changes
- Ear pain
- Facial numbness or drooping

# Triaging Dizziness (Gold, 2021)

- Timing
  - Acute or Gradual onset
  - Episodic
    - BPPV (seconds), Meniere's, TIA (minutes), Migraine (minutes to hours)
  - Constant
    - Stroke
    - Vestibular Neuritis

# Triaging Dizziness (Gold, 2021)

- Triggers
  - Positional – BPPV, Orthostatic Hypotension
  - Head movements – Unilateral or Bilateral vestibular hypofunction
  - Loud noise - SCDs
  - Pressure changes – SCDs, Chiari malformation
  - Busy environments / visual stimulation - migraine

# Rule Out “The Scary Stuff”

## “Red Flags”

- Accompanied by significant cardiovascular history, typical stroke risk factors
- Vertigo that’s not positional, worsening
- Sudden, unilateral hearing loss
- May be accompanied by other neurologic signs, unilateral weakness, facial asymmetries, etc.

# Safety Considerations with Epley CRM

- Risk for Cervical Stress (Saber et al., 2017)
  - For PC – BPPV, consider Semont Maneuver or Gans Maneuver (a bit less effective) if cervical extension limited or painful
- Vertebro-Basilar Insufficiency (Arnold, 2004)
  - Pre-manipulation hold at C1-2 and Full end-range rotation most effective at compressing contralateral vertebral artery



# Positional Tests

- Goal is to mechanically move debris through SSCs
- Reproduction of symptoms, along with nystagmus correlating to SSC being tested indicates treatment

# Dix-Hallpike Test for PC-BPPV

- Start sitting upright, positioned so head will tilt off edge of table but shoulders supported
- 45 degree head turn towards side you want to test
- Lie back keeping head at 45 degree rotation, and extend neck 20-30 degrees below neutral (chin higher than forehead)
- Keep eyes open – look for nystagmus
- \*\*Don't have to go fast\*\*

# Dix-Hallpike Test for Left PC-BPPV



# Dix-Hallpike for Right PC-BPPV



# Supine Roll Test for HC-BPPV

- Lie supine, neck flexed 20 degrees
- Roll to left and right sides keeping neck at angle, hold each position 30 seconds
- Nystagmus will commonly be present bilaterally if (+), more intense side is typically the culprit

# Roll Test for HC-BPPV



# Treatments



# Epley Maneuver for Left PC-BPPV



Wait until nystagmus  
stops, +1-2 minutes



# Epley Maneuver for PC-BPPV



**Wait 1 minute**



**Wait until nystagmus  
stops +1-2 minutes**

# Epley Maneuver for PC-BPPV



- Tips
  - Keep chin tucked down slightly as you sit back up; reduces likelihood of accidentally dumping debris into horizontal canal
  - Go slow, ensure proper neck angles
  - Don't have to lay down fast

# Epley Maneuver Video



# Semont Maneuver for L PC-BPPV





# Semont Maneuver for R PC-BPPV



# BBQ Roll for HC-BPPV (Right)



# BBQ Roll - Video



# Post-Treatment Recommendations

- Post-CRM Precautions – 24-48 hours
  - Avoid sleeping on affected side
  - Avoid extensive looking up or down
  - Avoid quick head movements
  - Sleep in reclined position, or with 2-3 pillows
- Most recent CPG deemed this unnecessary  
(Bhattacharyya et al. 2017)



# Reducing risk of Recurrence (Kim et al., 2021)

- Supplementing with Vitamin D
  - Basis of osteoporosis risk factor
    - 400 IU Vit D + 500 IU Calcium 2x daily showed significant reduction (Jeong et al., 2020)
- Address modifiable risk factors
  - Control diabetes, HTN, Hyperlipidemia

# Summary

- Dizziness is very common, usually is benign, but also can be serious
- Lots of things cause dizziness, most are manageable, and some are actually curable
- BPPV is relatively easy to treat, and patients get better FAST making it fun

# Thank you! Any questions?



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