The Connection Between Hearing and Overall Health

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- [Jack] Okay. Hello everyone. Thank you for attending the presentation today. My name is Jack Scott and I am a Senior Audiologist with GN hearing, which is the holding company for GN ReSound. I am within the research and development division, product management. I'm also an adjunct lecturer at Northwestern University, where I teach an undergraduate introductory course in audiology and at graduate level seminar in management of tinnitus and sound tolerance issues. I must confess that as I was going through my slides just now I realized that I did not include my email address on any of the slides, which is an error on my part. If you have any questions following the presentation or any questions that I am not able to answer through the presentation, because we are gonna be covering quite a bit of research articles out there. Feel free to give me, send me an email at jscott, my first name, first initial, last name @gnhearing.com. Thank you, Melissa, Melissa just put that up into the chat box. I know everyone is busy these days, and I appreciate you taking the time out of your day to be part of this event, but everyone as well, and your friends or family are staying safe. Let's go ahead and begin.

So the learning outcomes for this course, after this course, you should be able to identify the impact of health conditions on hearing loss. Describe the relationship between hearing loss and cognition and describe how improving audibility with modern technology can impact overall wellbeing and satisfaction of individuals. So in today's presentation, we're gonna do a brief introduction of hearing loss. We're gonna discuss some possible causes of hearing loss and their epidemiology. Look at the health impacts on hearing thresholds, discuss hearing loss impact on health, look at the relationship between cognition and hearing, and then we're gonna dig into some of the research and evidence of treating hearing loss and its outcomes on health and wellbeing. And finally, we're gonna provide a brief summary for what we learned over the past hour. Just another side note, unfortunately, I have a hyperactive amygdala, so my fight or flight response is quite active. So if I begin to talk too quickly during the presentation, please let me know that response unfortunately is not good for giving

presentations 'cause I tend to talk faster. It's also not very good for my tinnitus unfortunately. So as hearing care professionals, we understand the importance of hearing loss and the benefits of hearing aid use. And it's our professional responsibility to help convey those benefits in a concise and accurate way to our patients. In 2016, the NIDCD reported data, that in the U.S. about one in six adults, report some trouble hearing. So basically that's around 37.5 individuals. Of those, 28.8 million could benefit from some form of amplification or hearing aids. Yet the data shows that only one in four U.S. adults who could benefit from hearing aids have actually used hearing aids. For the ages between 20 to 69, that's about one in six and in adults over the age of 70, we're looking at around one and three.

However, as clinicians, we see daily the benefits of hearing aids on the quality of life of our patients. And we know the significant impact that hearing aids can have for them. In 2017, National Council on Aging, provided the top 10 common chronic conditions for adults age 65 and over. The top three by their reporting were hypertension, high cholesterol and arthritis. But this list did not include the chronic condition of hearing loss. The National Institutes of Health and the National Institute on Deafness and other communication disorder, reports that 33% of individuals over the age of 65 have some degree of hearing loss. Using this percentage of hearing loss would the fall between high cholesterol and arthritis as a common chronic condition in these individuals. Now I'm not trying to wedge our profession and passion into this list for some sense of importance, but because there are truly profound impacts that hearing loss can have on the daily lives and health of individuals, I believe it's important to emphasize how prevalent hearing disorders are, in the older population. Relative to other disorders that are typically on the top of mind. Well, let's take a closer look at why these demographics are so important and the relationship between health and hearing loss and vice versa. For the purpose of the presentation, most of the research reported is for subjects that either self-report hearing loss or subjects diagnosed with sensory neural hearing loss. That is hearing loss that is remediated primarily by nonmedical

intervention, such as hearing aids. As we know, there are multiple causes of sensory neural hearing loss. One of these is noise induced hearing loss, just for some demographics based on a 2011, 2012 CDC study involving hearing tests and interviews with participants, at least 12 million adults or 6% in the U.S. under the age of 70. And perhaps as many as 40 million adults or 24% have features of their hearing tests that suggest hearing loss in one or both ears from exposure to loud noise. From an occupational standpoint, oversight and protection is fundamental. But unfortunately the NIH also reported that one in two adults with hearing damage from noise, did not have noisy jobs.

So the damage may arise from recreational noise exposure. One reason why it's vital that our profession educate the public on causes and impacts of noise induced hearing loss. Another cause of hearing loss as we get older is age related hearing loss as we know. That age related hearing loss increases as we get older, but also previous noise exposure can exacerbate or accelerate age-related hearing loss. On average of the population, the NIH reported that 14% of adults between the age 20 to 69 had hearing loss. Now this is down 2% from a report between 1999 and 2004, showing some improvement. And as we get older the prevalence increases. As of 2012, men are still twice as likely as women, to have hearing loss. Age and noise exposure have about two potential causes of hearing loss. And the next portion of the presentation, I'll discuss and report on some additional aspects of health and medical related conditions, that may result in an increased susceptibility to changes in hearing thresholds. As mentioned previously, 58% of individuals over 65 years of age, have hypertension or high blood pressure. When you include the entire population, regardless of age, the number of American adults with hypertension, still occurs in one in three individuals. Now hypertension increases one's chance for a heart attack, stroke, chronic heart failure, and contributes to a thousand deaths per day. Knowing the susceptibility of the hair cells and cochlea to vascular histopath, pathological mechanisms, Agarwal and colleagues were interested in evaluating the relationship

between high blood pressure and hearing loss. To determine the likely association between hypertension and hearing loss, they reviewed 150 cases and 124 controls, both genders, age 45 to 64. Hypertension was verified through blood pressure readings, and it was classified into different grades of severity. Hearing was assessed at audiological frequencies. They found a significant association between hypertension and increased hearing thresholds. Specifically in the high frequencies and in the most severe grade of hypertension. They proposed that hypertension may be an accelerating factor of regeneration in the hearing system. Of course, more research is needed to evaluate the actual underlying causes. Another disorder or perhaps symptom that may affect hearing thresholds is sleep apnea. Now sleep apnea affects more than 18 million Americans. It has been associated with numerous cardiovascular conditions, including hypertension, coronary heart disease, cardiac arrhythmias, heart failure, stroke, and sudden death due to sleep apnea. And it's not the sleep apnea may be associated with inflammatory and ischemic phenomenon that may increase the risk of hearing impairment.

A study published in 2014 by the Albany Medical Center in New York, evaluated the cases of 13,967 people. They found that those with sleep apnea, also had increased risk of hearing impairment. Specifically, there was a 31% increase of risk for high frequency hearing loss, a 38% increase a risk for high and low frequency hearing loss and a 90% increase in risk for low frequency Hearing loss specifically. Joe Brown and colleagues, found that oxygen saturation recorded during sleep was inversely associated with severity of hearing loss. It reported that dose response relationship between the observed oxygen saturation and severity of hearing impairment or decreasing oxygen saturation was associated with increasing hearing impairment severity. They concluded that hypoxic injury, maybe a linking mechanism between sleep apnea and hearing loss. Now the cochlea is especially vulnerable anatomically to ischemia and vascular inflammation as it is supplied by an end artery. Arteries feeding the strive escalera the capillary rich network a lateral wall of cochlea are relatively

sparse at the apex as compared to the base. Therefore, the authors postulated that the hair cells in the cochlea at the apex that respond to the low frequency sounds, may be more susceptible to ischemia. One question that may arise that I was asked while I was kind of giving this presentation to a student here, was what about the level of C-PAP machines or machines that are used to help individuals with sleep apnea. A cursory research on the internet, just to kind of look up this data, found that most C-PAP manufacturers list, the decibel level ratings for each device. And the average C-PAP noise is rated at around 30 DB. Manufacturers suggests that C-PAP noise levels that actually wake you up or keep you awake, if the C-PAP machines are doing that, they should be evaluated or adjusted accordingly. Smoking is another risk factor that may result in health conditions that can impact hearing.

Well, we don't really discuss smoking as much these days, unfortunately around 34 million Americans still smoke and more than 480,000 U.S. deaths a year are related to smoking related disorders or illnesses. Jenkin and colleagues in 2016 studied the hearing thresholds of current smokers non-smokers and passive smokers. They found that in the current smoking group, the prevalence of bilateral speech frequencies, those frequencies of 500, 1,000, 2,000, 3,000 and 4,000 Hertz, they found a hearing impairment increased in ages of 40, between 40 to 69. And the rate of high-frequency bilateral hearing impairment was elevated in individuals age between 30 to 79. They also reported that the current smoking group has significantly increased hearing threshold, compared to the passive smoking group and the non-smoking group across all ages in both speech relevant and when they looked at high frequencies specifically, or those frequencies of 3,000, 4,000 and 6,000 Hertz. This passive smoking group did not having the elevated prevalent of either speech frequency, bilateral hearing impairment, or high-frequency bilateral hearing impairment, except from the age of 40. The authors provided no specific reasons why smoking result in increased risk of hearing loss, but given the concomitant diseases and disorders associated with smoking, the potential underlying issues may be a schemitic and vascular related. A

possible suspect that doesn't get its due recognition is the impact of the thyroid. And specifically the jolts, more specifically graves' disease, which is a condition in which the thyroid overproduces hormones, a condition called a hyperthyroidism. A common medication used to treat graves' disease, Propylthioracil was shown in 2004 to cause the blood vessels in the ears to swell and eventually cause hearing loss. When the medication was removed and steroids were presented, the hearing greatly improved. Now hypothyroidism, is when the thyroid under produces hormones. Iodine is important for thyroid function. And thyroid function and production of hormones, is needed for auditory maturation. So a recent study in 2018 showed that, in children with reduced iodine level, consequently reducing thyroid function and the hormones produced, it found that those children with reduced iodine levels, actually had a higher chance of hearing loss, compared to children with normal iodine levels. As we've discussed issues with circulation and the vascular system may impact hearing thresholds.

This is also potentially true for patients with diabetes. So diabetes is a disorder, where there's an impairment in the body's ability to regulate and process glucose, about one in every 10 people in America have some type of diabetes. People with diabetes that are at a higher risk of blindness, kidney failure, heart disease, stroke, and amputation of extremities due to blood flow issues. It was also found that hearing loss is twice as common in adults with diabetes compared to those who did not have the disease. The authors of the 2008 study report, diabetes related hearing loss as progressive, bilateral, sensory neural impairment with gradual onset predominantly affecting the higher frequencies. Bainbridge and colleagues observed generally stronger association between diabetes and high frequency impairment than low, mid frequency hearing impairment. When they examined hearing thresholds that specific frequencies, they observed higher thresholds at every frequency for people with diabetes, compared to people without diabetes. This pattern held across all age groups. They postulate that several biological mechanisms might explain an association between diabetes and

hearing impairment. The suspect with the same pathogenic changes to the microvascular, vasculature and sensory nerves that result in conditions such as retinopathy, the deuteropathy and peripheral neuropathy may also be impacting the end organs of the auditory system. As I reported from one of the first slides, about 18% of the population over the age of 65 years has chronic kidney disease. Now this is an important consideration when we think that over 200 of over the counter and prescription medications report some type of ototoxic effect on the inner ear. And that increased kidney disease may lead to increased levels of these medications remaining in the bloodstream, potentially exacerbating their ototoxic effects. Now typical usual suspects for considerations include, salicylates such as aspirin, antibiotics such as aminoglycosides, loop diuretics, chemotherapeutic agents, and nonsteroidal anti-inflammatory drugs, such as Advil and Aleve.

As with any case history, it's important to understand the medication patients are taking. And any additional diseases that may impact the body's ability to eliminate medications in a timely matter to reduce any inflammatory effects. Similar to diabetes on the additional impact of health, being overweight may also result in a variety of conditions that could result in hearing loss, such as sleep apnea, diabetes and high blood pressure. In a recent study in 2018, it was found that obese patients have a 21.5% rate of sensory neural hearing loss compared to 13.44 in non-obese peers. The authors also reported that obesity was associated with a 1.73-fold increase in the odds of getting sensory neural hearing loss. Unfortunately, one actor in the current healthcare arena that may impact hearing and hearing threshold, it's COVID-19 or the Coronavirus. At present the U.S. has reported an infection rate of around 10,804 per 1 million Americans. As we are still in the fray of the pandemic, little is known about its immediate and longterm impact on the auditory system. Although researchers are starting to perform case studies and preliminary research about relatively small in sizes. And have begun hypothesizing potential impacts based on what we know about other respiratory illnesses and treatment medications, we are still learning. As we

know, patients with underlying cardiovascular disease, diabetes or chronic lung disease have a higher likelihood of hospitalization and death from COVID-19. Some recent early studies have shown that patients who have had COVID-19 have shown reduced TEOAE acoustic emission amplitudes and increased high frequency hearing loss. In addition, some patients have reported a perception of balance issues. Although the underlying cause is still unknown. The potential impacts of COVID-19. The fact that it is a viral infection and viral infections may lead to increased risk of labyrinthitis or received vestibular neuritis. In addition, one side effect of COVID-19 is hypoxia or reduced oxygen levels. And as we sort of discussed, the inner ear has been shown to be susceptible, to changes in oxygen levels. Finally, several of the medications currently being evaluated to reduce the symptoms or improve the outcomes of patients with COVID-19 could potentially be ototoxic.

Although more information is needed on a level of prescription and for the review of side effects for these medications. Again, these are early days, but given the current infection rate, hospitalization and survival rate as a profession, I believe we will begin to see patients that may have had COVID-19 and the more we understand its impact, we can serve the needs of these individuals. So let's look at hearing loss and its impact on health. Through market track research, Kochkin and colleagues have reported on the myriad that impact on other areas of health, specifically social and emotional factors. Those with hearing loss have reported irritability, negativism and anger, fatigue, tension, stress, and depression, avoidance or withdrawal from social situation, feelings of social rejection and loneliness, reduced alertness and increased perceived risks to personal safety, reduce job performance and earning power and diminished psychological and overall health. In the most recent market track 10 that was released in February, 2020. Harvey reported that those with hearing difficulty are three times more likely to report the following conditions, hearing difficulty of course, memory issues, or memory loss falling, or balance issues, tinnitus and cognition issues. Now falls had been evaluated for the past several decades, fall risk in patients with hearing

loss. This is an area that has been researched. I realized kind of, as I was going through this presentation that I forgot to reference that should be on this slide specifically, that is some work out of Franklins lab at John Hopkins University, an article specifically published in 2012. So from that article Lynn and his group use data from the U.S. National Health and Nutrition Examination survey from 2001 to 2004. Participants had their hearing tested and answered questions about whether they had a fall in the past year. Franklin and his group reported that people with a 25 dB hearing loss, which they classified in the article as mild, were nearly three times more likely to have a history of falling than those with no hearing loss. And for every additional 10-decibels of hearing loss, meant an increased 1.4-fold risk of falling.

These findings held after the research accounted for other factors, linked with falling, such as age, sex, race, heart disease, and balance. They suspected that people with impaired hearing don't have good awareness of their overall environment, which makes them more likely to trip and fall. But they also added, and I concur from additional studies that I've evaluated on gait and hearing that part of the issue may also arise from the increased cognitive effort due to the hearing loss, pulling additional resources from gait and mobility. A recent two-part report based on analysis of health data from more than 150,000 people, 50 and older, reporting age-related hearing loss and no evidence of hearing aid use. This was an article that was a collaboration between Johns Hopkins University, AARP Services, OptumLabs, and University of California, San Francisco. This article found that untreated hearing loss is associated with a 52% greater risk of dementia, a 41% higher risk of depression, and then almost 30% greater risk for falls when compared with those who had no hearing loss. The report also showed that those with untreated hearing loss, experienced almost 50% more hospital stays and had a 44% higher risk of being readmitted to the hospital within 30 days, compared to those with hearing loss over a 10 year period. As we've seen from the previous study for the past and from past several years, there's been a lot of interest in the relationship between cognition and hearing loss. Over the next several slides, I

should say, we will examine the research and theories behind this potential relationship. The first, why is the topic of the abnormal brain or abnormal aging brain and possible way to modify risk and important area for discussion. Just to provide some epidemiology information on dementia. Let's talk about why this is important. So in 2010, it was estimated at 35.6 million people in the world have dementia. This number is expected to double every 20 years resulting in 115.4 million individuals by the year 2050. A majority of these individuals live or live, I should say are in low and middle income countries, seeing a greater percentage in North Africa and the middle East. However, this increasing trend is also observed in Europe and North America. In 2005, it was estimated that the economic burden for dementia care worldwide, including healthcare costs, caregiver burden, or I'm sorry, paid and unpaid caregivers is estimated at around $315 billion.

How does dementia manifest? The cognitive or neuropsychiatric symptoms for dementia are an inner interference of ability to function at work or usual activities and represented decline from previous level of functioning and performance. The symptoms are not explained by delirium or other major psychiatric disorders. And the cognitive impairment is detected and diagnosed through case history with the client or some knowledgeable informant, as well as certain objective cognitive assessment of mental status or some other neuropsychological testing. Finally, the cognitive impairment involves a minimum of two of the following components. Impaired ability to acquire and to remember new information, impaired reasoning, handling of complex tasks, impaired visuospatial abilities such as the inability to recognize faces, common objects or environments, and also impair language function. And finally changes in personality, behavior or comportment such as changes in mood on characteristic, mood swings, agitation, loss of empathy, compulsive or obsessive disorders. So this reminds me of a patient that I had in clinical practice one time where following the hearing aid fitting, we went over the orientation, insertion and removal battery insertion removal. And at the end of the hearing aid fitting, I thought everything was fine. He

seemed to grasp everything appropriately came back in two days later, could not remember anything that I told him, could not remember how to insert the device, how to change the battery. During the appointment he took copious amounts of notes of everything that I was saying because he was a constant note taker. Two days later, he came back in with the exact same problem, again took copious amounts of notes. Now for this individual through a very sensitive conversation that we had together in a very candid conversation about what I was seeing, I was able to perform the MOCA on him, the Montreal Cognitive Assessment, which is a screening tool to determine if someone may need further evaluation for reduction in cognitive decline. And upon taking that, he did actually show that he was falling outside of normal limits, and then I did refer him on to a neuropsychologist, specifically in urologist, I should say, for a followup assessment. And I'm sure within your clinical practice, you may have seen something very similar. Now, this schematic which I know is very small on the screen, but we're gonna blow up quite a bit. 'Cause an infographic that recently came out of a Lancet article in 2017, that actually shows the modifiable risk factors for dementia over the lifetime.

In the article, it was reported that 35% of risk factors for dementia are modifiable. And what we're gonna see is that there are percentages associated with these different aspects that show that if you remove that modifiable risk factor from the timeline, you will see a certain percentage of reduction in new cases of dementia if the risk is eliminated. So we're gonna sort of blow this up and go section by section and in a little bit more detail. At the very top of this timeline is a gene. And this is the APOE e4 allele gene, which increases an individual's risk for developing late-onset Alzheimer's disease. The NIH reports that people who inherit one copy of the APOE e4 allele, have an increased chance of developing the disease. Those who inherit two copies of the allele are actually at a greater risk of developing disease. And that the APOE e4 allele may also be associated with an earlier onset of memory loss and other symptoms compared to individuals with Alzheimer's disease who did not have this allele. Now,

currently there is work on trying to be able to modify the gene expression, to reduce the chance for developing Alzheimer's if someone does present with this gene. Education is another factor for increasing the chance for Alzheimer's. So less education can actually increase someone's chance for getting Alzheimer's disease at a later date. And then as reported in Lancet, hearing loss is at 9%. So if we were moved hearing loss or hearing loss were eliminated, we would see a 9% reduction in cases of dementia from this risk factor. For hypertension, it's around 2%. And then for obesity, it's around a 1% reduction. And we move into later life. We can see that smoking, depression, physical inactivity, social isolation and diabetes are all modifiable risk factors for developing dementia. Based on the current data in the literature that we've discussed, we know that risk factors don't work in isolation, that there may be some sort of relationship.

The data from market track and others show that people with untreated hearing loss report more depression or depressive symptoms reduced physical activity, increase those social isolation, so taken all together, that's around an 18% reduction new cases. When you add hearing loss to this, or if you see hearing loss as potential factor that may cause downstream changes in these other components. Now this is a strong stretch I understand. However, there is some current research showing that and more research studies are kind of on the way or in the process to try to prove, or to try to show some of these sort of theories, if you will. Now since 1986, data has shown some type of relationship between hearing loss and cognition. Uhlmann and colleagues performed a case control study and 100 individuals who had Alzheimer's type dementia and 100 age, sex and education match controls. They found the prevalence of a hearing loss of 30 dB or greater, was significantly higher in individuals with Alzheimer's than in controls, even when adjusted for potentially confounding variables. There was a correlation between the amount of hearing loss and a higher adjusted relative odds of having dementia. Work out of Frank Lin's group at John Hopkins in 2011, kind of brought this relationship to the forefront of the profession and in the eyes

of lay individuals. I think the profession did a good job of making the lay public where the potential consequences, although the jury was still out at that point, if amplification could bend the curve so to speak and reducing some of these cognitive effects. Little looked at longitudinal data for 639 people, page 36 to 94, for about 12 years worth of data. And they reported that for each 12 decibel loss and hearing the risk of dementia rose about 20% compared with those who could hear normally. The potential risk of dementia doubled among those with mild hearing loss tripled among those with moderate hearing loss and increased five-fold among those with severe hearing loss. The relationship they reported persisted between hearing loss and dementia persisted, even when other factors linked to cognitive disease like hypertension, diabetes and smoking were taken into account. Although I would be remiss if I didn't say that correlation does not equal causation as so why there was a relationship potentially found, again data is still coming out, research is still being done to sort of look at this relationship between hearing loss and cognition. And how are hearing loss and cognitive decline potentially related ?

Since the earlier studies were starting to get kind of a better idea, but there are still some areas that need to be closely researched. So we have no definitive answers yet, but there's a variety of possible theories out there of the potential relationship. 2017, Stahl come out with an article, reviewing some of the possible hypothesis for the relationship. The first, the common cause hypothesis assumes the existence of a common factor that is responsible for the progressive degradation in physiological systems with aging. Cognitive, as well as not cognitive changes with advancing age or the result of multiple dysfunctions, which are partly distinct and partly entangled or related to each other. According to the hypothesis, as Stahl reported, both hearing loss and cognitive impairment are caused by some common underlying processes, such as generalized effects of the aging brain or age related cerebrovascular disease and its original view, he reported the hypothesis data that sensory acuity, including hearing and vision acuity could be markers for global integrity of the brain. The theory that I

think most audiologist or hearing care professionals are familiar with, is a cascade or deprivation hypothesis. According to this hypothesis, uncorrected hearing loss may lead to cognitive decline and eventually dementia because hearing impairment is suspected to affect brain integrity as suggested by several MRI studies. And so in Stahls summative article, he discusses a variety of different studies. For example, the MRI study or one example of an MRI study that conducted 126 participants age 56 to 86, show that those patients or participants with hearing impairment actually exhibited accelerated brain atrophy or particularly in the right temporal lobe compared to participants with normal hearing. Stahl also referenced in another study that was conducted on around 2,900 participants that reported that hearing impairment was associated with smaller total brain volume. And then finally a study showed that experimentally induced hearing loss in young mice cause decreased performance in spatial working and recognition memory task at six months, providing evidence for a cause of relationship between the hearing and cognitive impairment. The alternative view or path sort of postulates hearing loss maybe linked with cognition because that leads to reduced physical activity, lower mood and poor engagement and social and leisure activities.

And so he reports on two studies that talk about the strength of the association between hearing impairment and cognitive decline is reduced after systematically controlling for social participation variables. So the link between the hearing loss and cognition could be an indirect link mediated by reduced social and physical activity. Again, going back to that list it's a infographic. And then another mechanism that Stahl sort of reports on, is the hypothesis of the cognitive load hypothesis, which looks at the link between the hearing loss and cognitive decline related to the fact that if you have a hearing loss, resources for speech understanding for processing the degree to signal takes resources from other cognitive task, from working memory and may inadvertently sort of accelerate to the detriment that I've got 100% . So it's almost an allocation of resources if you will, taking away from working memory cognitive tasks, to be able to

perform auditory processing, all that degraded speech signal that's coming in due to the hearing loss. Now regardless of the actual cost or cause or a hypothesis or myriad of relationships between causes impact of hearing loss on cognition, the question, how can we as audiologists and hearing care professionals potentially impact this relationship? In essence, where can we put our finger in the dam so to speak to at the very least effect the impact of hearing loss and perhaps upstream effects on cognitive function? So how can we reduce listening effort? On audiology, we know that there are several effective methods for reducing listening effort, hearing aids or any other type of professionally fit personalize amplification, whether that's traditional hearing aids, bone conduction, hearing aids or cochlear implants, the use of remote microphone technology, whether digitally modulator or frequency modulator devices, whether they're traditional FM systems or proprietary remote microphone systems to improve signal to noise ratio and thusly ideally reduce listening effort or cognitive effort. In addition, therapeutic interventions, and so this is a bit of my soap box, I think attention should not be limited to the technological side of audiology and hearing health, but also include the therapeutic or rehabilitative side. And it's important on improving speech understanding and reducing listening effort.

The incorporation and education of communication strategies for our patients and their communication partners, the introduction of our rehabilitation classes, whether they're online group or individual to support the use of amplification and the education of listening strategies and speech reading. And finally the importance of self efficacy. As a person with hearing impairment, correct it or not, right? In requesting ideal listening and seating arrangements in background noise situations. Not just through amplification, but also through the other counseling components of our all rehabilitation that we provide to the patients. So there's hope and data that corrected hearing loss may actually result in improvements in several factors that we discussed today. The first that we'll discuss is from PROTECT, a study called PROTECT, which is out of the UK. And so PROTECT stands for a Platform for Research Online to Investigate Genetic

and Cognition in Aging. And so this was presented at a poster at the American Alzheimer's Association Conference in 2019. This study got quite a bit of traction in the press and in the news. And so again, this is an online study. I'm looking at sort of cognitively healthy adults, age 50 and over. Participants were invited to perform a range of cognitive tests up to three times over a length of seven days. But this study actually occurred over three years. They self-reported current problems with their hearing and use of hearing aids. And as you can see from the numbers that they provided within the poster presentation, they had a quite large in size of about 4,000 reporting hearing loss. And then of those 5,900 used a hearing aid and around 2,800 did not. They also online were able to do evaluations of measures of attention and working memory. And they actually showed that individuals that used, using hearing aids at baseline actually had higher measures of attention to working memory and higher cognitive performance relative to their cohort that did not wear amplification.

But they also showed as well, was that over the three year timeline, those individuals that did not wear hearing aids, actually had a poor or worse trajectory for the measures of attention working memory and episodic memory, compared to the individuals that did wear hearing aids. And again, I think one of this was quite a large study, quite a longitudinal study and so again, it got quite a bit of traction because it was one of those studies that kind of showed that yes, hearing aids may potentially over a trajectory, be some sort of remediation tool for reducing the impact of cognitive decline or mediating cognitive decline I should say. And then Franklin and his group are actually undergoing a multi-site NIH-funded study. This study is called ACHIEVE, which stands for the Aging and Cognitive Health Evaluation in Elders study. And so this study is investigating two different treatments that promote healthy aging and cognitive health in older adults. And so basically there's two arms to the study. You have the control group, which is the group that's gonna receive successful aging education programs. And then you're gonna have the treatment group, which is a group that is actually gonna receive hearing aids and a hearing loss program. This is a very exciting

study because this is the randomized control study. So participants will be randomly selected to either receive the successful aging education or the hearing program where they're gonna be filled with amplification. These individuals will also be evaluated for three years on an annual basis. And at the end of the study, they're also gonna allow participants to be able to participate in the other arms of the study. So those individuals that are randomly assigned to let's say the aging education program, after the end of the three year study will actually be able to go into the hearing loss program to receive amplification. And this study is actually looking at quite a variety of different components. At baseline they're gonna be looking at cognition and memory, executive domains, language domains, social engagement, perceived loneliness. They're gonna look at physical function of the lower extremities.

Again, that relationship to gait, or I should say specifically to falling, they're gonna look at grip strength. They're gonna look at physical activity through the use of an accelerometer. They're also gonna get self-reported physical activity and function, they're gonna look at depressive measurements, hearing handicap, hospitalizations, and quality of life measurements, and so they're gonna be able to get wide a number of sort of baseline numerics and demographics on these individuals that the them be able to follow for the three years to see if indeed amplification and the hearing loss program or the hearing program that actually provides some sort of remediation, which I think is very exciting. So they currently have around 950 participants enrolled in the study and they ended recruitment already. So if you go to the NIH website clinicaltrials.gov and look at the study, I believe that they're done with recruitment in 2018 COVID pending hopefully they'll have the results by the end of the year, this year. And so it'll be very exciting to see if they can get the data and then when that becomes public to us. In a recent study in 2018, patients were sort of followed or assess from a longitudinal data that they had for a period of 25 years. This study provided again, it's providing sort of more robust evidence. Specifically they were looking at 3,700 participants, aged 65 were included, around 1,289 reported hearing problems at

around 2300 reported no trouble hearing. Results found an increased risk of disability and dementia in those with hearing loss and an increased risk of depression in men who reported hearing problems. In the bottom three sort of outlined sections of this table. We're looking at disability in activity of daily living disability and instrumental activities of daily living, which are those activities that allow an individual to live independently in a community. Although not necessarily for functional living, the ability to perform IADLs can significantly improve the quality of life. And they're also looking at reported dementia and then reported dementia scores by patients with self-reported here in trouble and no hearing aids was significantly different from participants with no hearing trouble. And the scores for patients with self-reported hearing trouble but with hearing aids, was not significantly different from those with no reported hearing trouble. And so what's great about this study, if I can use that word is that they were able to sort of use this control the no hearing trouble.

I think comparing individuals with reported hearing trouble with no hearing needs and those individuals with hearing aids and showing significant or significant effect I should say, significant differences between those individuals with reporting to hearing in trouble with no hearing aids, versus no hearing trouble and no significant difference between those individuals with no hearing trouble and those individuals with self reported hearing trouble with hearing aids. A study in 2018 from the University of Michigan, which was published in a journal of the American Medical Association Otolaryngology, found that hearing aid users are more likely to visit their doctors for not emergency appointments. Now, this is kind of an interesting observation and the study author speculates that more doctor visits those with hearing aids actually visited their doctor about 4% more often than people with hearing loss who didn't wear hearing aids may actually be a sign of the hearing aid users having better attention to their health. And as we can see in the data without hearing aids, there's a higher number of hospitalization and emergency department visits versus their corrected hearing loss cohorts. And a study authors assumes that because people who use hearing aids can

hear better, maybe be able to communicate more effectively with their physicians and take care of themselves better. In addition, the author reported the respondents who use hearing aids in fact, actually had a lower rate of diabetes and hypertension. And so this is kind of an interesting study as well, again, showing which is kind of interesting for those with hearing aids and increased number of doctor visits, but they actually had a lower number of hospitalizations and emergency department visits relative to their cohort that did not wear hearing aids. And then, although not necessarily to relate it to health, one aspect that is affected when you think of individuals that have unaided hearing loss, is household income. And so in 2005, 40,000 households were surveyed utilizing the national, what's called the national family opinion panel. And hearing loss was shown to negatively impact household income on average up to $12,000 per year, depending on the degree of hearing loss. And so the less degree, the severity of hearing loss, the less impact it had on the income, but the board degree of hearing loss, the greater impact it had on me that income.

And actually the use of hearing instruments was shown to mitigate the effects of hearing loss by about 50%. So amplification did actually help income. This was a great landmark study by the Better Hearing Institute, I'm looking at this. And then based on these results, they estimated that the annual cost in lost earnings do that entry the hearing loss was around $122 billion. So just sort of summarize with regard to the market track survey, MarkeTrak 10 that came out in 2020, in the February edition of seminars and hearing this is kind of an interesting figure that I think was quite telling. It's a great example of how hearing aids may improve the lives of those with hearing losses. And it has several aspects that we've discussed over the past hour, but also includes quite a bit more even focusing on work relationships and performance. The sample size was quite large. So looked at 702 participants who are current owners who are fit with hearing aids in the last five years. The dark blue on the far right, indicates them reporting a large improvement or a lot better with the hearing aids and the yellow represents the same or no improvement, or no at least detriment since

receiving hearing aids. And so looking at the very top, as you can see, and as expected with hearing aids, there's a better or a lot better improvement with hearing aids for overall ability to communicate effectively. Totaling the rating four and five together, that's about a 61% reported improvement of either better or a lot better with the hearing aids. We can also see that 53% of individuals found that hearing aids improve their overall quality of life. And if we continue to read through the other attributes, we can see for some people, there was a perceived improvement in relationships at home, relationships at work, a sense of independence, a sense of safety, a confidence in self emotional health, and also a sense of humor, which is quite interesting. Although mental ability and memory and physical health are sort of at the bottom of this figure. Again, if you sort of take all those together, sort of add up the values, it shows that 67 to 71% of individuals felt that these actually remained the same. And so with amplification, we did not see a reduction in mental ability or physical health, which is great, but also I guess more importantly is that we did see for 26 to 30% of the individuals that actually found an improvement. So about one in four or one in three, found some type of improvement. And to me, I think that's a great story for why someone should invest in a hearing aids. In the market track data for 2020 also solidifies some assumptions that we know as hearing care professionals. And that is the change in perception of hearing aids in the past several years.

So one of the things that we noticed with this, and as I was going through my academic training in the mid '90s, I was taught about the hearing aid effect. And so the hearing aid effect is the idea that when you look at so an image of somebody with a hearing aid that there's negative connotations or negative perceptions of those individuals. Catherine Palmer in 2013, did a study reevaluating the hearing if hearing aid effect and actually found that individuals with BTE, standard size BTEs were perceived as actually more trustworthy than individuals with traditional Bluetooth devices. And she surmises that hearing aid effect has diminished if not completely disappeared in the 21st century. And so I think this figure again, sort of shows

responses, shows which is interesting when you ask the question of how often do you feel embarrassed when we look at non-owners because of the hearing difficulty versus the owner, because of the hearing aids, the green being never, 73% of a hearing aid owners, reported they never feel embarrassed because of wearing hearing aids. Although individuals with hearing loss who don't have hearing aid reported only about 16% or 35%, depending on the hearing loss, how often they feel embarrassed because of their hearing difficulty. And then how often they feel rejected or made fun of because 78% of hearing aid owners very rarely feel rejected because of their hearing aids, but a lower number of those individuals that have hearing loss they don't have hearing aids, actually feel rejected because of their hearing difficulty. When they say never, they feel more projected. So I think I'm gonna just make it in the time. But in summary, we discussed several medical and health related issues apart from presbycusis and nose exposure that can potentially impact someone's hearing thresholds, untreated hearing loss may impact different aspects of health or wellbeing, including, but not limited to social emotional falls, cognition, hospitalizations, and also income. And the current data and ongoing research shows that hearing aids may reduce the prevalence of several of these above items and Franklins randomized control trial is gonna be a great addition to the literature for their pushing the research forward.

So finally, the benefits of hearing aids are not just a reason to get them as far as being able to communicate overall, but there's actual changes that occur through amplification that can significantly help individuals that have hearing loss. That's all I have for today. I really appreciate y'all attending. I think I just got you right at the hour, I apologize. Please send me an email if you would, if you have any questions at jscott@gnhearing. That's jscott@gnhearing. So it looks like we have a few questions and I'll try to answer these as much as I can. So was this a certain age group from one of the individuals that may be referring to a specific slide that came up? I apologize for not knowing that one of the other participants asked a question with higher risk for fall

does remediation of hearing suggest the risk for fall, but also decrease with amplification, any data to support this again, potentially, I think what would be great is when we get Franklins results coming out to be able to show that there might be a component. And then, so one of the questions is the rate of hearing loss for obese patients. The rate of hearing loss for obese patients. Let me see if I can go back to the previous slide for that, looks to be around 21.5%. It's all work with the moderator to make sure that that is updated if necessary in the questions. Okay. Thank you again, feel free to send me an email. If you have any questions, jScott@gnhearing.com and thanks for your time today.