Hearing Loss in Older Adults: A Public Health Perspective

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Prevalence of Hearing Loss in the United States, 2001-2008

- Hearing loss defined as a better-ear PTA of 0.5-4kHz tones > 25 dB

Lin et al., Arch Int Med. 2011

Age-Related Hearing Loss (ARHL)
Basic Questions

- What are the consequences of ARHL for older adults?
- What is the impact of treating ARHL on older adults?
- How can ARHL be effectively addressed in the community?

John Smith, 72 y.o.

Hearing Loss & Hearing Aid Use Prevalence in the U.S., 1999-2006

Chien & Lin, Arch Int Med, 2012

Age-Related Hearing Loss (ARHL)
Basic Questions

- What are the consequences of ARHL for older adults?
- What is the impact of treating ARHL on older adults?
- How can ARHL be effectively addressed in the community?
Healthy Aging

Avoiding Injury
Maintaining Physical Mobility & Activity
Keeping Socially Engaged & Active
Health Resource Utilization

Hearing Loss

Hearing Loss & Healthy Aging
Common Cause or Modifiable Risk Factor

Cognitive Load
Hearing Loss
Cognitive & Physical Functioning

Common pathological process

Hearing Loss & Cognitive Load

- Kahneman model of shared attention and resource capacity (D. Kahneman, Attention & Effort, 1973)

Cognitive Resource Capacity

Auditory Perceptual Processing Requirements
Available Cognitive Resources For Performance of Tasks
Age-Related Decline

“Effortful listening”
Intensity → “Sunday”
Hearing Loss & Cochlear impairment
Decreased sensitivity & distortion in sound encoding
Common pathological process
Hearing Loss & Cognitive Load

Poorer hearing is associated with:
A. Reduced language-driven activity in primary auditory pathways

B. Increased compensatory language-driven activity in pre-frontal cortical areas

Grossman et al, Brain Lang, 2002

Hearing Loss & Healthy Aging

Common Cause or Modifiable Risk Factor

Cognitive Load

Brain structure/function

Social Isolation

Common pathological process

Grossman et al, Brain Lang, 2002

Hearing Loss & Healthy Aging

Common Cause or Modifiable Risk Factor

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Brain structure/function

Social Isolation

Common pathological process

Cole & Cacioppo, Genome Biology, 2007
Cole & Cacioppo, PNAS, 2011

Hearing Loss & Healthy Aging

Common Cause or Modifiable Risk Factor

Social Isolation

Cognitive & Physical Functioning

Health Behavioral Pathways
- Smoking
- Adherence to medical tx
- Diet
- Exercise

Psychological Pathways
- Self-eval
- Self-efficacy
- Coping
- Sense of well-being

Physiologic Pathways
- HPA axis response
- Immune system fxn
- Cardiovascular reactivity

Social isolation is associated with upregulation of pro-inflammatory genes & increased inflammation

Cole & Cacioppo, Genome Biology, 2007
Cole & Cacioppo, PNAS, 2011

Double Hit Theoretical Model

Hearing Loss & Brain Structure/Function

Microvascular Disease

Alzheimer’s Neuropathology

Hearing Impairment

Lin & Albert, Aging & Mental Health, 2014

Hearing Loss & Healthy Aging

Common Cause or Modifiable Risk Factor

Cognitive Load

Brain structure/function

Social Isolation

Common pathological process

Lin & Albert, Aging & Mental Health, 2014
Hearing Loss & Healthy Aging
Datasets for Epidemiologic Analyses

- **NHANES**: National Health and Nutritional Examination Surveys
  - Cross-sectional, representative sample of U.S. population
- **BLSA**: Baltimore Longitudinal Study of Aging
  - Ongoing prospective study of older adults since 1958
- **HealthABC**: Health, Aging, & Body Composition Study
  - Prospective, population-based study of ~3000 adults 70 years and older

Hearing Loss & Cognition
Background

- **Memory**
  - Free and cued selective reminding test (FCSRT)
- **Executive Function**
  - Trail Making B
  - Stroop Mixed
  - Digit symbol substitution
  - Psychomotor/processing speed
  - Verbal function & language

These tests are not dependent on hearing.

Executive Function: Trail Making B

Executive Function: Stroop Mixed

Projected Worldwide Prevalence of Dementia 2010-2050

Alzheimer's Disease International, 2009
Hearing Loss & Cognition

Executive Function: Digit Symbol Substitution Test (DSS)

NHANES N = 605 adults 60-69 years


BLSA N = 347 adults >60 years

Hearing Loss and Cognition

Cross-Sectional Studies

Models adjusted for age, sex, race, education, diabetes, smoking, hypertension

Hearing Loss & Cognitive Decline

Adjusted 3MS & DSS scores by years of follow-up and hearing loss status in 1,966 adults > 70 years followed for 6 years


text

41% faster rate of cognitive decline in 3MS scores in HL vs. NH

Hearing Loss & Accelerated Brain Volume Decline

BLSA

• Hypothesis: Hearing loss is associated with accelerated atrophy in the superior, middle, and inferior temporal gyri

• 126 participants (56-86 yrs) in the neuroimaging substudy of the BLSA

• Mean follow-up duration of 6.4 years

• 1.5T MRI performed annually

Voxel-Based Analyses

Difference in mean gray matter volume change in those with HL vs. NH
Age-Related Hearing Loss (ARHL)

**Basic Questions**

- What are the consequences of ARHL for older adults?
- What is the impact of treating ARHL on older adults?
- How can ARHL be effectively addressed in the community?

The question of whether treating hearing loss could delay cognitive/physical decline or dementia remains unknown.

There has never been a randomized clinical trial of treating hearing loss to explore effects on reducing the risk of cognitive decline/dementia.

**Hearing Loss & Cognition**

**Mechanistic Pathways**

Hearing loss intervention could:
- Reduce the cognitive load of processing degraded sound
- Provide increased brain stimulation
- Improve social engagement

Role of HL as a potentially modifiable, late-life risk factor for cognitive decline & dementia
**Conceptual Model for the Aging, Cognition, and Hearing Evaluation in Elders (ACHIEVE Healthy Aging) RCT**

In collaboration with Marilyn Albert, Joe Coresh, Richey Sharrett, ARIC Study Team (T. Mosley, D. Knopman, C. Jack), and U. South Florida (T. Chisolm, A. Eddins)

**Intervention**
- Best-Practices Hearing Rehabilitation Treatment
- Successful Aging Control

**Proximal/Mediating Outcomes**
- Audibility of speech & environmental sounds
- Enhanced Verbal Communication & Social Engagement

**Primary Outcome**
- Cognitive Functioning

**Secondary Outcomes**
- HRQL
- Social/Leisure Activities
- Daily Functioning
- Mobility
- Brain structure

**Intervention Proximal/Mediating Outcomes**

**Secondary Outcomes**

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**Age-Related Hearing Loss (ARHL) Basic Questions**

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**Age-Related Hearing Loss (ARHL) Prevalence in the U.S., 1999-2006**

<table>
<thead>
<tr>
<th>Age (in years)</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-59</td>
<td>0</td>
</tr>
<tr>
<td>60-69</td>
<td>10</td>
</tr>
<tr>
<td>70-79</td>
<td>30</td>
</tr>
<tr>
<td>80+</td>
<td>80</td>
</tr>
</tbody>
</table>

**Prevalence of Hearing Aid Use**

- **United States** (Arch Int Med, 2012)
  - 26.7M adults ≥ 50 years with hearing loss
  - 3.8M use hearing aids
  - Overall rate of HA use: 14.2%
- **England and Wales** (NICE Report, 2010)
  - 8.1M with hearing loss
  - 1.4M use hearing aids
  - Overall rate of HA use: 17.3%
Barriers to Hearing Health Care (HHC)

Cost/Affordability

Access to Services & Technology

Current (only) gold-standard model of HHC:
- Repeat clinic-based visits with audiologist/dispenser for evaluation, counseling, sensory management, fitting
- FDA/state regulations restrict direct access to hearing aids

Barriers to Hearing Health Care (HHC)

Cost/Affordability

Awareness & Understanding

Access to Services & Technology

Technology Design & Utility

Hearing when it really matters...

Proprietary 2.4GHz or 900MHz

FM Receiver

Streamer

Remote Mic

Barriers to Hearing Health Care (HHC)

Cost/Affordability

Awareness & Understanding

Access to Services & Technology

Barriers to Hearing Health Care (HHC)

Cost/Affordability

Awareness & Understanding

Access to Services & Technology
How can ARHL be effectively addressed in the community?

**Future Trends**

- Understanding & approaching hearing loss in the context of healthy aging/public health
  - Institute of Medicine Workshop – Report due 2016
  - White House Conference on Aging & President’s Council of Advisors on Science & Technology – Report due Fall 2015

**IOM Workshop on Hearing Loss & Healthy Aging**

January 13-14, 2014 Washington, D.C.

- Two-day workshop addressing:
  - Implications of HL for healthy aging/public health & needed areas of research
  - Developing innovative models of care & technologies to address HL
  - Short & long-term collaborative strategies to approach HL as a public health priority in the U.S.

www.iom.edu/hearingloss-aging

PCAST is an advisory group of the nation’s leading scientists and engineers who directly advise the President and the Executive Office of the President. PCAST makes policy recommendations in the many areas where understanding of science, technology, and innovation is key to strengthening our economy and forming policy that works for the American people.
How can ARHL be effectively addressed in the community?

Future Trends

- Understanding & approaching hearing loss in the context of healthy aging
  - Institute of Medicine – Report due 2016
  - White House PCAST – Report due Fall 2015

- Innovations in hearing health care/technology
  - Accessible services & affordable technology

Innovations in Hearing Health Care

Affordable & Accessible Options are Needed

- **Technology** – Personal sound amplifiers (PSAP)
  - Over-the-counter “hearing aids” with in-situ testing & verification
  - Cost < $100-300

Electroacoustic Analysis of PSAPs

Innovations in Hearing Health Care

Affordable & Accessible “Stepping Stones” are Needed for Hearing Health Care

- **Technology** – Personal sound amplifiers (PSAP)
  - Over-the-counter “hearing aids” with in-situ testing & verification
  - Cost < $100-300

- **Services** - Community health care workers
  - Community-based hearing screening
  - Counseling, education, & provision of sound amplifiers & other assistive technologies
  - Referral as needed
**Access HEARS: Hearing care Equality through Accessible Research & Solutions**

**HEARS Intervention:**
1. Hearing loss screening
2. Self-fit amplification device
3. Individual programming
4. Counseling
5. Expectation management
6. Communication strategies

- Pilot Studies in Multiple Populations
- Outcomes in participant & communication partner
- Social Engagement
- Communication Activities
- HRQL

**Pilot Studies in Multiple Populations**
- Carrie Nieman
- Sara Mamo
- Janet Choi

**Licensing & Dissemination**
- Non-profits
- Local government


**Communication Tips and Tricks**

1. Attention First
2. Get Face to Face
3. Speak Slowly
4. Big Ideas and Key Words
5. Repeat then Reword
6. Summarize

**Communication Tip #2: Repeat then Reword**

If someone did not understand you, repeat it once. If that does not work, reword it.

- What did you think of the meal?
- What did you think of the meal?
- Tell me about the food.

Repetition only works once.

**How We Hear**

There are 3 main steps in how we hear.

- Sound enters ear
- Signal goes to brain
- Brain interprets signal

- Checklist
  - Explain the 3 steps of hearing

** Baltimore HEARS**

- Learn to Use a Listening Device
- Understanding Hearing
- Communication Tips and Tricks

**Normal Hearing**

- How are you?

**Some Hearing Loss**

- How are you?

**A lot of Hearing Loss**

- How are you?
Additional Models of Hearing Health Care are Needed

<table>
<thead>
<tr>
<th>Role</th>
<th>Time/Expense</th>
<th>Expertise</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Audiolist as the Leader of a Team</td>
<td>3-6 months</td>
<td>$$$</td>
<td>Gold Standard Audiology Care</td>
</tr>
<tr>
<td>Community Health Worker</td>
<td>1-2 months</td>
<td>$$</td>
<td>$$</td>
</tr>
<tr>
<td>Personal Sound Amplifier</td>
<td>1/2 day</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Earpiece</td>
<td>1-2 hours</td>
<td>$</td>
<td>$</td>
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<tr>
<td>Hearing Aid Dispenser</td>
<td></td>
<td>$$$$</td>
<td>$$$</td>
</tr>
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How can ARHL be effectively addressed in the community?

Future Trends

- Understanding & approaching hearing loss in the context of healthy aging
  - Jan 2014 Institute of Medicine Workshop in the U.S.
- Innovations in hearing health care/technology
  - Accessible services & affordable technology
  - Open wireless standards

Open Wireless Standards

- Fundamental limitation of all hearing aids?
- How to increase signal-to-noise ratio?
- Options:
  - Post-microphone
  - Algorithmic processing of sound
  - Pre-microphone
  - Hearing loop systems
  - Proprietary wireless systems (2.4Ghz, 900Mhz)
Hearing when it really matters...

Convergence of medical devices with consumer electronics

How can ARHL be effectively addressed in the community?

Future Trends

Acknowledgments