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Vanderbilt Audiology Journal Club: Clinical Insights  
from Recent Hearing Aid Research  
Recorded February 9, 2022

Presenter: Todd Ricketts, PhD; Erin Margaret Picou, AuD, PhD;  
H. Gustav Mueller, PhD

- Thank you and welcome to Vanderbilt Audiology Journal Club: Hearing Aid Technology for Practicing Audiologists. We have as our presenters today Dr. Erin Picou and Dr. Todd Ricketts as well as Dr. Gus Mueller, who is also serving as our host. Today's course is part of the Industry Innovations Summit on AudiologyOnline. It's where we take a month to celebrate innovation in the hearing industry. So, what better way to do that than to review some evidence and on hearing aids with some of the leaders in the field? Thank you for joining today's course. To check out other courses that are part of the Industry Innovation Summit, you can find those in our course library. We'd like to thank our title sponsor, Care Credit and all of the companies who are participating in this year's summit.

And at this time, it is my pleasure to turn the microphone over to Dr. Mueller. He holds faculty positions with Vanderbilt, University of Northern Colorado and Rush. He is a contributing editor for AudiologyOnline, where I'm sure you've read his very popular and informative 20Q column. He's a consultant for WSAudiology, and you can read more about him on our website. Dr. Mueller, great having you here and I'll turn it over to you.

- Well, thank you Carolyn. And I'd sort of asked my way to come in here. I'm not gonna do much hosting, but I really just wanted an excuse to come on and mention the fact that this is our 12th birthday, anniversary, however you want to call it, of the Vanderbilt Audiology Journal Club. So, we've been doing it for a while. I tried to do some counting and I think we've done close to 50 of them over the 12 years. One time we were doing four or six a year, and now we're only doing two or three a year. And I also wanted to point out that that YouTube video that just about crashed the internet, you can actually go on and listen to Carolyn and I discuss Vanderbilt Journal Club Audiology.

I just checked, Carolyn, we have 332 views over the 12 years. You know, that's not bad, 10 a year. Dr. Cliff, who's I guess is our competitor, I did check on one of his. He

had roughly 34,000, so we're a little behind, but I think we'll catch up, I'm pretty sure, after today. So let's see. What do I wanna do here? I wanna, oh there we go. I needed this icon. So, I thought I'd go back to our first year, which was sort of interesting. The hot topic in hearing aids was dead regions and frequency lowering. This was the time when all the manufacturers were talking about should we have frequency lowering or not with their products. We were all looking for dead places in the cochlear, but I also was interested is one of the very first articles that was presented was real world benefit from directional microphone hearing aids, written by some folks from Vandy including our own, Todd Ricketts.

So, Todd, I'm glad you solved that problem 12 years ago and we don't have to think much about it anymore. And, here are our presenters today. Todd has actually been with us since the very first year, so this would be your 12th year presenting. Erin, I think has been with the last eight years and I have to say that not everybody presents every year except for these two people, who it's always great to have them here and we're looking forward to it today. What we're gonna start off with is Erin talking about factors affecting hearing aid adoption by adults with high frequency. So Erin, I'm turning it over to you.

- Thank you, Gus. I am very happy to be here today. So thank you all for tuning in. I love the opportunity to talk about hearing aid research. So, the two articles that I'm gonna talk about today are about hearing aid use and hearing aid persistent use. So, there's sort of a theme around that. The first one was this study published in the American Journal of Audiology called Factors Affecting Hearing Aid Adoption by Adults With High Frequency Hearing Loss: The Beaver Dam Offspring Study. And I'm going to advance the slide. So, the question here is, what is the 10-year incidence of hearing aid adoption among adults with high frequency hearing loss? And what factors are associated with hearing aid adoption?

So, we know, because you are tuning in and you're a practicing audiologist, that hearing loss is common. And it's even common in middle age adults. So, about 21% of adults in the 48 to 59 year old range have hearing loss. We know that hearing loss is associated with communication difficulties and has some psychosocial consequences. We all know also that hearing aids can really improve communication and have improvements for quality of life as well. Despite all of these benefits and the difficulties associated with hearing loss, we also know that hearing aid adoption rates are pretty low, given the powerful benefits of hearing aids. So, estimates range from 8 to 36% of people who could be wearing hearing aids are wearing hearing aids, or have adopted hearing aids.

We know that there are some factors that are associated with hearing aid adoption. For example, severity of hearing loss. So, people who have more self perceived difficulty or more hearing loss are more likely to adopt hearing aids. People who have more resources or a higher socioeconomic status are also more likely to adopt hearing aids, as are those who have general health, who are healthier and are more active in their lifestyle and leisure activities and more active are more likely to adopt hearing aids. So, in this study, the question is, well, we know that there are all these factors that are associated with hearing aid adoption rates, but yet, we don't have all of the variability explained.

So, we're still trying to figure out who's going to adopt a hearing aid? What factors can inspire somebody to adopt a hearing aid? Is there anything we can do to take those hearing aid adoption rates from 8 to 36% to 50 or 75% or 100% would be great? How can we increase hearing aid adoption rates? So in this study they looked at the Beaver Dam Offspring Study. So this is an ongoing longitudinal cohort study of middle aged adults. They are all the adult offspring of people who were in the Epidemiology of Hearing Loss Study. So, lots and lots of data for a long time, well characterized sample. So, they're looking at hearing aid adoption rates in this group, and in this particular

study they looked at people who were in the 2005 to 2008 baseline, that had baseline data available.

They've got followups every five to 10 years. About 85% of people who were in those baselines are still being followed, and they're for this study, looking at people who have pure tone averages, high frequency pure tone averages of greater than 25dB. And they're also focusing on middle age adults. So they expanded their age range to include the lower end to the 40s to think about how just high frequency hearing loss and middle aged adults adopt hearing aids. And then, within that dataset they asked, have you ever worn a hearing aid or amplifying device? And in that data also, they've got audiometry and a lot of hearing related co-variants. So, self reported hearing loss, history of noise exposure, other kinds of assisted technology, whether or not they use closed captions, what kinds of situations they have difficulty in, if they have tinnitus, and also an HHI, A or E screening results.

So, in the study they looked at these demographic covariates lifestyle, covariates and health covariates and all coming together to see if they could determine factors associated with risk of hearing aid adoption. So, what I'm gonna show you are hazard ratios, but in this case a hazard is a good thing. So, it would mean that somebody has adopted hearing aids for 10 years or is 10 years out from their hearing aid adoption. I'm summarizing their data here. I'm plotting their hazard ratios for many of the factors that they looked at and the hazard ratio of one would mean that factor is not at all related to hearing aid adoption rate. Hazard ratio that's higher than one means there's a more likely to adopt a hearing aid and lower than one means less likely.

So what we're looking at are a bunch of the factors they looked at and it turns out not all of them were statistic significant. So, handedness, obesity, sex, number of chronic diseases, we'll just cross those off the list because they weren't related to hearing aid adoption. We see a small affect of age and education, so if somebody had more

education they were more likely to adopt hearing aids, and if they have, if they were a little bit older they were a little bit more likely to adopt hearing aids. But, really the most powerful factors in this dataset were HHIE score, the use of closed captions, degree of self-reported difficulty and whether or not their friends and family think that they have a problem hearing.

So, compared to all those demographic things like age, word recognition score, and education, we see these psychosocial and emotional consequences of hearing loss playing a really pretty big role in the risk of hearing aid adoption. So, why is this important? Well, they are, like I said, they're looking at people who have high frequency hearing loss and slightly younger demographic. So, we're seeing that these factors are related to hearing aid adoption, even at sort of the, the boundaries of people who are hearing aid candidates, and we're also seeing that the demographic factors are playing less of a role than those social and emotional factors. So, the consequences of hearing loss on the social and emotional factors are motivating people to get hearing aids.

And the reason I wanted to talk about this study and specifically selected it was because of these two things. The fact that people who report using closed captions are significantly more likely to be hearing aid adopters I think is really telling. And also, the strength of that relationship between whether or not they say that friends think they have a problem and they have hearing aid adoption, and they adopt hearing aids. So, both of these things really speak to me and I think that you can find out pretty easily in clinic by asking whether or not they use closed captions or whether or not their friends think they have difficulty hearing, and also speaks to how much time people, how important TV and friends are in our patients' daily lives.

So, does this matter clinically? Yeah, I think that these are, that we can be on the lookout for high HHIE scores, the use of closed captions, and friends reporting they have trouble. But, do remember that this study really, the focus, the authorship was on

middle aged adults who have high frequency hearing loss, and it's all people who are offspring of other people who are enrolled in a longitudinal studies. So, these are the caveats of the findings, but I do think that they, that these are good things to keep in the back of your mind when you're working clinically. The other study that I wanted to bring up today is also about hearing aid use, and this is a study where they're looking at the electronic health records in the Veterans Administration's hospital.

And this study was published in Ear and Hearing. So, in this study they asked, is there an association between hearing related and health related variables? And then also, can we use large scale electronic health records as a database for answering useful, clinical, and scientific research questions? So, as you might expect based on the last study I talked about, we really don't fully understand all the factors that go into hearing aid adoption use. In that last study, I think I forgot to mention it, but hearing aid use rates in that middle aged population were really pretty low. So, we still don't know fully why that is and we can't explain all the variability in use rates. Electronic health records, that is the electronic medical records that are accessed by system-wide hospital system, they are potentially just full, they have lots and lots of data because healthcare providers are regularly putting in those data, so you can mine the healthcare records to find out information about lots of different things.

So these datasets can be really powerful. And yet, as a field, we don't use them very often. There's a couple of studies here where people have looked at safety risks for audiology referrals. So, are audiologists catching red flags? Looking, there's a study in 2013, looking at noise notches for people who have hearing loss. There's a 2016 paper I think we might have talked about in one of our previous Journal Clubs, looking at hearing aid adoption with or without the presence of a significant other. But, there aren't really, these are okay studies, but there aren't very many of them looking at electronic health records. So this group wants to, in this paper they described really the development of the dataset that came from electronic health records.

That's really a big picture piece of this, and they're able to combine a lot of diagnostic healthcare processes and outcome variables and then their goal is to eventually really dig into those datasets. But, as a first pass in this study they're looking at the relationship between health and hearing aid use in veterans. So, if any of you are working in the VA system, well, you might have contributed some data to this, but also, you might be familiar with these sources. But, like rows or the CDEW or HLR. So in this study they're looking at, they're combining information from a bunch of different sources and looking at demographic and health related variables and the outcome measure that they're looking at are battery orders.

So, they're using battery order as a indication of hearing aid use persistence. So, in the study they described the extensive data cleaning they had to do. There's missing data and no response data, some text data. They've, if you're interested you can get into the supplemental material and figure out, follow along with all the data cleaning they did. It's pretty interesting to think about. The other thing they did, like I said, is they used hearing aid use persistence. They're looking at battery orders 24 months post fitting. So in the VA system the batteries are provided by the VA and all they have to do is fill out a postcard and get your batteries mailed to you. And so, they're using this as an indication of hearing aid use persistence, because presumably nobody's ordering batteries if they're not using the hearing aids.

And it also gets around some of the hours per day kinds of metrics where somebody might only want to wear their hearing aid two hours a day, but that's still enough for them. So it's not confounded by the audiologist recommendation and we just get to see who is still using their hearing aids. So they looked at a sample of people who had health records from 2012 to 2014. They've got, in the big sample, they've got 731,000 patients who had a new hearing aid order. Most of those were new hearing aid users,



53%. Because it is the VA system most of them were male. Most of them were fit bilaterally and most of them were receiver-in-the-canal hearing aids.

They found that hearing aid use persistence to 24 months after fitting was pretty high, 63% of people who had a hearing aid order placed were still ordering batteries 24 months out. And this use persistence, the authors noted is higher than treatments for other things. So, people who are taking asthma medications or have an intervention for COPD or hypertension use rate 24 months out are generally lower for those conditions than hearing aids in this study. They also have the IOI-HA data and response rates for this outcome were pretty low, but also, generally high. So the response rates were pretty low because they weren't mandatory, but generally people in this sample were pretty happy with their hearing aids. In this study they describe a lot of data validity.

So they check to make sure that the outcome scores were pretty similar to published data. They confirmed a moderate relationship between self-perceived difficulty and audiometric thresholds and confirmed a relationship between age and hearing loss. And all of those steps were necessary to feel really good about the data that they were mining. But, in terms of hearing aid use for 24 months out, they found that experience matters. So, persistence was lower for new hearing aids than experienced hearing aid users. They also found that age matters. So, it was lower for younger people, people in the 60 to 69 year old group, than for older patients. And they found that general health matters. So people who have higher multiple morbidity index scores, so more chronic conditions, simultaneously, they were less likely to use their hearing aids 24 months out.

And it was even more impactful for new hearing aid users. So if you're a new hearing aid user and you have lots of other health conditions going on you were less likely to continue to be using your hearing aids 24 months out. So, why is this important? Well, this article did two things. One it's really starting to establish the VA system as a source

for electronic health research, and it validated the data that are in there. Also, it gave us the opportunity to look at hearing aid use persistence, which is about 63%, and shows us that age, experience, and general health and that experience and general health interaction are all important factors in hearing aid adoption. Does it matter clinically?

Yes, I'm excited to see what else they do, other things that they dig into with this big dataset. Big datasets are a powerful way to answer questions. They can both hide and reveal nuance. So they can detect small differences if you have a big dataset. But, there's also this risk of ascertainment bias. Is everybody asking the same questions in the same way? And, it's difficult to interpret missing data. So, how do you interpret a no response on audiogram, for example. So we lose some information when we have to make everything numeric. But, it's still powerful interestingly to look at hearing aid related factors and then, I do feel obligated to comment on the, that the VA system is a really specific healthcare setting with a specific population.

So, we need to do more work like this to determine the generalizability of these findings to other healthcare settings. So, I had just talked about two different sides looking at hearing aid use, and Dr. Ricketts is now gonna take over and talk about some followup here.

- All right, thank you very much, Dr. Picou. So, this is a study from Alicea and Doherty that really called to me because one of the things that we repeatedly see in surveys that many hearing aid wearers find the most useful from their hearing healthcare providers is followup care. And so, followup care is something that is clearly valued. But, this is a study that says, well, can we even do better with followup care? Can we target followup care skills? So, they asked whether targeted re-instruction improves hearing aid wearers use and care skills compared to the standard of care which we typically go through when we see patients in the clinic? They also asked if memory

function, hearing handicap, and hearing aid related attitudes might affect hearing aid use and care skills.

They're really trying to get an idea of who we might individualize this for. So, just a little background. These authors previously have shown adults with poorer working memory capacity struggle more with hearing aid use and care. And so, it's clear that we might be able to further improve hearing aid followup care. We also know that patients level of hearing handicap and attitude toward hearing loss and hearing aids are really significantly related to motivation to take action for hearing problems. In addition, there are several tools that have been developed that clinicians can use to really assess hearing aid use and care skills. So, why does this matter for individual patients? Well, we know that a lot of information is presented during a hearing aid orientation and we really know that people struggle to remember it.

We've got data out there showing that around half of medical information is forgotten almost immediately by patients and half of the recalled information is remembered incorrectly. So, this is something that we really do need to improve when we get this information to patients. An additional factor is almost all experienced hearing aid users report that they know how to use hearing aids, but only half of them can actually demonstrate these skills. And that is evidence that patients really don't always know what they don't know or as infamously described by Donald Rumsfeld, for those of you that are old like me, these were described as unknown unknowns. So, the idea is that targeting the specific skills can provide more limited information and focus on the specific problem areas that patients might need help with during followup care.

So they looked at 13 older adults without hearing aid experience that were randomly assigned to receive targeted re-instruction at a two week followup, and 13 who did not receive targeted re-instruction, so a total of 26 participants. And they used the Practical Hearing Aid Skills Test or the PHAST R to kind of target re-instruction for individual

patients. All these patients had normal cognitive function, finger dexterity function, normal or corrected vision, and they were fit with hearing aids provided, and provided a standard orientation like you might in any clinic. All were administered the HHQ and a hearing attitudes and rehab questionnaire prior to the fitting and at four week post fit. Hearing aid use and care skills were assessed at the fitting and then again for post fitting using the HASK.

The HASK is a Hearing Aid Skills and Knowledge test that was developed by adapting a combination of the PHAST, which I briefly described earlier and the Hearing Aid Probed Recall Inventory. And so, these are really focused on skills, troubleshooting skills, knowledge of hearing aid use and care. So, the PHAST is a clinician administered survey that asks hearing aid users to actually demonstrate eight hearing aid use and care skills. These include inserting and removing the hearing aid, opening the battery door, changing the hearing aid battery, cleaning the hearing aid, changing the volume, using the hearing aid on the telephone, and using the noise program or directional microphones. And they used this to target re-instruction based on a three point criteria.

Two, they performed correctly with no difficulty, one, they performed with one or more mistakes, or zero, they couldn't perform the task at all. So, they found that all 13 participants who had targeted re-instruction needed targeted re-instruction at the fitting and 12 of the 13 also needed it at the two week followup. Interestingly though, the PHAST R scores were not significantly different at these two points in time. They also found that this didn't really take that much time. It took a total of about nine minutes, in between four and 18 minutes, depending on the participant. Working memory, hearing handicap, and hearing aid related attitudes weren't found to be correlated with hearing aid use and care skills. But, they did find that there were significant differences in use and skills outcomes between the groups at four weeks.

The knowledge outcomes weren't significantly different, but they did show the same trend. This is the trend that we see and the significant differences. And I think it's kind of an interesting finding because what we might often expect from re-instruction is that skills might improve, but in fact, what we saw is without targeted re-instructions skills actually tended to deteriorate. So, if you look at the targeted group, you can see at the fitting and four weeks post fitting, the skills are really similar and they're really similar to those that don't have that targeted re-instruction. However, four weeks post fitting, those without targeted re-instructions really had a decline in skills. The three skills that declined significantly were microphone port cleaning, activating the phone program, and changing the wax trap.

Those that received targeted re-instruction showed a 23% improvement on microphone port cleaning and wax trap changing tasks, while the standard of care group really decreased in those skills by 38 and 23%. Now, switching to the phone program is tough for a lot of our patients, and it was difficult for both of these groups, but certainly less so for those that received targeted re-instruction. We had successful completion in 39% with those with targeted re-instruction versus 8% for those without. After the four week trial all people reported they could use their hearing aids well. However, they were unable to perform several of the basic use and care skills. So it's clear that there were still some unknown unknowns for those patients, even those with targeted re-instruction.

This study demonstrates that it is possible to target hearing aid user skills in individuals to improve training and potentially its efficiency because the idea is to really focus on those things that patients struggle with and identify those things as quickly as possible so we can help people move along in this process. So, does this really matter clinically? Well, certainly hearing aids continue to evolve and they require user skills that are often a challenge for patients. One of the things that's nice to see is the developers of the PHAST are currently updating it to include additional required skills

for modern hearing aids including recharging hearing aids. So the real goal here is moving unknown unknowns to more known knowns so that we have better outcomes.

And so, the picture on the left is someone looking for unknown unknowns and turning them into known knowns and really just a shameless on my part because I really want to stick a picture of my daughter when she was a little girl into my power point presentation. One thing that I think we can see from this study is a targeted training approach may really provide individual patients with improved use and care skills in a manner that is clinically viable and time efficient. So, we typically during these reviews, focus on a very small number of articles, but I was struck that there are a few articles that are really tied to this followup care that I think helps further inform where things are with followup care.

We have lots and lots of emerging data showing benefits supporting followup care, but there are still some challenges in care that remain. For example, Bennett et al published an article last year showing that self reported hearing aid problems really decreased significantly after they have a followup appointment. However, travel, especially those that live far away from clinics, can really be a barrier to these benefits. Fortunately however, there are a number of groups working on ways to provide followup care at a distance. And for example, Ferguson et al showed that a multi media intervention on a mobile platform is a feasible and beneficial use in the self management of hearing aids. Further, Tao et al showed that teleaudiology followup appointments are beneficial and really lead to similar improvements in outcomes compared to face-to-face appointments. So, I've talked a little bit about followup care and one of the things some audiologists do during followup care is they adjust hearing aid gain and I think, Gus, you might have something to say about that.

- Yeah in a way, I most certainly do. And in fact, we're gonna go down memory lane just a little bit here. I'm guessing that most of the people listening were not fitting

hearing aids in the 1980s, so I have a photo here of what our life was like then. So, this is the type, custom hearing aids were also very popular then. And for those of you who are not aware, that red arrow actually should be pointing to what is called a potentiometer, which was the only adjustment that we had on these hearing aids. And so, what we all did is we carried screwdrivers that looked just like this with us all day long. We'd usually start the year off with about five of them and at the end of the year they'd be all gone and nobody seemed to really know where they went, sorta like clothes disappearing in the dryer, I guess, and then we'd buy five more for the next year.

The point here being, is when a patient says, you know, this doesn't sound quite right, the alternative that we had was to go to that potentiometer, which I can see right now was set to L, which is low frequency emphasis and we'd turn it to the right, which is H, which is high frequency emphasis. The truth is the difference between L and H were only about 5dB at 500 hertz. But, that's all we could do. And so, normally the way it would go is Bob would say, oh, Dr. Mueller, can you just make this sound a little bit better? This is again, followup care, right. And so, you know, to try to make the guy happy I'd turn it from L to H and go the old, well, does that sound better?

And sometimes you'd get a yes. Sometimes you wouldn't get a yes. Then you'd take the hearing aid and leave the room, stay away for a while, drink a little coffee, come back and what you do is just put it back on the L setting and ask Bob how that sounded and quite frequently Bob said it sounded great. And that was followup visits for frequency shaping. Why am I going through all this? Well, because it relates to the article that I'm gonna talk about. So we're moving 40 years ahead, or 35 years ahead. This is a group that have done some publishing in this area relative to just noticeable differences. They have three, four articles on this over the past four years.

You can find some of them in Trends. I think some of them are open access if you're interested in this. Actually I think they're from Scotland, if I recall, and they're looking at this in a much more scientific way than what we did with Trim Pots back in the 1980s. So let's talk about what they did. So what they did is they had a group of experienced hearing aid users and they were listening to speech and I'll show you, it was filtered speech, and they made changes and the listeners would determine if it was better, worse, or if it was the same. And so, the reason that I selected this particular article, and thank you, Todd and Erin, for giving me a few minutes to talk about it, is I think that this is something that really applies to you clinicians because for many of you it's something you do maybe on the day of the fitting or sometimes in followup care when you're trying to make people happy.

So they had all kinds of experimental adjustments. I'm on bullet number two now. And so, they were both increments and decrements of 4dB, 8dB, and 12dB for three different frequency bands. And I have a slide here that I will show you. And then also, to look at the reliability of their overall measure they actually, there were 10 times that were sorta sham trials where there was no difference. So you know, they wanted to see, do people say there was a difference when there really wasn't a difference? Thank you. So, remember earlier I said that the greatest difference was an 8dB difference and they did it for three different bands. So this is just a visual of what I had said to you before of how they changed it.

And I think I mentioned, but I should say again, these people were all fitted originally to now prescriptive targets. So, they're starting off at a prescriptive fit and then, this is when the patient says, oh, gee, this is just too tinny, can you fix that? And then you have to make a decision, do I tweak or don't I tweak? What do I do? And this would be tweaking up to plus or minus eight. So, these are the findings that were published in the journal. And although they are, it's a very meaningful display, I thought that I could explain it to you better if I replotted 'em into bar charts, which is what I did. Okay, what



you'll see in this slide and the next two, 'cause I have one slide for each frequency band.

So, the way I have this set up on here is if it's blue that means that the person noticed a difference and it was worse. If it's gray, the person noticed a difference and it's better. If it's orange, which is the main teaching point here, the orange bars, if it's orange they didn't hear a difference. So, what you see here is 95% of the time, let's look at the middle orange bar. When there wasn't a difference the patient said, yeah, I don't hear a difference, this is good. And as you might expect, because this is low frequencies, and you know, patients in general think it sounds more mellow if you give them more lows, when you started adding in the lows they started to hear a difference at around at 4dB 30% of them did.

Then it went up to more like 50% higher. If you're looking at the improvements, 60% thought it was better when you added 12. Notice that when you took away lows they reported that things were worse. That would be the pie blue bars to the left part of the chart. Okay, so that was for low frequencies, probably not the most interesting of the group. So now we're gonna look at mid frequencies. What you should notice then is for the mid frequencies, the orange bars at minus four and plus four got bigger, wherein 70 to 82% of the time the participants were not hearing a difference when the difference was 4dB, plus or minus. Notice that when it became, got up to eight they started to notice a difference and it was somewhat of almost a fairly even spread between better versus worse for when it got out to the plus 12.

Finally, what I think is the most interesting is the high frequencies, simply because that's what we end up changing the most because of patient complaints and sometimes due to feedback and other reasons. So, what you see here is a lot of orange, okay. And I think what stands out to me is let's do minus eight and plus eight. At minus eight 80% of the people still never heard a difference of an 8dB change in the

frequency response. At plus eight 62% was still not hearing a difference. Now, you know, these were people with typical downward sloping hearing loss, so for some of these audiobility could start to become an issue, but remember, they were fitted to prescriptive targets to begin with.

I think the main point here is plus or minus four, very few people heard anything better or worse. And in the clinic when you're making changes how big are the changes that you typically make? Often times it's only 2dB, 4dB, 5dB, something like that, which then takes me to the final slide. So, does this matter clinically? Yes it does. You know, it's pretty easy to start tweaking and put a smile on the person's face when they're sitting there in the office next to you. But, the question really is, am I really making a difference or does this have to do with some placebo effect or does it have to do with a halo effect? They just know that that's the right answer and they wanna please you.

Or maybe it's just random luck, like we used to do with the potentiometer going from N to H and back to N satisfied a lot of people. But obviously, if you really believe you wanna stray away from the prescriptive method, which we could talk about that forever, but let's assume you do if you're doin' tweaking, then I think you wanna be making changes and really making sure that these changes are meaningful. I know these same researchers a few years back came up with I think the number of 5dB for JNDs, for speech signals. So and you see here they might even be bigger than that in the high frequencies, although they didn't specific report JNDs. My point is, I think when we're making changes like that we need to make sure that the differences that we change in the programming is sizeable enough that the patient has the potential to actually report a difference.

You could maybe do an A, B, A comparison to see if it's reliable or not. And, that's it for me, so we'll move right on to whoever is next.

- All right. So, I wanted to finish up talking about an article from Plyler and Group talking about hearing aid technology levels and how this effects listener outcomes. So, they really asked, do hearing aid technology levels affect hearing aid outcomes and are there individual patient factors, like noise acceptance or listening environment, that really can tell us something about outcomes or preference. So, just in terms of a little background, one of the things that's important, and I think this has been said when people looked at hearing aid technology level, for the last decade or so, is that basic hearing aids are anything but basic anymore. Really, when we're talking about entry level hearing aids these are actually quite advanced devices when we compare them to what we considered to be advanced hearing aids of 15 years ago or so.

So there really has been some advances in hearing aids. But, the fact remains that they're still being dispensed across various levels of technology and often times this is used to justify rather large differences in costs. However, studies really don't support that there's really large outcome differences when we look across different levels of technology. We can look at lab data. We can look at targeted survey data and we can show that in the lab at least there might be some differences for some of these technologies, but it really doesn't seem to show up in general outcome measures out in the field. That said, if you look at it in these studies, nearly all participants, even when they're blinded, reported that there's a technology preference, with approximately half indicated in a definite preference for one level of technology or the other.

So I think really helping us understand the affects of technology on patient preferences and outcome is really a critical factor if we are going to describe ourselves as evidence-based practitioners when we're selecting technology particularly, when we consider just how much cost difference there is on these different levels of technology. So what they did, they looked at 24 older adults with a range of hearing aid experiences and one of the things that was kind of a nice control in this particular study is they fit a single hearing aid that's actually programmable to basic and premium levels

of technology. So they were able to do this without actually changing the hardware of the hearing aid, but simply changing the programming.

Patients were all fitted to NAL NL2 targets and they just did a two week trial with each of the two technology levels. They did a variety of aided outcomes including hearing aid determined listening environment and program. They looked at high frequency speech in quiet, speech recognition in quiet. They looked at speech recognition in noise when the speech was in front, so the noise was in back, both at a high and low signal noise ratios. They looked at acceptable noise level or signal noise ratio acceptance, but they did this in a slightly different way where they fixed the speech level at 65, and then they had some subjective ratings for outcomes. Those included the SSQ12 satisfaction ratings and how much they preferred the devices after each of the two trials.

So, in terms of level of technology, one of the things that we know about modern hearing aids, as I said previously, is the basic level of technology is already pretty advanced. What happens with premium technology is often times more automation and more sophistication. And so, in this specific example, the hearing aids had a number of pre-settings based on the environment the hearing aid thought it was in, and what was happening in the basic hearing aid was there was three environments that the hearing aid was choosing between, where there are seven environments that are being chosen between in the premium processing. In addition, in this specific instrument, the premium programming also included processing aimed at reducing the distortion and binaural cues that we commonly see with some hearing aid processing, including advanced microphone and rate processing.

And that kind of binaural processing was not available in the basic programming. So, what they found amongst group. So, much like we have seen in previous studies, there were no significant differences in speech recognition in noise or in quiet in the lab

across the two technology levels. Now this isn't terribly surprising because they really weren't doing a sophisticated speech in noise test, it was simply speech front and noise back. And so, you're really limited by the sophistication of the directional microphone in that condition, which is really limited by the number of microphones that you have, and these are two microphone devices. There were also no significant differences in subjective ratings as measured by the SSQ12 or satisfaction for speech in quiet, speech in small group or music.

However, the premium technology program did result in slightly better ANL scores. That is, they tolerated more signal noise ratios, and speech in large group satisfaction ratings. So, they did do some data logging, but this is my opinion of this article, it's difficult to look at data logging and analyzing whether they were in the right environment or not because in all cases it was the hearing aid logging what program they were in and the hearing aid logging what the environment was estimated to be. So, because of this, I don't think that they can derive a firm conclusion from those data, but I think that they do, the authors do point out that any benefits from technology looking at whether those are related to individual listening needs in a future study might be of interest.

So, one of the things where this article starts to get interesting though, is when they looked at preferences. They found that 14 individuals preferred the premium level of technology and nine the basic level, and there was only one that exhibited no preference, again, and they're blinded to the level of technology. For participants who preferred the premium level interestingly enough, outcomes for the ANL and satisfaction for speech in both small and large groups were significantly higher when using the premium level of technology. However, those that preferred the basic level of technology did not show any significant differences in outcomes between the premium and basic level. And so, what this suggests is those that did prefer the premium level

actually had that preference supported by differences in outcomes for that level of technology.

What this study concludes is really that differences across hearing aid technologies really often don't show up in general outcome measures or real world group data, despite what we see in the lab. However, these data really do provide evidence that individual preferences for higher level technologies are present in some individuals and are supported by outcome measures measured in those individuals. However, I think this also demonstrates that some listeners really can't tell the difference between basic and premium technologies and really don't have outcome differences between those technologies or they may prefer basic technology and they don't really feel there are any outcome differences between those technologies nor can we measure any. However, if we find that the differences that those that preferred the high technology level are predictable based on clinically measurable factors, an evidence-based criteria for recommending technology level may still be identified.

So, this study that I just reviewed demonstrated that individual listeners can exhibit differences in hearing aid preference, but it's not really predictable from patient factors like hearing loss. It is of interest to know, are there individual differences in hearing aid satisfaction and are they predictable based on individual patient factors? And that's the exact question that Davidson et al asked in the systematic review trying to look at satisfaction, hearing aid satisfaction in adults and whether it was predictable. This study really showed that you can predict some satisfaction with hearing aids, but the best predictor for satisfaction was really speech recognition in noise ability rather than traditional measures which we use to differentiate individuals like pure tone average.

And so, I think this is another data point showing the potential benefits from speech recognition in noise in helping us differentiate our patients when we're looking at technology levels. And in fact, if we go back to the Plyler study, what I've done is

re-plotted some of the data from the Plyler study in a way that they did not analyze. And so, if you look at the dark gray bars, those are the patients that preferred the premium technology for both the speech recognition in noise collapsed across their measures for premium and basic. And the light gray bars is the group of people that preferred the basic technology and their speech recognition in noise collapsed across the different measures for both premium and basic.

And you see a pretty obvious and interesting trend here. What you see is that those that preferred the premium technology have an SRT50 of around 8dB, and just as a reminder, when we're looking at 50% speech recognition performance in noise, down on this is better performance. If you look at those that prefer basic technology, however, both for premium and basic, their scores are falling around four and half or 5dB. So these data actually suggests, it's a small group, it's a small end, but it does agree with some other studies out there that preference was possibly related to speech recognition in noise such that those with poorer SRT50 scores had more preference for higher level technologies. So, in summary, we've looked at five main articles today, and these happen to be the ones that we asked questions about.

And so in summary, we found that middle aged adults who notice hearing difficulty use closed captions and have friends or relatives who notice communication difficulties are more likely to adopt hearing aids. Further, we showed new hearing aid users, hearing aid users age 60 to 69, and people who have multiple medical diagnosis are less likely to be persistent hearing aid users 24 months after the fitting. Again, as Dr. Picou pointed out, with the caveat that these are patients within the VA. In addition, we showed that speech recognition in noise abilities are related to the magnitude of hearing aid satisfaction. We demonstrated that using something like the PHAST R we can provide targeted re-instruction and demonstrate that this re-instruction supports better hearing aid use.

And finally, even though outcomes are similar for different levels of technology, patients who prefer premium devices have better outcomes from premium devices than basic devices, at least on some measures. And that's all we have for you today, wrapping this up. We're kind of past our time, but we'll go ahead and open it up.

- Thank you guys. We have one question. It's for Dr. Mueller. The study that you covered, were the magnitude of adjustment changes determined by real error for those patients or did they just merely click the arrow a certain number of times?

- I don't think that there was probe mic measures going on, but when you say click the arrow, this is a research study, so they weren't using manufactured software, they were using actually experimental signals that they had developed themselves. So, if you're questioning was when they did 4dB was there really a 4dB change? I would think yes. I showed the one slide that showed the measurements that they had done in their lab to insure that.

- Great, one more question and then we'll wrap up. For Dr. Ricketts, the slide you created about premium and basic and SRT50, can you review that result again?

- Yeah, and so, basically the different groups are the dark gray versus the light gray. So, the dark gray is the group that preferred premium and the light gray is the group that preferred basic. And it's not that there's a difference across the outcomes for the premium hearing aid versus the basic hearing aid, which is the left column versus, left group of columns versus the right group of columns. It's that if you look at the two dark gray bars together versus the two light gray bars, those that preferred premium technologies had aided SRT50s of around eight. So, they're really struggling in noise, whereas those that preferred the basic technology had aided SRT50s around four and a half or five.



And so, they're not struggling as much in noise. And we would expect, even though we don't have unaided values, we would expect a correlation at least between these values and unaided values. And that is, we would expect those that have poorer aided would also have poorer unaided. And so, this suggests that you know and again, not a huge dataset, but it does agree with some other data, this would suggest that those that really struggle in noise might be those that prefer more premium technology.

- Thank you for reviewing those again. Thank you all for another edition of the Vanderbilt University Journal Club, and like I mentioned, participants please feel free to review this recording. It will be posted in the next few days on AudiologyOnline. Thanks to everyone at Vanderbilt and we hope to see you soon in another edition of Advanced Journal Club.