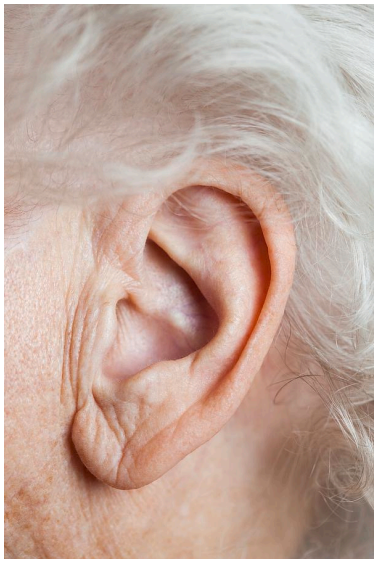
Vestibular Function and Cognitive Impairment

Mary Henry, Au.D
Brenna Carroll, Au.D.

Where do we get our Balance?

Eyes



Inner Ears

Body

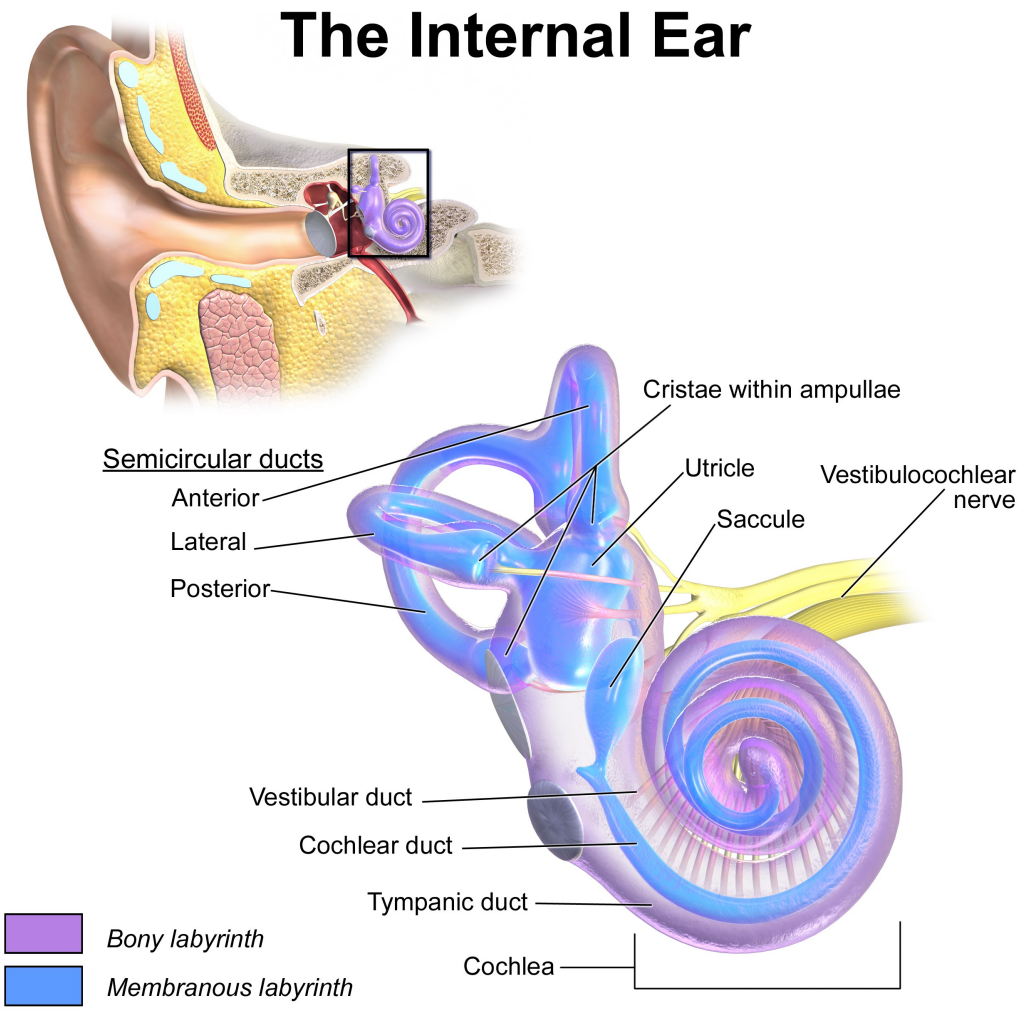
And central connective pathways

Aging and Balance

- Eyes
  - Age related macular degeneration
  - Cataract
  - Diabetic retinopathy
  - Glaucoma
- Body
  - Postural stability & Gait
  - Weakened joints, neuromuscular control, etc
- Ears
  - Neuronal & Hair Cell loss (otoliths & semicircular canals)
  - Our vestibular tests are age-normed

Inner Ear

- We have 6 organs in each of our inner ears:
- 5 for Vestibular (Balance)
  - 2 **Otoliths** – For sensing gravity
    - Saccule
    - Utricle
  - 3 **Semicircular Canals** – For angular head motion
    - Horizontal
    - Anterior
    - Posterior
- 1 for Hearing (the Cochlea!)



Vestibular dysfunction and Cognitive Impairment

- Significant evidence for an associations between vestibular loss, increased risk of falling, and cognitive decline (including mild cognitive impairment) and early-stage dementia (Harun, et al., 2016; Lach, et al., 2017; Zalewski, 2015).

- Higher overall risk of sustaining injurious falls over time.

Vestibular tests

- VNG (Videonystagmography)
  - Age-normed results for oculomotor testing
  - Higher incidence of BPPV in the elderly
  - Vestibular decline changes can be subtle and highly variable
- VEMP (Vestibular Evoked Myogenic Potential) >70 years
  - Otolith and vestibular nerve test and SSCD screening
  - Reduced amplitude over ~60 years of age, not uncommon to be absent.

- Accumulated effects of age on the electrical resonance of the hair cells
- Age-related changes in the mechanical properties of the inner ear organs (Piker, et al.)

- Sometimes difficult to isolate exact lesions due to multi-system physiology and complex anatomy.

Economy and Mortality of Falls

- Fall-related injuries
  - Estimated $10 to $20 billion dollar annual cost
  - Sixth leading cause of death in the elderly population
  - 20% mortality rate.
  - Estimated 115% increase in the geriatric population over 65 years of age by the year 2050
  - Patients with dementia have a significantly higher fall rate (4.05 falls/year) than their counterparts without dementia (2.33 falls/year) (Lach, et al.).

The number of balanced-impaired patients with a declining vestibular system is certain to reach near epidemic proportions (Zalewski, 2015).

What can we ask patients?

- **What medications are you taking?**
  - Side effects and interactions that may increase your risk of falling
- **Have you fallen before?**
  - Describe what happened (looking for possible cause)
  - Any head or bodily injury that resulted from fall(s)?
- **Could your health conditions cause a fall?**
  - Ears, Eyes, and Body! They are complex, integrated systems and it is important to rule out issues with each one.
- **Quick case history:**
  - Rule out BPPV
    - Spinning vertigo with fast head movement, each lasting < 1 min
  - Describe, Duration, Triggers
  - DHI: Dizziness Handicap Inventory

Tips to reduce fall risk
(in addition to ears/eyes/body assessment)

- Shoes 
  - Reduce fall risk, but can also prevent joint damage
- Keep moving 
  - Whatever level fits the patient's needs: Even gentle activities like walking, water workouts or tai chi can improved strength, balance, flexibility and coordination
  - Concerns for safety? Monitored exercise programs or PT
- Light up the room! 
  - Night lights, lamps, flashlights for emergencies

Tips to reduce fall risk
(in addition to ears/eyes/body assessment)

- Home Hazards
  - Furniture in high traffic areas
  - Loose rugs, floorboards, carpeting
    - Secure with tacks, slip-resistant backing, or remove altogether
  - Bathroom:
    - Non-slip mats, bath seat (+ handheld shower nozzle), grab bars

- Assistive Devices
  - Hand rails on both sides of stairs
  - Non-slip treads for bare-wood or slippery steps
  - Raised toilet seat or one with armrests

Hearing loss and vestibular loss

- What affects hearing can also affect balance
  - i.e. Meniere's disease, Labyrinthitis, Semicircular Canal Dehiscence, Acoustic neuroma, in addition to other anatomical, vascular, or neural changes of inner ear or 8th cranial nerve.
- Degraded hearing in older adults has been associated with reduced postural control (PC) and higher risk of falls.
  - Both hearing loss and falls have dramatic effects on older persons' QoL
  - Physiological, cognitive, and behavioral processes that may influence auditory system and PC (Agmon et al., 2017)

Amplification and Balance

- Postural stability can be improved with a single fixed sound source. The benefit that the vestibular system has from auditory cues is still not as great as that received from visual cues. (Zhong & Yost, 2013)
- Several studies have found auditory cues to improve static balance measured on a sway platform. (Shayman et al., 2020)
- A small subset of participants improved clinically across several outcomes, supporting that audition (HAs and CIs) may have a clinically beneficial effect on static balance in some patients. (Weaver, Shayman & Hullar, 2017)

There is SOME association with hearing ability and balance, however more research is needed and should never be the sole therapy for someone with balance issues.

Summary

- The balance system is complex and often involved several specialties (eyes, ears and body!) to determine the etiology of dizziness.
- Parallels between cognitive impairment and vestibular decline have been identified in research.
- Prevention for falling is the primary concern

Resources

- Agmon M, Lavie L, Doumas M. The Association between Hearing Loss, Postural Control, and Mobility in Older Adults: A Systematic Review. *J Am Acad Audiol*. 2017;28(6):575-588. doi:10.3766/jaaa.16044
- Arshad Q, Seemungal BM. Age-Related Vestibular Loss: Current Understanding and Future Research Directions [published correction appears in Front Neurol. 2017 Aug 21;8:391]. *Front Neurol*. 2016;7:231. Published 2016 Dec 19. doi:10.3389/fneur.2016.00231
- Harun A, Oh ES, Bigelow RT, Studenski S, Agrawal Y. Vestibular Impairment in Dementia. *Otol Neurotol*. 2016;37(8):1137-1142. doi:10.1097/MAO.0000000000001157
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- Melo RS, Lemos A, Paiva GS, et al. Vestibular rehabilitation exercises programs to improve the postural control, balance and gait of children with sensorineural hearing loss: A systematic review. *Int J Pediatr Otorhinolaryngol*. 2019;127:109650. doi:10.1016/j.ijporl.2019.109650
- Zalewski CK. Aging of the Human Vestibular System. *Semin Hear*. 2015;36(3):175-196. doi:10.1055/s-0035-1555120

Fall prevention tips:

- https://www.mayoclinic.org/healthy-lifestyle/healthy-aging/in-depth/fall-prevention/art-20047358