What No One Is Saying: The Impact of Diabetes on Hearing and Balance

April 14, 2021
CDC Welcome

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Centers for Disease Control and Prevention (CDC)
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  - Sign in at TCEOnline
  - Complete the evaluation
  - Pass the posttest with 60%

https://tceols.cdc.gov/
Password: Diabetes
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• If you have never registered in TCEOnline, you will have to create a new account.
  • Returning users should login with their existing username and password.
Today’s Moderator

Kathy Dowd, AuD
Executive Director
The Audiology Project
Setting the Stage: Diabetes and Ear Health

**Hearing Loss**
- Cochlear microangiopathy
- Neural degeneration

**Balance and Fall Risk**
- Foot neuropathy and vision effects
- Vestibular effects of diabetes

**Diabetic Pain and Infection Control**
- Ototoxicity
- Vestibulotoxicity
Audiology Scope of Practice

- Audiology evaluation and management of hearing
- Balance screening and evaluation
- Treatment of hearing loss and balance problems
- Counseling for social, job, personal
- Tinnitus, cochlear implants, pediatric specialties
Today’s Objectives

1. Identify the underlying relationships between blood sugar management, hearing loss, and balance as it relates to both prediabetes and diabetes.

2. Explain the benefits of regular ear health screenings and education for people with diabetes as part of diabetes care and self-management, including through the provision of diabetes self-management education and support (DSMES) services, and in community or team-based clinical settings.

3. Understand how to utilize communication, education, and other strategies and resources for promoting screening for ear health conditions and for supporting people with diabetes, or those who are at risk for type 2 diabetes, who already have hearing loss or difficulties with maintaining balance.
Have a Question for our Speakers?

Submit your question by clicking the Q&A icon located below. We’ll do our best to answer all questions during the Q&A portion at the end of this webinar.
Today’s Presenters

Patricia Gaffney, AuD
Christopher Spankovich, AuD, PhD, MPH
Erin G. Piker, AuD, PhD, CCC-A
Anjulyn M. Ballard, PhD
OVERVIEW OF AUDITORY AND VESTIBULAR SYSTEMS

PATRICIA GAFFNEY, AUD
NOVA SOUTHEASTERN UNIVERSITY
Poll Question #1
Ears

- Ears are missing from most consumer awareness information
- Very few resources have the ears listed

Hearing Loss and Diabetes in the United States

37.5 million adults have some trouble hearing

122 million adults have diabetes or prediabetes

Link Between Diabetes and Hearing Loss


- Odds ratio of 1.82 of mild or greater hearing loss
Odds Ratios from Studies for Participants with Hearing Loss and Diabetes

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>OR (95% CI)</th>
<th>Diabetes Cases/N</th>
<th>Non-diabetes Cases/N</th>
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</thead>
<tbody>
<tr>
<td>Bamanie et al.</td>
<td>2011</td>
<td>3.24 (1.76, 5.97)</td>
<td>57/109</td>
<td>22/87</td>
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<tr>
<td>Mozaffari et al.</td>
<td>2010</td>
<td>3.00 (1.33, 6.79)</td>
<td>24/80</td>
<td>10/80</td>
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<tr>
<td>Uchida et al.</td>
<td>2010 [40-64 years]</td>
<td>1.98 (0.95, 4.12)</td>
<td>9/67</td>
<td>98/1349</td>
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<tr>
<td></td>
<td>2010 [65-86 years]</td>
<td>1.36 (0.86, 2.15)</td>
<td>50/84</td>
<td>419/806</td>
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<tr>
<td>Cheng et al.</td>
<td>2009 [NHANES I]</td>
<td>1.81 (1.30, 2.52)</td>
<td>69/150</td>
<td>970/3033</td>
</tr>
<tr>
<td>de Sousa et al.</td>
<td>2009</td>
<td>2.69 (1.22, 5.90)</td>
<td>16/27</td>
<td>210/598</td>
</tr>
<tr>
<td>Aladag et al.</td>
<td>2009</td>
<td>0.84 (0.37, 1.91)</td>
<td>28/63</td>
<td>18/37</td>
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<tr>
<td>Mitchell et al.</td>
<td>2009</td>
<td>1.62 (1.21, 2.16)</td>
<td>105/210</td>
<td>630/1648</td>
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<tr>
<td>Sakuta et al.</td>
<td>2006</td>
<td>1.77 (1.15, 2.70)</td>
<td>62/103</td>
<td>274/594</td>
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<tr>
<td>Hetzer et al.</td>
<td>2005</td>
<td>1.44 (1.13, 1.82)</td>
<td>248/371</td>
<td>982/1681</td>
</tr>
<tr>
<td>Wei Huang</td>
<td>2004</td>
<td>6.48 (3.21, 13.10)</td>
<td>56/75</td>
<td>25/80</td>
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<tr>
<td>Dalton et al.</td>
<td>1998</td>
<td>1.83 (1.46, 2.30)</td>
<td>203/344</td>
<td>1333/3029</td>
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<tr>
<td>Marumo et al.</td>
<td>1984</td>
<td>2.54 (1.18, 5.47)</td>
<td>86/110</td>
<td>24/41</td>
</tr>
<tr>
<td>Minami et al.</td>
<td>1977</td>
<td>3.20 (2.04, 5.04)</td>
<td>55/89</td>
<td>256/763</td>
</tr>
<tr>
<td>Overall (I-squared = 76.2%, p = 0.000)</td>
<td></td>
<td>2.15 (1.72, 2.68)</td>
<td>1251/2273</td>
<td>6126/17921</td>
</tr>
</tbody>
</table>

NOTE: Weights are from random effects analysis
Falls and Diabetes in the United States

36 million falls in older adults per year

122 million adults have diabetes or prediabetes

Vestibular Loss, Falls, and Diabetes

- Li, et al (2019) found a higher incidence of vestibular dysfunction in patients with diabetes
- Chen, et al (2020) meta-analysis showed diabetes was a risk factor for benign paroxysmal positional vertigo (BPPV)
- Walley, et al (2014) showed abnormal performance on postural testing and abnormal vestibular tests with diabetes patients
- Agrawal, et al (2010) reported that vestibular dysfunction increased the odds of falling in older adults
Poll Question #2
Audiologists

- Masters or doctoral level non-physician provider
- Counsel patients; evaluate hearing, tinnitus, and vestibular
- Treat and manage with hearing aids, tinnitus maskers, vestibular repositionings/rehabilitation
- Variety of settings: hospitals, ear, nose and throat (ENT) offices, universities, Veterans Affairs (VA) medical centers, and private practices
Professionals Who See Those with “Ear” Complaints

<table>
<thead>
<tr>
<th>Otolaryngology</th>
<th>Audiology</th>
<th>Hearing aid dispenser</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Physicians that treat medical and surgical issues of the ear</td>
<td>• Assess hearing, tinnitus, vestibular of all ages</td>
<td>• Assess hearing</td>
</tr>
<tr>
<td>• Prescribe medication</td>
<td>• Treat and manage disorders of hearing and vestibular (ex. hearing aids,</td>
<td>• Fit with hearing aids</td>
</tr>
<tr>
<td>• Education: DO, MD</td>
<td>repositionings)</td>
<td>• Education: minimum of HS diploma</td>
</tr>
<tr>
<td></td>
<td>• Education: Masters, AuD, PhD</td>
<td></td>
</tr>
</tbody>
</table>
**Inner Ear - Cochlea**

- **Hair Cells**
  - These small hair cells are the sensors for hearing
- **Stria Vascularis**
  - Blood supply to the cochlea


https://acoustixhearing.co.nz/media/24822/acoustix-hearing-damaged-ear-hair-cells-widx-apS-4.jpg
Hearing Loss

Conductive
- Hearing loss caused by an abnormality of the outer/middle ear
- Can often be treated through medication/surgery

Sensorineural
- Hearing loss caused by damage to the cochlea or auditory nerve
- Permanent hearing loss*
- Typically treated with a hearing aid or cochlear implant

Mixed
- Hearing loss that has a conductive component and a sensorineural component
- The conductive component could be treated
Vestibular

https://greymattersjournal.org/content/images/2020/06/The_Vestibular_System_and_the_Spins--_A_Proposal.jpg
Inner Ear - Vestibular

Semicircular Canals
Detect rotation
Angular movement

Otoliths
Detect gravity,
linear acceleration,
tilt, centrifugation

Vestibular Pathway

https://otorrinos2do.files.wordpress.com/2009/12/4.jpg
Key Takeaways

- Impacts of diabetes on the ear are often not addressed
  - Need to ask the questions and make the referrals

- Audiologists are the professionals who test hearing and vestibular
  - Knowing where to refer

- Hearing loss and vestibular loss is permanent
  - Prevention is key
References


DIABETES AND HEARING

CHRISTOPHER SPANKOVICH, AUD, PHD, MPH
ASSOCIATE PROFESSOR, VICE CHAIR OF RESEARCH
Poll Question #3
Delhez et al. (2019)
How Does Diabetes Cause Damage?

- Microangiopathy
- Mitochondrial dysfunction
- Advanced glycation end products
- Inflammation
- Glutathione dysregulation
- Protein synthesis dysfunction
- Glutamate excitotoxicity
Recap: Summary of Literature

- Overall, the evidence indicates that diabetes is a significant determinant of hearing dysfunction.
- Human and animal studies suggest both cochlear and neural deficits related to microangiopathy, oxidative stress, and glutamate excitotoxicity.
- Diabetes can create earlier onset of hearing loss and increase risk for other hearing loss-related factors (e.g., noise).
Screening and Diagnosis
Diagnosis

• **Sensorineural Hearing Loss (SNHL)**
  – Damage to inner ear sensory and neural receptors
  – More common type of hearing loss expected

• **Conductive Hearing Loss (CHL)**
  – Limited data on CHL and diabetes
  – General increase for infections warrants exclusion

• **Mixed Hearing Loss**
  – Combination of SNHL and CHL

• **Tinnitus and Sound Sensitivity**
  – Commonly related to hearing loss and associated with diabetes even without hearing loss
When to Screen/Considerations

• Upon diagnosis of diabetes, a baseline hearing evaluation is recommended (be aware of psychological status)
• Hearing loss can manifest early

High risk considerations:
• Reduced hearing (particularly in noise)
• Tinnitus perception
• History of high noise exposure
• History of ototoxic drug use
  – e.g., aminoglycosides, platinum-based chemotherapy, furosemide (intravenous in particular)
• Sensitivity to sound
• Ear pain or drainage (Otolaryngology)
• Sudden hearing loss (Otolaryngology)
• Dizziness complaints
### Screening Recommendations

**Table 1.** Audiologic Screening Questions for Diabetes.

<table>
<thead>
<tr>
<th>Question</th>
<th></th>
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<tbody>
<tr>
<td>1. Do you or your family perceive any change in your hearing?</td>
<td></td>
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<tr>
<td>2. Do you have hearing difficulty in quiet or noise?</td>
<td></td>
</tr>
<tr>
<td>3. Have you had your hearing tested in the past 2 years?</td>
<td></td>
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<tr>
<td>4. Do you know how diabetes can affect your hearing?</td>
<td></td>
</tr>
<tr>
<td>5. Do you know what to do if you perceive a change in hearing?</td>
<td></td>
</tr>
<tr>
<td>6. Do you know how to reduce your risk for hearing loss?</td>
<td></td>
</tr>
</tbody>
</table>

*If the patient answers “yes” to question 1 or 2 or “no” to questions 3 through 6, it is recommended they be referred for a diagnostic audiological evaluation.*

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*Piker, Spankovich, Romero, Memering, Pierantoni (2020)*
Diagnostic Recommendations

• Comprehensive audiological evaluation (at minimum)
  – Air Conduction
  – Bone Conduction
  – Speech Audiometry

• At least every 2 years, annual or greater if high risk factors indicated or patient reports change in hearing status
Diagnostic Considerations

• **Extended high frequencies**
  - >8000 Hz may show early changes, consider testing based on patient subjective complaints if hearing below 8000 Hz within normal range

• **Otoacoustic emissions**
  - Byproduct of active mechanism of cochlea
  - Can show subtle changes due to alterations in cochlear active process prior to changes in thresholds

• **Auditory evoked potentials**
  - Can show effects of sensitivity to neuropathology and glutamate excitotoxicity

• **Tinnitus evaluation**

• **Central auditory processing**
Recap

• The most common type of hearing loss related to diabetes is sensorineural.
• Asking simple questions about hearing status, presence of tinnitus, or ability to understand speech in noise can serve as a useful screening.
• A comprehensive audiological evaluation can help set a baseline for hearing and allow for early counseling on prevention.
• Testing every 2 years is recommended, more often depending on risk factors (e.g., ototoxic drug use).
• Be familiar with high risk factors (such as history of high noise exposure)
Prevention and Treatment
## Prevention 3 x 3

<table>
<thead>
<tr>
<th></th>
<th>Primary</th>
<th>Secondary</th>
<th>Tertiary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary</strong></td>
<td>Prevent hearing loss</td>
<td>Early identification and intervention</td>
<td>Management and rehabilitation</td>
</tr>
<tr>
<td><strong>Secondary</strong></td>
<td>Individual counseling (e.g., hearing</td>
<td>Individual diagnostic evaluation and</td>
<td>Amplification, cochlear implant, auditory</td>
</tr>
<tr>
<td></td>
<td>conservation)</td>
<td>counseling</td>
<td>rehab</td>
</tr>
<tr>
<td><strong>Tertiary</strong></td>
<td>Community</td>
<td>Improved access to preventative care</td>
<td>Improved access to hearing health care</td>
</tr>
<tr>
<td></td>
<td>Improved access to hearing diagnostics</td>
<td>Improved access to hearing care</td>
<td></td>
</tr>
<tr>
<td></td>
<td>System</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Media/public health campaign</td>
<td>Health fair, screening, referral</td>
<td>Living with hearing loss classes (group AR)</td>
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</tbody>
</table>

- **Primary Prevention:** Prevent hearing loss. Includes individual patient counseling (e.g., hearing conservation) and community media/public health campaign.
- **Secondary Prevention:** Early identification and intervention includes individual diagnostic evaluation and counseling.
- **Tertiary Prevention:** Management and rehabilitation includes amplification, cochlear implant, and auditory rehab.
- **System Improvement:** Includes improved access to preventative care, improved access to hearing diagnostics, and improved access to hearing health care.
Prevention: Direct

Patient Counseling

- Persons with diabetes have greater susceptibility to acquired hearing loss
  - Noise: Use hearing protection
  - Ototoxic medication: Careful monitoring
  - Earlier onset related to age: Difficulty understanding speech in background noise, tinnitus

Evaluation is Important

- Baseline
  - Threshold assessment, speech in noise, otoacoustic emissions
  - Follow-up at least every 2 years, earlier if at risk
- Further counseling
Prevention: Indirect

Patient Counseling

- Poorly managed diabetes and presence of co-morbidities is associated with greater incidence of cochlear and auditory neural pathology
  - Insulin control
- Level of physical activity and quality of diet are associated with risk of diabetes complications
- including hearing loss
Figure 1. A. High frequency (HFPTA) and B. low frequency pure-tone average (LFPTA) and healthy eating index quintiles.
Manage your ABCs

Ask your health care team to help you set and reach goals to manage your blood sugar, blood pressure, and cholesterol and stop smoking—also known as the ABCs of diabetes.

- **A1C (a measure of your average blood sugar over 3 months):** The goal set for many people is less than 7% for this blood test, but your doctor might set a different goal for you.

- **Blood pressure:** High blood pressure causes heart disease. The goal is less than 140/90 mmHg for most people but check with your doctor to see what your goal should be.

- **Cholesterol:** LDL or “bad” cholesterol builds up and clogs your blood vessels. HDL or “good” cholesterol helps remove the “bad” cholesterol from your blood vessels. Ask your doctor what your cholesterol numbers should be.

- **Smoking:** If you smoke or use other tobacco products, take steps to quit. Call 1-800-QUIT-NOW (1-800-784-8669) for support.

Teach your family about your diabetes and the ABCs so they can help you.
Aural Rehabilitation and Communication

- Communication strategies (patient-provider interaction)
- Assistance listening devices (pocket talker and smart devices during clinical encounters)
- Speech reading

Eby, Arteaga, Spankovich (2020)
Management

- Hearing Aids
  - Non-surgical
  - Slight to profound hearing loss
- Cochlear Implants
  - Severe to profound hearing loss
Recap: Diabetes and Hearing

**Prevention 1,2,3** is
- Auditory and diabetes management
- Hearing conservation, lifestyle (diet + physical activity), ABCs
- Improved access to preventive care

**Early Identification**
- Thresholds including extended high frequencies
- Otoacoustic emissions; auditory brainstem response
- Improved access to hearing diagnostics

**Management**
- Auditory rehabilitation
- Amplification/cochlear implant
- Improved access to health care
Any questions? Email: cspankovich@umc.edu

References


• Austin et al. (2009). Diabetes-related hearing changes, Laryngoscope 119 (9) 1788-1796.


• Piker et al. (2020). What you need to know about the hearing and vestibular consequences of diabetes, ADCES in Practice, September Issue, 20-27.
DIABETES AND BALANCE

ERIN G. PIKER, AUD, PHD, CCC-A
JAMES MADISON UNIVERSITY
Risk of Falls

• Each year 3 million older people are treated in emergency departments for fall injuries
• 1 out of 5 falls causes serious injury
  • broken bones, head injury
  • 95% of hip fractures caused by falling
• 2015: total medical costs for falls > $50 billion
• Many who fall, even if not injured, become afraid of falling

https://www.cdc.gov/falls/facts.html
Risk Factors for Falls

**EXTRINSIC | Factors**
- Lack of stair handrails
- Poor stair design
- Lack of bathroom grab bars
- Dim lighting or glare
- Obstacles & tripping hazards
- Slippery or uneven surfaces
- Psychoactive medications
- Improper use of assistive device

**INTRINSIC | Factors**
- Advanced age
- Previous falls
- Muscle weakness
- Gait & balance problems
- Poor vision
- Postural hypotension
- Chronic conditions including arthritis, stroke, incontinence, diabetes, Parkinson’s, dementia
- Fear of falling

Effective clinical and community interventions exist for the following fall risk factors:

- Vestibular disorder/poor balance
- Vitamin D insufficiency
- Medications linked to falls
- Postural hypotension
- Vision impairment
- Foot or ankle disorder
- Home hazards

Poll Question #4
Risk of Falls and Vestibular Impairments

- Abnormal gait, dizziness\(^1\)
- Independent risk factor for falling
  - Increase odds of falling over 12-fold\(^2\)

\(^1\)Anson et al. (2019); \(^2\)Agrawal et al. (2020)

73% vestibular impairment
Risk of Falls and Diabetes

• Independent risk factor for falling
• Annual incidence of falls 39\%^3
• Can affect vision, proprioception, and vestibular

^3Yang et al. (2016)
Central Nervous System

Proprioceptive

Visual

Vestibular

Central Nervous System
Diabetes and Vestibular Pathology

- National Health and Nutrition Examination Survey (NHANES)\textsuperscript{4}
- N = 1,136; 17% had diabetes
- Peripheral neuropathy
  - Mild 19%
  - Severe 7.1%
- Retinopathy
  - Mild 54%
  - Severe 22%
- Vestibular dysfunction 54%

\textsuperscript{4}Agrawal et al. (2010)
Diabetes and Vestibular Pathology (cont.)

- SCC dysfunction\textsuperscript{5-7}
- Otolith dysfunction\textsuperscript{8-10}
- BPPV\textsuperscript{11-14}
Diabetes, Vestibular Pathology, and Risk of Falls

- Patients with diabetes 70% more likely to have vestibular loss and/or balance problem
- Vestibular loss in patients with diabetes increases odds of falling 2-fold (Odds Ratio 2.3)
- Diabetes risk associated with BPPV

Longer duration of diabetes, greater serum hemoglobin A1C levels

4 Agrawal et al. (2010)
Vestibular/Balance Screening Strategies Overview

Functional balance:
- Romberg on foam
- Timed Up and Go
Vestibular/Balance Screening Strategies: Timed Up and Go

Vestibular/Balance Screening Strategies

Self-report

- “Have you fallen”, “do you have a fear of falling”
- Dizziness Symptom Profile – can pick up cases of BPPV

- Counseling and information

Key Takeaways - Vestibular

• Risk of falls
  – Vestibular impairment = risk of falls
  – Diabetes = risk of falls
  – Vestibular and Diabetes = GREATER risk of falls

• Effects of diabetes on vestibular system
  – Epidemiologic evidence of strong association
  – Clinical evidence emerging

• Screening
  – Self-report
  – Functional
  – Counseling
References and Resources

References


Resources

- Risk of falls facts: [https://www.cdc.gov/falls/facts.html](https://www.cdc.gov/falls/facts.html)
- Timed Up and Go: [https://www.cdc.gov/steadi/pdf/TUG_test-print.pdf](https://www.cdc.gov/steadi/pdf/TUG_test-print.pdf)
VESTIBULAR THERAPY

ANJULYN M. BALLARD, PHD, ORISE FELLOW
CENTERS FOR DISEASE CONTROL AND PREVENTION
DIVISION OF DIABETES TRANSLATION
Vestibular Therapy Overview

- **Goal** - to alleviate symptoms
  - Dizziness
  - Imbalance
  - Vertigo
  - Visual Disturbance

- **Vestibular system damage** - damage is normally permanent, restoration of vestibular function tends to be small

- **Compensation from other senses** - vision/sight, sensory from lower limbs
  - Needed to reduce symptoms
Prescription and Administration of Activities

Facilitated by an Occupational Therapist or Physical Therapist

• Trained to identify the problem(s) related to the vestibular disorder
• Critical for prescribing exercises that target individual symptoms
Prescribed Exercise Methods

**Habituation**
Used to reduce dizziness through repeated exposure to visual stimulation

**Gaze Stabilization**
Used to improve control of eye movement to make vision clear during head movement

**Balance Training**
Used to improve steadiness so that daily activities for self-care, work, and leisure can be performed successfully

*Treated Symptoms:*
- Things appear to bounce or jump around with head movement
- Difficulty walking on uneven surfaces or walking in the dark
Tai Chi

• Used by the general public
• Recommended by therapists
  – Balance training
  – *Does not directly target symptoms of dizziness or unstable vision*
• Best to have someone consult with a therapist or medical professional
• Uninsured/under-insured?
  – Identify local pro bono services
  – Locate other community resources
Vestibular therapy is used to treat symptoms that result from inner ear damage

- Administered by Occupational Therapists and Physical Therapists
- Best to seek therapy from either professional
  - Trained to identify the symptoms and prescribe specific therapeutic activities

Tai Chi

- Exercise activity that’s generally been used to help restore balance
- Does not directly treat dizziness, vertigo, and visual disturbance
  - It may help alleviate these symptoms in some capacity
In Summary…

• Impacts of diabetes on the ear are often not addressed
• Refer to an audiologist for problems with hearing and balance
• Prevention is key because hearing and vestibular loss are permanent:
  – Manage the ABCs of diabetes
  – Early identification of hearing and balance problems
• Audiologists can help manage hearing loss by fitting for hearing aids
• Vestibular impairment and diabetes both create an increased risk of falls
  – Screenings for vestibular impairment are short, simple, and can help identify someone who may need further evaluation
• Vestibular therapy by trained professionals is used to treat symptoms from inner ear damage
• Tai Chi is an example of an activity that is generally used to help restore balance
Use the Chat Box!

What resources (handouts, webinars, etc.) would be helpful to you so that you feel more comfortable talking about this topic?
Take Charge of Your Diabetes:
Healthy Ears

Share CDC’s new resource for people with diabetes!

https://www.cdc.gov/diabetes/library/factsheets/healthy-ears.html
QUESTION AND ANSWER

Please type your questions into the Q&A box
Thank You

Send questions after the webinar to:
DDT_DiabetesWebinar@cdc.gov

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National Center for Chronic Disease Prevention and Health Promotion
Division of Diabetes Translation

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.