

CDC, Division of Diabetes Translation
What No One Is Saying: The Impact of Diabetes on Hearing and
Balance
Quick Learn

Transcript

Welcome

Betsy Rodriguez: Good afternoon and good morning to viewers in the West Coast, Alaska, and Hawaii.

Welcome to our webinar, What No One Is Saying: The Impact of Diabetes on Hearing and Balance. My name is Betsy Rodriguez, and I am a senior public health advisor in the Division of Diabetes Translation of the Centers for Disease Control and Prevention.

Today's Moderator – Kathy Dowd

At this time, I am pleased to introduce our moderator for today's webinar, Dr. Kathy Dowd, executive director of The Audiology Project. Kathy Dowd is the executive director of The Audiology Project, working to raise awareness of the links between diabetes, hearing loss, and vestibular and risk of falls. She received her undergraduate [degree] in French at Spalding University in Louisville, Kentucky, in 1972; a master in audiology from University of Louisville in 1978; and a clinical doctorate from Salisbury University in 2008. Dr. Dowd's experience in audiology is in school education audiology, state agencies, ENT clinics, and private practice. Kathy, take it from here.

Today's Presenters

Kathy Dowd: I'm so pleased to present our expert panel. Dr. Patricia Gaffney, AuD. She is a professor of audiology at Nova Southeastern University in Fort Lauderdale, Florida. She teaches didactically and clinically in the specialty areas of vestibular diagnostics and treatment and amplification. She received her BA from the George Washington University and AuD from the University of Pittsburgh in 2005. Dr. Christopher Spankovich is an associate professor at the University of Mississippi Medical Center School of Medicine in the Department of Otolaryngology and

Communications Sciences. He serves as the director of Clinical Research for the department as well as the director of Education for the Division of Audiology. He obtained his BA in psychology from the University of North Carolina at Wilmington, his master's in public health in behavioral science and health education from Emory University, and his AuD from Rush University, and a PhD in hearing sciences also from Vanderbilt University. Dr. Erin Piker is an associate professor and director of the Vestibular Sciences Lab in the Department of Communication Sciences and Disorders at James Madison University (JMU) in Virginia. Prior to her position at JMU, Dr. Piker spent four years as the director of auditory and vestibular research at Duke University Medical Center. She received her AuD from Vanderbilt University in 2008 and her PhD in hearing science with a minor in neuroscience from Vanderbilt University in 2012. Anjulyyn Ballard, PhD, is an exercise physiologist and a recent graduate of Georgia State University. She is an ORISE (O-R-I-S-E) fellow in the Division of Diabetes Translation at CDC, and she's currently working in collaboration with partners and stakeholders on the programs and services that are under the National Diabetes Prevention Program.

Hearing Loss and Diabetes in the United States

Patricia Gaffney: So, let's look at some basic epidemiologic data. There are approximately 122 million adults in the United States that have diabetes or prediabetes, according to the 2020 National Diabetes Statistics Report. Additionally, there are 37.5 million adults that have some degree of hearing loss. So, there is an overlap of these two groups, but are they intertwined or are they just coexisting issues?

Odds Ratios from Studies for Participants with Hearing Loss and Diabetes

Horikawa, et al. in 2013 performed a meta-analysis of studies of diabetes and hearing loss. They used 13 studies which had a pooled participant number of 20,194. They concluded that there is a higher prevalence of hearing impairment in patients with diabetes, compared to patients without diabetes, regardless of age. The figure shown here is a forest plot of odds ratios of hearing

impairment for participants with diabetes compared to those who do not [have diabetes]. There was a consistent positive association between diabetes and hearing impairment. In this graphic here, the size of the squares represents the statistical weight of each study. The pooled odds ratio is indicated by the unshaded diamond at the bottom, which shows an odds ratio of 2.08. This suggests that hearing impairment is more prevalent in those with diabetes than adults without diabetes.

Professionals Who See Those with “Ear” Complaints

So, I just want to clarify how audiology fits into the professional space as far as who sees patients with ear complaints. So first off, otolaryngologists. Otolaryngologists, or ENTs, are physicians that see patients to treat medical conditions through medication or surgery, such as ear infections, tumors, or other diseases. Audiologists, as we discussed before, are non-physicians with master's or doctoral level degrees to evaluate hearing, tinnitus, and vestibular dysfunction, and hearing aid dispensers (or hearing instrument specialists) are generally individuals who can test hearing and fit hearing aid devices. In some states, they are allowed to evaluate tinnitus, but they cannot evaluate vestibular function, and they cannot evaluate children. The minimum level of education is a high school diploma.

Ear Anatomy and Physiology

So, I'm going to talk a little bit about the anatomy and physiology of the ear, so we're all on the same page. The ear is divided into three main sections. The first is the outer ear. This starts with the pinna aka the earlobe, goes through the ear canal up to the tympanic membrane or the eardrum. So, sound travels down this ear canal to vibrate the tympanic membrane. From there we have the middle ear. The middle ear is the tympanic membrane through the ossicles. So, the tympanic membrane vibrates, which then in turn vibrates the three ossicles—our malleus, incus, and stapes, and then we get to the inner ear. So, the inner ear is comprised of two sections. We have the vestibular section and the cochlear sensory section. The inner ear is fluid filled, and the

stapes pushes on the membrane, the oval window, to move that fluid.

Hearing Loss

There are three types of hearing loss. First is conductive hearing loss: this is hearing loss caused by an abnormality of the outer or middle ear. This can be something as simple as ear wax or more significant like a middle ear infection or otosclerosis. Typically, conductive hearing losses can be treated through medication or surgery. Next is sensorineural hearing loss, which is a hearing loss caused by damage to the cochlea and/or the auditory nerve. This hearing loss is generally permanent, and therefore it is treated with hearing aids and/or cochlear implant, if the hearing loss is severe enough. [The third type of hearing loss—] mixed hearing loss, is a combination of a conductive component and a sensorineural hearing loss. In many cases, the conductive component can be treated through medication or surgery, but there's still an underlying sensory loss. With diabetes, what we are mostly talking about is sensorineural hearing loss. Therefore, the damage to the auditory nerve in the cochlea is going to be permanent and generally progressive over time. With diabetes, the change in hearing would be gradual, and patients may not be aware of the loss until it is more significant.

Vestibular

So, let's switch gears and talk a little bit about the anatomy [and] physiology of the vestibular system.

So, the other half of the inner ear is the vestibular portion of the inner ear. This is the end organ that senses where we are in space. There are three semicircular canals. We have the anterior, often called the superior; we have the horizontal, also called the lateral; and the posterior, also called the inferior. We also have two otolith organs, the utricle and the saccule.

Inner Ear – Vestibular

Our three semicircular canals detect rotation and angular movement based on the fluid moving in the canals, deflecting the cupula and the underlying hair cells. You see that in the left picture, the cupula is centered over the hair cells at the bottom, and as the fluid moves, the hair cells bend

creating a response. In the right picture, it depicts the otolith organs, the utricle and the saccule. Both of these detect gravity, linear acceleration, tilt, and centrifugation. The otolith has a membrane with calcium carbonate crystals called otoconia sitting on top. As the weight of the crystals shift, it stimulates the hair cells underneath, causing a response. Abnormalities of either one of these can cause dizziness, vertigo, unsteadiness, imbalance, or tilt.

Vestibular Pathway

Benign paroxysmal positional vertigo is one common cause of positional vertigo caused by the otoconia coming out of the utricle and going into one of the semicircular canals. So, how does all of this relate to falls? To keep upright and balanced, there are three systems that are working together. We have vestibular, vision, and somatosensory. From the ear, there are neural projections that drive the eyes and the vestibulo ocular reflex, or the VOR pathway, to keep vision stable when we move. There's also communication to and from the cerebellum to help with motor movement and coordination. And additionally, there are projections from the ear that go down the vestibulospinal tract to coordinate posture and movement across the body. Knowing that diabetes also causes retinopathy and neuropathy, we can see that this is a perfect storm of fall risk issues when multiple balance systems are impaired.

Modifiable and Non-Modifiable Factors

Christopher Spankovich: Currently, we cannot modify our genetics, yet, however, we can modify our risk for hearing loss related to noise exposure and medications that can cause damage to the inner ear that we call ototoxic medication. Though there is some level of hearing loss that we can expect with age, particularly in the higher frequency range above the levels that are critical for speech understanding. So, [while] humans can hear from about 20 to 20,000 hertz, frequency ranges above 8,000 hertz don't have a lot of critical elements to hearing loss or critical elements to speech understanding, but indeed, that's where we can see the earliest effects of age. The area important for speech, though—damage there is not necessarily inevitable.

Screening and Diagnosis

Next, we're going to switch topics and talk about screening and diagnosis. What do we need to do to sort of screen individuals if they're having hearing difficulty? How do we make a diagnosis of that?

Diagnosis

So, the most common type of hearing loss, as Dr. Gaffney already mentioned, related to diabetes is going to be sensorineural hearing loss. This is going to be damage to the inner ear, sensory, and neural receptors. There is limited data to support [the idea] that diabetes can cause conductive hearing loss, but individuals with diabetes are at general increased risk for infections. So, we want to rule this out. Mixed hearing loss, as we heard, is a combination of these two things. We also need to consider tinnitus. Individuals with diabetes are at increased risk of reporting tinnitus, and tinnitus is a perception of ringing or buzzing in the ears.

When to Screen: Considerations

So, when do we screen and how do we screen? Well, it is our general recommendation that we want to screen as soon as possible after identification of diabetes, but we need to be cognizant that the diagnosis can be overwhelming for the patient, and that they have other things that they're dealing with as well. But our screening can start with some simple questions, and [we should] be aware that a person with diabetes can develop hearing loss earlier in life, and there are tools for reducing progression and for prevention. There are also high-risk considerations we need to be aware of. If a person has tinnitus, then they should [could] likely be referred to audiology for a hearing assessment. If they complain specifically of hearing difficulty and noise, [that's] another reason. If they have a job or occupation or activities or hobbies that are high noise exposure, again, they should [may] be referred. If they have a history of ototoxic drug use—these include

aminoglycosides, platinum-based chemotherapies, even furosemide, particularly if it's delivered intravenously— they should be monitored over time while they're on those drugs. Now, I will point out also the importance of our ENT colleagues. If the patient presents with a sudden hearing loss, if they're reporting ear pain, if they have drainage from their ear or blood and pus coming from the ear, these are reasons to refer to the otolaryngologist—to the ENT, because those can be medical issues. But the vast majority of hearing issues you're going to see with the diabetes population is [are] not going to be medically treatable. It's going to be under the scope of the audiologist and counseling and use of amplification and aural rehabilitation strategies and management.

Screening Recommendations

Okay, so how can we screen? So, some basic questions can help us screen, and those are listed here.

Just asking the person, do they feel like they're having any hearing difficulty, or does their family perceive that? Have they ever had their hearing tested before? Beyond asking questions, you can actually purchase little screening tools. An example is here—where this device here will, when you press a button, will play a tone to the ear. If the patient hears it, then they pass, and if they don't, then they likely need a referral for a diagnostic evaluation. What we recommend for a diagnostic evaluation is a comprehensive audiological evaluation, and this next slide shows what that looks like.

Diagnostic Recommendations

We can observe here an audiogram to the right. So, this is a hearing assessment that we will perform, and this is when you raise your hand when you hear the beep. We can do other tests as well, but this is one of our primary tests, and this should [is recommended to] be performed at least

every two years or annually, or even more often if there are higher risk factors. So, for example, if they were on an ototoxic drug.

Prevention and Treatment

So finally, we're going to move into the topic of prevention and treatment of hearing loss.

Prevention 3x3

So, when we think of prevention and treatment, we think of primary, secondary, and tertiary. Primary is going to refer to that we're preventing a hearing loss from occurring at all. Secondary is that we're going to get some early evidence of that and then try to prevent further progression, and tertiary is that they have hearing loss, and we're going to try to intervene for the issues that they're having, the hearing difficulties that they're having.

Prevention: Direct

So, we want to start with patient counseling. Persons with diabetes have greater susceptibility to acquired hearing loss. So, this can be utilization of hearing protection devices when around a loud sound; turning down the volume on the iPhone or whatever loud music they may listen to in the car; recognize that if they're on ototoxic medication, they do need to have careful monitoring; and letting the patient understand and know that they could have an earlier onset of hearing loss. And one way to recognize this is decreased understanding of speech, particularly in noisy backgrounds. Second, the evaluation establishing a baseline hearing test is critical for us to monitor hearing and monitor changes over time as well as to implement further counseling. And this further counseling can include topics that diabetes educators work [on] with their patients all the time, and this can be talking about physical activity, talking about nutrition.

Diabetes and Balance

Erin Piker: My research is on the vestibular sensory system, which is one we're not typically conscious

of. We're usually unaware of it until it stops working correctly. In a more sudden acute case, this can cause vertigo, and symptoms can be very severe. But in more gradual cases, like what we would see with aging or what I would expect with something like diabetes is symptoms are often manifested as our balance. So, we're going to talk about balance with a focus on risk of falls.

Risk of Falls

So, these are some falls facts right from the CDC. Each year, 3 million older adults are going to be treated in the emergency department for falls injuries. As many as one in three adults over 65 fall; however, only about 50% tell their doctor, and one out of five falls can cause a serious injury. The most serious are often broken bones, such as a hip fracture or a head injury, such as a traumatic brain injury. Falls are also costly. They're not just costly to individuals and their body but also to society. In 2015, the total medical cost for falls was over 50 billion, and many who fall, even if not injured, can become afraid of falling.

Risk Factors for Falls: Extrinsic and Intrinsic

So, remember, if one out of three fall but only half tell their doctor, this is an issue, because a fear of falling could cause a person to become less active. When that happens, they can become weaker, and when that happens, that can increase the risk of falling. So, there's a lot of things that can put someone at risk for falls. The CDC also has some fact sheets here on risk factors for falling. Most falls are going to be caused by an interaction of multiple risk factors, and they can usually be divided into either extrinsic things—those are things in your environment, so it could be dim lighting or a slippery surface, and then intrinsic. And in the population I work with, my patients are often advanced age. They've either previously fallen, or they have a fear of falling, and many have chronic conditions, but all of them are seeing me because of a gait or balance problem. The more risk factors a person has, whether extrinsic or intrinsic, the greater their chance of falling. So it's important to reduce risk factors, because that will lower the chances of

falling, and to do that, we need to be aware of the risks.

Risk Factors for Falls

So, on the next slide, I'm just sort of focusing here that one of the major factors that contributes to gait and balance problems is going to be a vestibular disorder, and Dr. Gaffney touched on this. Fortunately, vestibular disorders and/or poor balance are one of the risk factors for which an effective intervention exists.

Diabetes and Vestibular Pathology

I want to focus on some of the more clinical studies and particularly some of the large population-based epi studies that really raised the issue of diabetes, vestibular loss, and risk of falls. And one of the first big ones was 10 years ago, and it was from the National Health and Nutrition Examination Survey, the NHANES survey that Dr. Gaffney mentioned. So, they investigated the relationship between diabetes, vestibular function, and their evidence was very compelling. So, out of a sample of over 1,100 adults over 40, 17% had diabetes. Of those with diabetes, mild peripheral neuropathy was in 19%, severe was less common in 7%. Mild retinopathy was common in 54%, severe retinopathy in 22%, but the vestibular dysfunction, which is less studied and less tested for, was reported in 54% of patients. And so, it was just as common as mild retinopathy.

Diabetes, Vestibular Pathology, and Risk of Falls

Quick brief summary of what we know so far about diabetes and vestibular pathology and risk of falls.

Patients with diabetes are 70% more likely to have a vestibular impairment. The exact nature of that impairment still remains elusive. The clinical lab studies haven't caught up yet, but data from NHANES and others suggest that vestibular loss independently increases the odds of falling in patients with diabetes more than two-fold, and this is after adjusting for peripheral

neuropathy and vision issues. Patients with diabetes are also more likely to develop BPPV, and we have pretty strong consistent evidence for this. An interesting finding in the BPPV literature is that diabetes doesn't just cause more BPPV to occur, but it also causes more frequent recurrence of this type of vertigo. However, if blood sugar is controlled, this risk decreases. So, the association is reversible, and these numbers and rates of BPPV are largely driven by individuals with longer duration of the disease and those with higher A1C levels. So, duration and severity of the disease matters, and better controlled diabetes will reduce all of these risks.

Vestibular/Balance Screening Strategies

So, screening strategies. Currently, there is not enough evidence to suggest everyone with diabetes needs to have an extensive vestibular workup, right. We have less evidence relative to the auditory system, and it's relatively easy to get to hearing tests, whereas it's more difficult to get an extensive vestibular evaluation. But screenings that are simple, brief, and inexpensive and can lead to a known effective treatment is what I'd recommend. So, these are some examples of functional screenings. By function, I mean looking at overall balance, and it can be something like a quick assessment of balance, like the Romberg on foam, and this is the assessment done by the NHANES study. It's a very simple screener. It doesn't require training to administer, but basically, there's four 30-second conditions of balance. This picture is illustrating the fourth condition, which is the hardest condition, the most vestibular taxing condition, where the eyes are closed and the person stands on a piece of foam. Ignore the Google Glasses on this picture. This is from my lab, and the Google Glasses were for something else, but if someone cannot stand on foam with their eyes closed for 30 seconds, it's highly suggestive of a vestibular disorder.

Vestibular/Balance Screening Strategies

So, that was the Romberg on foam. That's a static balance measure. All you have to do is stand for 30 seconds. Another simple functional balance measure that looks at more dynamic movements is

called Timed Up and Go (TUG), and the CDC has a PDF of how to conduct this screener to assess mobility. The website is here, and it's also on the list of resources at the end of these slides.

Timed Up and Go doesn't require any training to administer either. You basically need a chair, a space of about 10 feet in front of the chair, and a stopwatch. Of course, now we'll just use our phones, and we won't even need stopwatches anymore. So, that's an easy screen.

Vestibular/Balance Screening Strategies

Another screener—and Dr. Spankovich touched on this—is just a simple question, just asking, “have you fallen or do you have a fear of falling?” If they say yes to those two things, they're at risk for falls. There are also many validated questionnaires for vestibular loss, but I'm recommending one here that I worked on with some colleagues at Vanderbilt University, and it's called the Dizziness Symptom Profile (DSP). It's 31 questions; it's a Likert scale. It takes a few minutes to fill out, but it's going to screen for the seven most common vestibular diseases. But I recommend it for this population because it includes BPPV.

Vestibular Therapy

Anjuly Ballard: Okay, so vestibular therapy is a type of physical therapy used to adapt or strengthen other senses in order to treat balance related disorders. Some of the common problems that result from vestibular disorders are dizziness and balance, vertigo, and visual disturbance.

Prescription and Administration of Activities

As we've learned today, damage to the inner ear is the cause of these symptoms. In order to alleviate the symptoms, the brain has to learn to use other senses, such as vision or balance from the lower limbs in order to compensate. Prescription and administration of vestibular therapy should be facilitated by an occupational or physical therapist. They are trained to adequately identify problems related to an individual's vestibular disorder. A therapist exam will confirm where the symptoms of dizziness or imbalance, for example, are coming from, and they can

prescribe exercises that directly target the identified symptoms.

Prescribed Exercise Methods

Here are some prescribed exercise methods that therapists use. Now, please be aware that the following information is being shared for educational purposes only and should not be used to diagnose symptoms or prescribe exercises. Again, diagnosis and prescription should be completed by a trained therapist. Depending on the vestibular-related problems, three principal methods of exercise are generally used, that being habituation, gaze stabilization, and/or balance training. The images that you see here are basic examples of the exercise categories. Several types of exercises exist for each category with some being more advanced than others. However, a trained therapist can prescribe the best exercises for an individual based on the severity of their symptoms and what someone can tolerate, because again, safety is priority.

Habituation: habituation is used to reduce dizziness through repeated exposure to visual stimulation. So, of course, if someone comes to a therapist and describes that they have symptoms of dizziness, then more than likely they would use habituation exercises to treat that symptom. Gaze stabilization is used to improve control of eye movement to make vision clear during head movement. So, if someone came and said that they—that things appeared to bounce or jump around with head movement—then a therapist would be likely to use gaze stabilization exercises to treat those symptoms, and then we have balance training. Balance training is used to improve steadiness, so that daily activities such as self-care or leisure activity can be performed successfully, and some symptoms of balance disorders or balance symptoms would be difficulty walking on uneven surfaces or difficulty walking in the dark.

Tai Chi

So, aside from the general prescribed exercise methods that we just looked at, I want to talk a little bit about Tai Chi. Tai Chi is an exercise that is generally used for a variety of health benefits, including balance. Tai Chi is also recommended by trained therapists. It primarily aids in

increasing balance, because it increases sensory that comes from the feet and lower limbs. However, if someone's imbalance is caused by dizziness or unstable vision, Tai Chi may not completely alleviate these symptoms, because it doesn't target visual stimulation or control of eye movement. Again, it primarily increases sensory that comes from the feet or lower limbs, however, it is best to consult with a therapist or medical professional before starting any exercise regimen. And, of course, if insurance or cost are a concern, sometimes therapists provide free or community service. So, this may be an option for individuals who may not be able to afford therapeutic services.