



# The Impact of Hearing Loss on Cognitive Health



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# ABOUT



North Ohio AuD Consortium - 2014  
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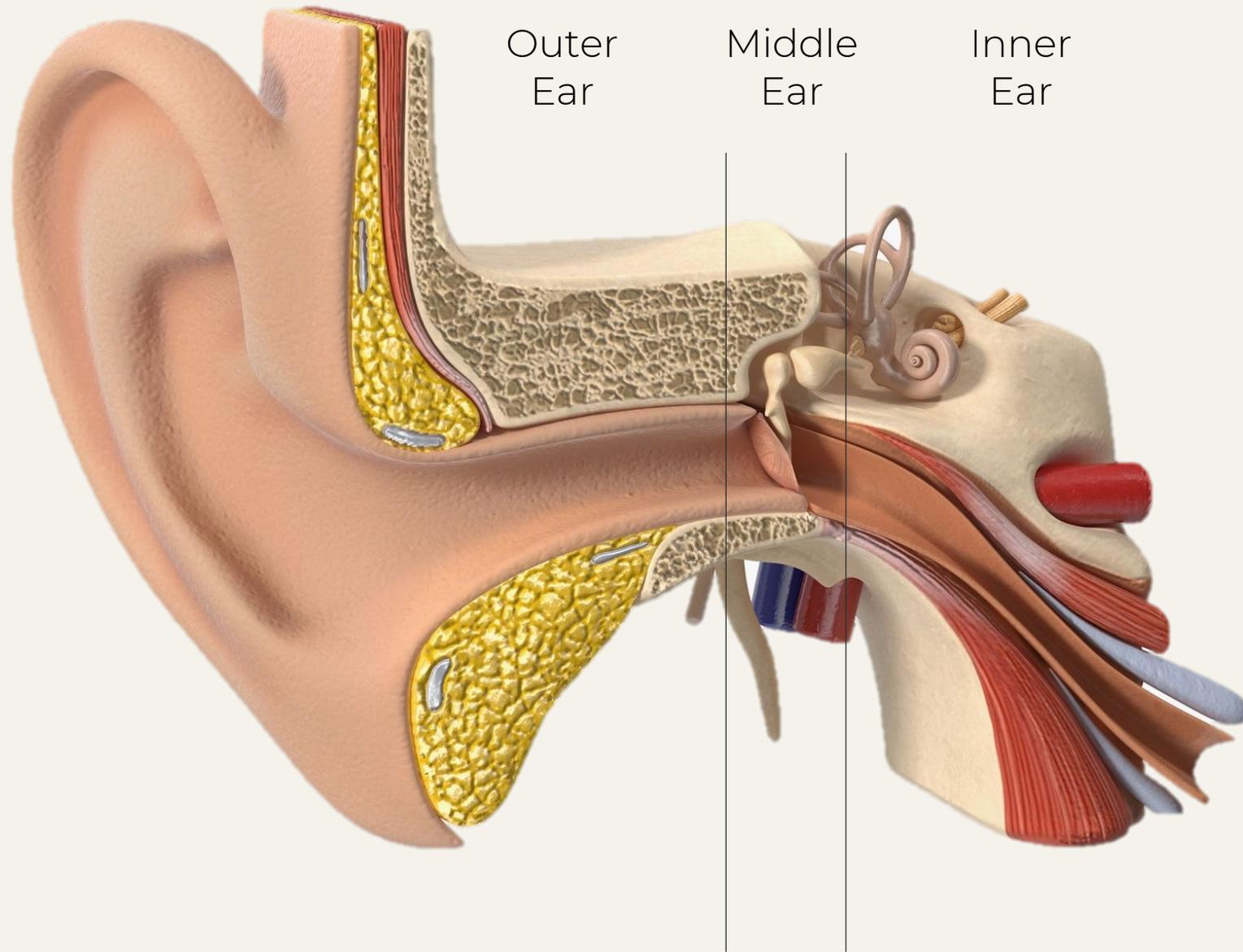
The Ohio State University  
Adjunct Professor

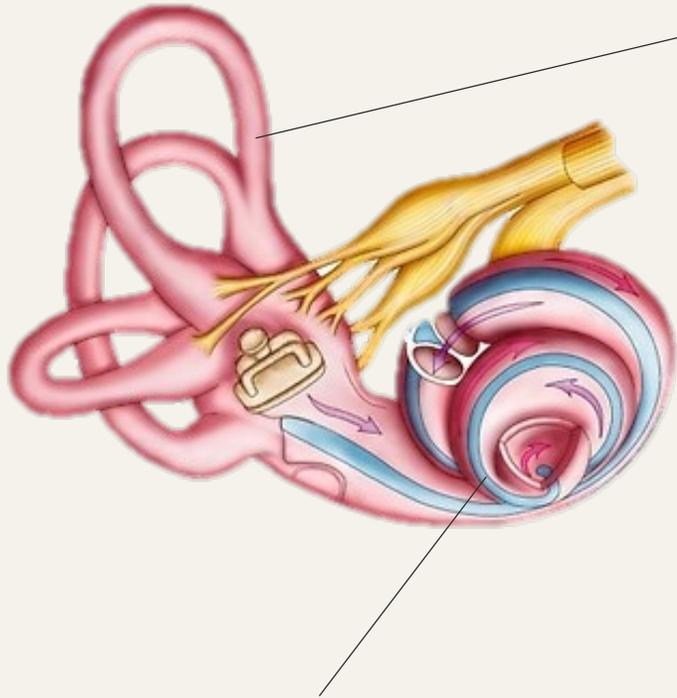


# Agenda

- Review of Hearing Loss
- Ear – Brain Connection
- Implications of Hearing Loss
- Management Options for Hearing Loss
- Referral Considerations





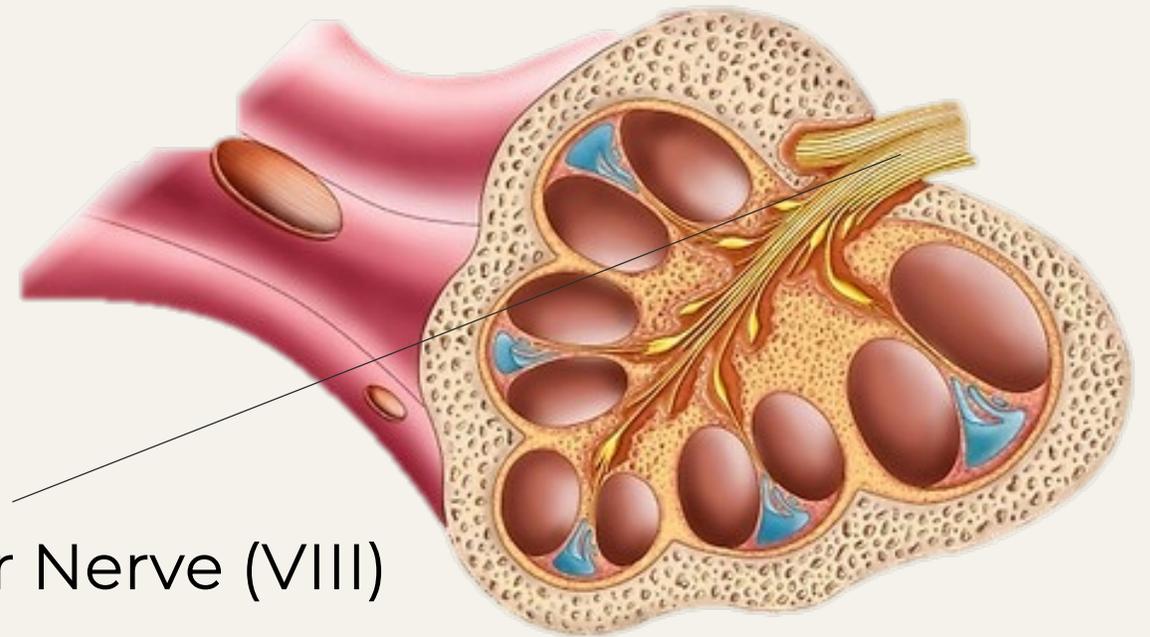


## Semicircular Canals

- Determines peripheral vestibular function
- Sends information about angular velocity
- Site of BPPV

## Cochlea

- Organ of Hearing
- Arranged Tonotopically



## Cochlear Nerve (VIII)

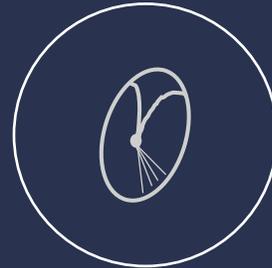
- Transmits neural signals to brain
- Merges with vestibular nerve and courses through internal meatus

# Mixed Hearing Loss

## Conductive



- Wax Occlusion
- Otitis Externa
- Foreign Body



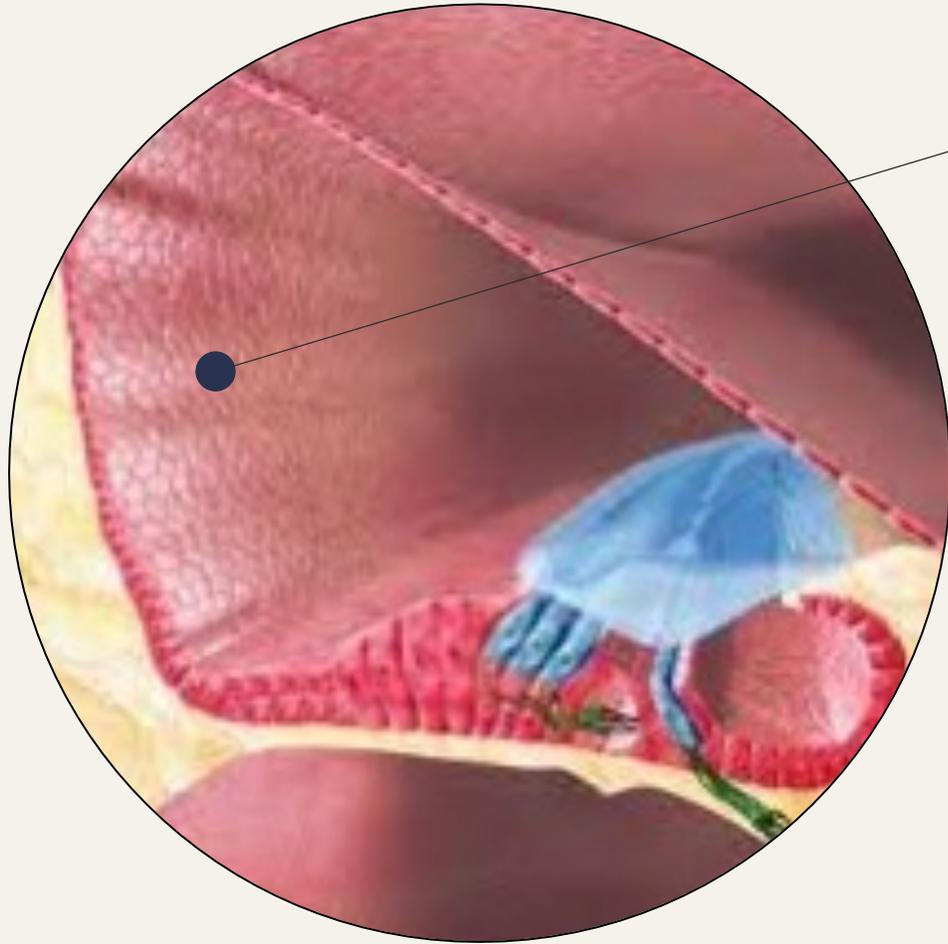
- Ruptured TM
- Ossicular Chain Disorders
- Otitis Media

## Sensorineural



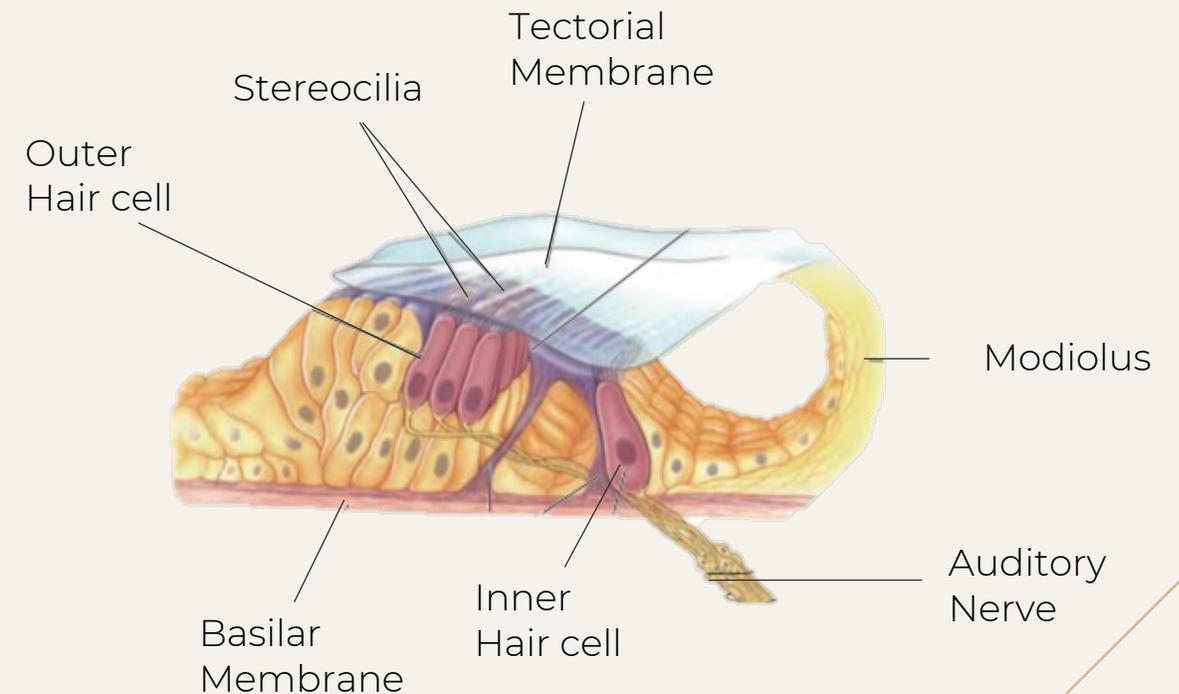
- SNHL
- Neural HL
- Ossification
- Anatomical Deformity



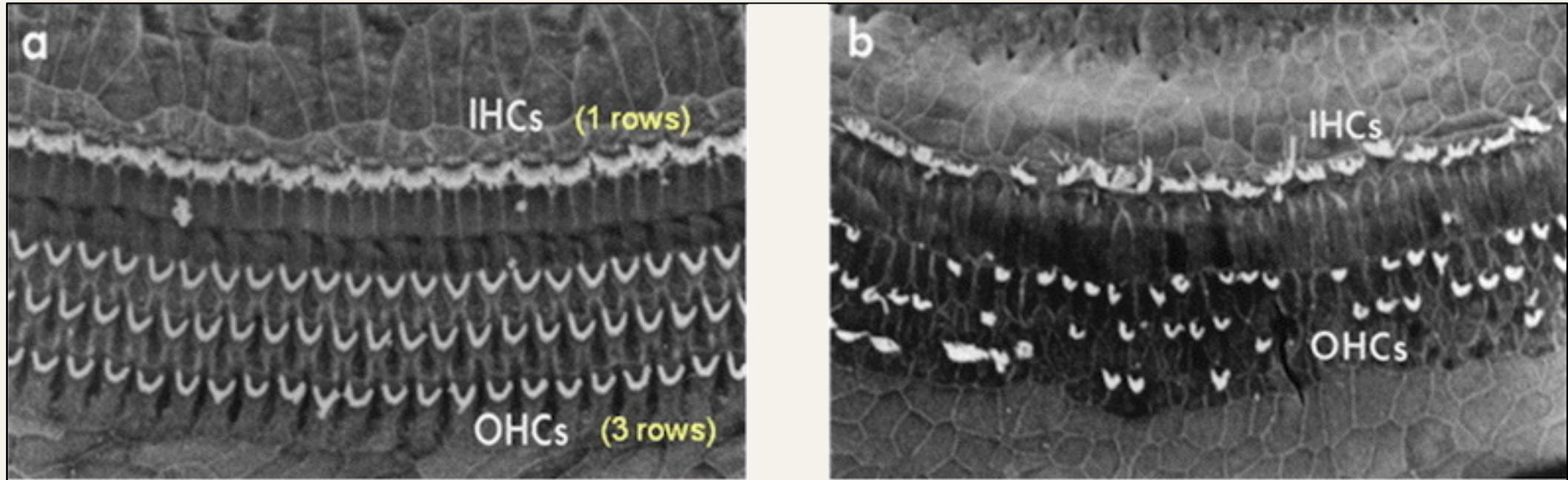


## Stria Vascularis

- Determines ionic composition of Scala Media
- Highly vascular
- Impacted by cardiovascular health



# Cochlear Hair Cells



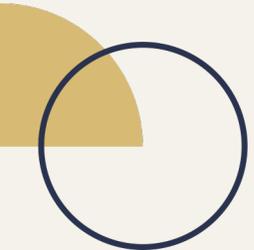
Normal

Damaged



# Hearing Loss and Brain Health

- Ears collect sound but brain processes and interprets information
- Localization happens at the level of the brainstem / thalamus
- Primary auditory cortex interprets
  - Timing cues
  - Intensity cues
  - Frequency cues
  - Complexity of sound (i.e., background noise)
- Higher processing involves
  - Processing harmony, rhythm, and melody
  - Intonation, voice complexity, tonal qualities



# Why does this matter?

**01.**

## Cognition

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Untreated hearing loss has been linked to the development of dementia in older adults.

1 in 9 people over 65 years of age have Alzheimer's disease.

**02.**

## Fall Risk

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Even mild hearing loss (25dB) is associated with a nearly 300% increase in fall risk in adults.

1 in 3 Americans over 65 years of age will sustain a fall.

**03.**

## Cardiovascular Disease

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CVD has been linked to sensorineural hearing loss due to compromised blood flow to the cochlea.

14.3% of adults aged 65-74, 24.2% aged 75 and older have CVD.

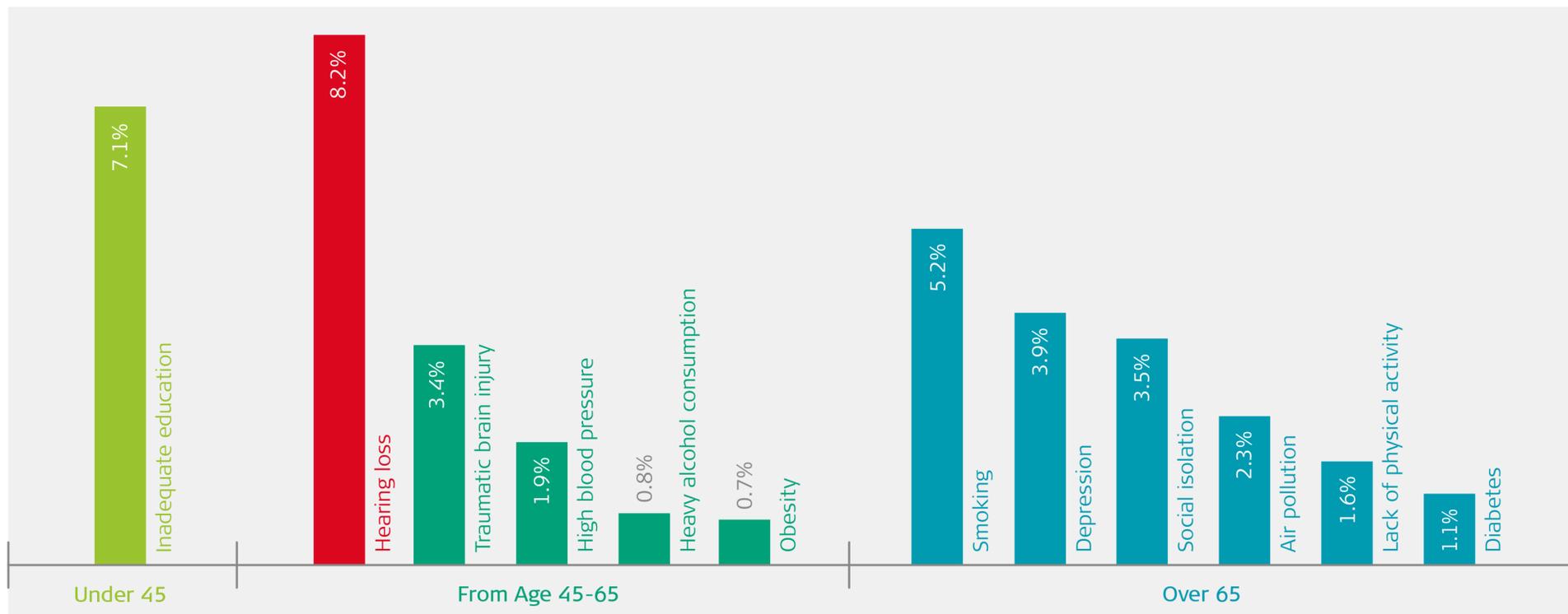
# Dementia and Alzheimer's disease



- 2021 healthcare costs from all types of dementia = \$355 Billion
- Deaths from Alzheimer's disease increased **145%** - 2000-2019
- Heart disease increases risk of developing Alzheimer's disease
- Alzheimer's disease current affects approx. 6 Million Americans



# Modifiable Risk Factors for Dementia



Percentages (as weighted population attributable fractions) indicate decreased dementia prevalence if each potentially modifiable risk factor is eliminated, with 60.3% of risk unknown.

Source: Data from Livingston, G., Huntley, J., Sommerlad, A., Ames, D., Ballard, C., Banerjee, S., Brayne C., (...), & Mukadam, N. (2020) Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *The Lancet*. 396(10248), 413-446. doi:10.1016/S0140-6736(20)30367-6



# Pathophysiological Mechanism

- Increased Cognitive Load
    - HL increased amount of cognitive effort
    - Brain must work harder when auditory input is distorted
    - Auditory deprivation may lead to brain structural changes
    - Structural changes may lead to poorer working memory
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# Pathophysiological Mechanism

## • Changes in Brain Structure and Function

- There is evidence that HL causes cerebral alterations
  - MRI studies indicate lower brain volume in bilateral temporal lobes
  - Chronic HL leads to less activation of auditory pathways - a dysfunction of auditory – limbic pathway and atrophy of frontal lobe and hippocampus.
  - Higher level areas compensate for weaker areas leaving them unavailable for use.
- 
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# Pathophysiological Mechanism

- Common Pathological Conditions

- Suggests one condition causing both HL and cognitive impairment
  - Primarily vascular
    - Atherosclerosis
    - Smoking
    - Diabetes
  - Possible genetic component
  - Syndromic associations
- 
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# Pathophysiological Mechanism

- Social Disengagement
    - Social interactions less satisfactory for those with HL
    - Social isolation is risk factor
      - Cognitive decline
      - Auditory deprivation / reduced cognitive stimulation
      - Loneliness / depression
    - Depression associated with HL often manifests as lethargy or other somatic symptoms
      - Increased transcription of pro-inflammatory gene
- 
- 



# Evaluation of Hearing Impairment

- The average patient in the US waits 7 years before seeking treatment
  - Allows time for irreversible decline in cognitive function and speech understanding
  - Hearing loss is often not detected/treated in patients with cognitive impairment
  - More recent evidence suggests a central auditory component in early stages of AD
    - CAPD testing recommended as low-cost and effective evaluation precursors to AD



# Clinical Recommendations



**Immediate baseline hearing assessment  
and retest every 2-years**

**Treat a hearing loss if present**

# Options for Treatment



**Hearing  
Aids**



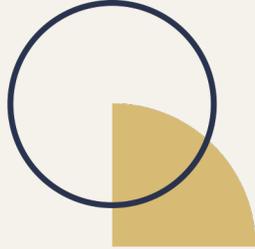
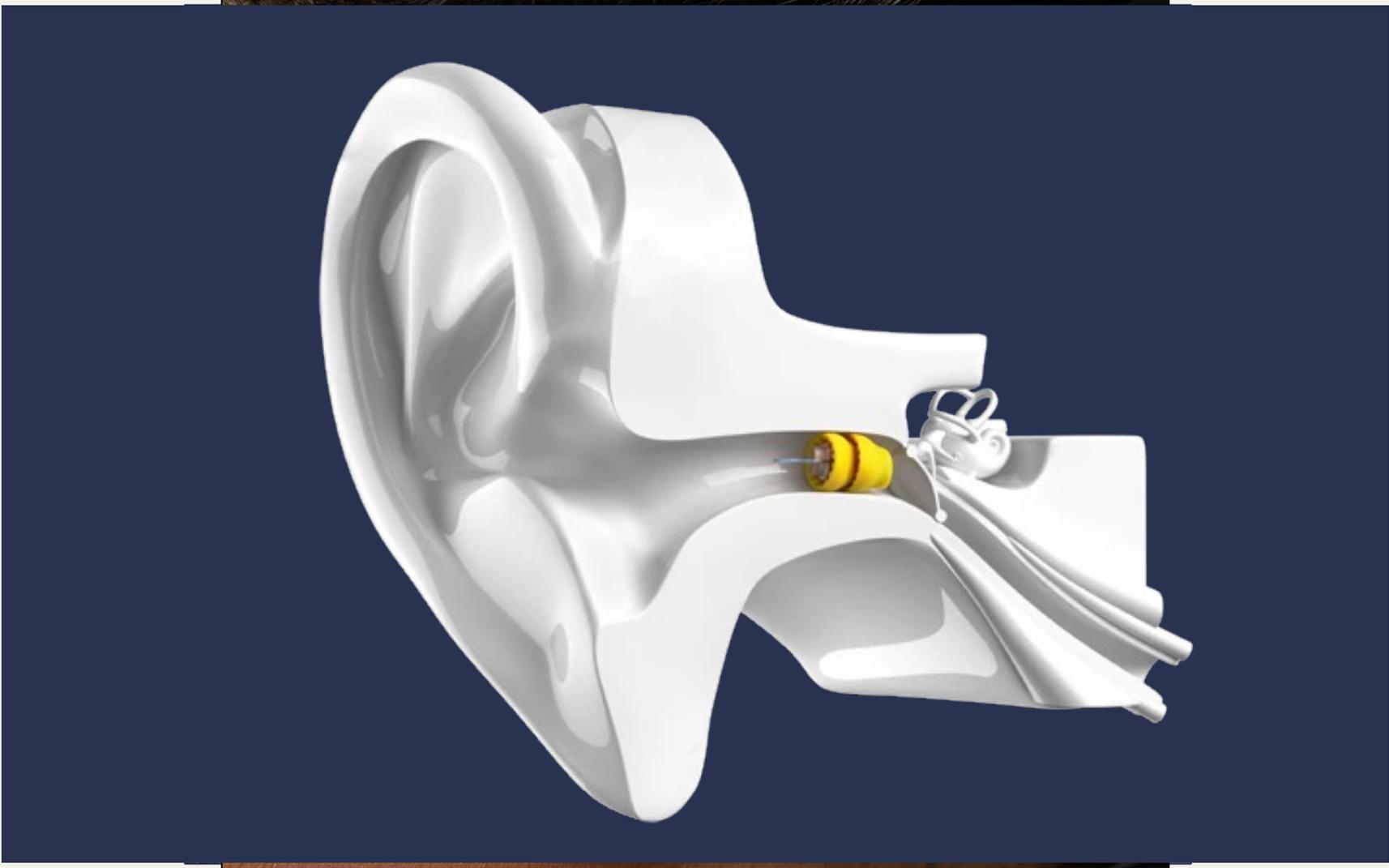
**Amplification  
Devices**



**Cochlear  
Implants**





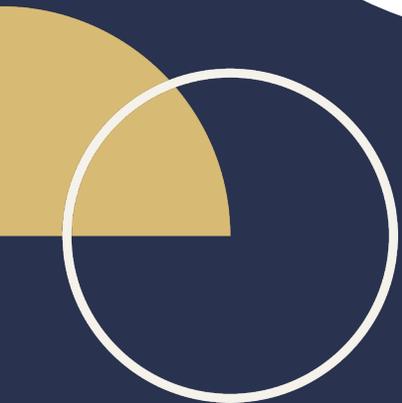




# Hearing Aids



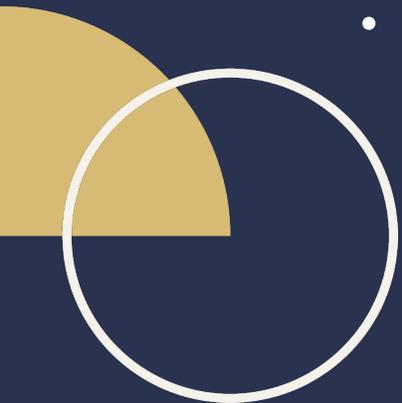
- Prescription hearing aids
  - Reduction in rate of cognitive decline
  - Improvement in cognitive performance
  - Increased spatial awareness and cerebral activation
- Patients must recognize and accept that there is a treatable problem
- Recommended as part of a larger treatment plan





# Hearing Aid Technologies

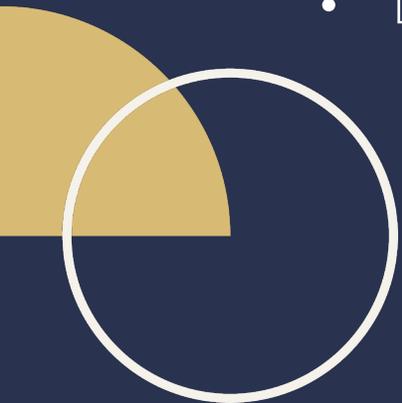
- Deep Neural Networks
  - "Mimics" the function of the cerebral cortex
- Machine learning and Artificial Intelligence
  - Automatic adaptation to varying environments
- Rechargeable (16 - 50 hours)
- Waterproof (1 meter)
  - iPhone and Android compatibility





# Amplification Devices

- Easily applied - inpatient and outpatient settings
- Improvement noted in some outcomes
  - Communication
  - Depression
- Low-cost and easy-to-use
  - Often cumbersome to move between environments

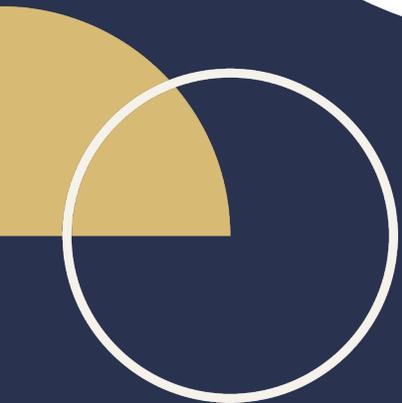




# Cochlear Implants

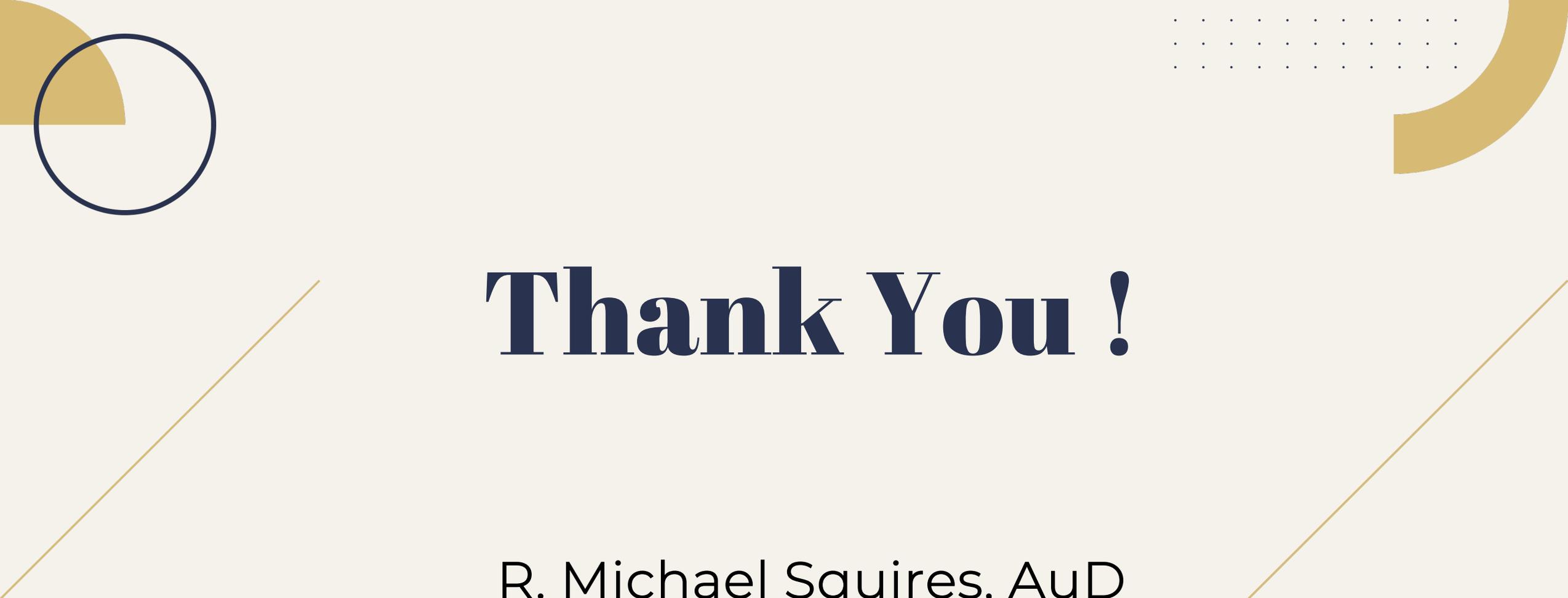


- Moderate-to-profound Hearing Loss
- Data regarding use of these devices for patients with cognitive impairment is limited.
- Research suggests that CI use improves attention, working memory and processing speeds



# Conclusion

- More research is needed to investigate the molecular connection between hearing loss and cognitive decline
- Hearing loss is a significant modifiable risk factor for cognitive decline
- Hearing rehabilitation has been proven to improve cognitive function
- Audiologist should be part of the medical team for management of cognitive decline
- Auditory rehabilitation should accompany a therapy plan for cognitive decline to increase individual and societal benefits



# Thank You !

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