Understanding Rehabilitation Needs of Adults with Cochlear Implants

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Welcome everyone, thank you for joining us today. My name is Rachel, I am a cochlear implant consumer specialist with Advanced Bionics, and I cover the Ohio and Kentucky region for Advanced Bionics. Before we get started here today, as Anna was mentioning, we have a couple of housekeeping items to go over.

If you need any technical support during the presentation, please contact Audiology Online at one 800, seven five three, two one six zero, or email customerexperience@continued.com. Any opinions of non-AB employees are their own and not those of the company, and this webinar is being recorded. So let's just take a quick minute to get acquainted with that chat feature that Anna mentioned.

So on the left-hand side of your screen you'll see that Q and A pod. At the bottom of the pod there's a space for you to type your questions and comments for the presenter. So let's just test this function out. Would you mind typing in there where you are joining us from? I see California, Arizona, Utah, more California, South Carolina, Colorado, Michigan, wonderful, lots and lots of people from all over. So thank you so much for joining us today. And I notice that I'm missing a slide here .

So to introduce our presenter today, today we have Dr. Moberly who will be discussing the rehabilitation needs of adults with cochlear implants. This webinar is the first in a four part learning series that is brought to you by Advanced Bionics, and the Ohio State University team. Dr. Moberly is associate professor in the division of otology, neurotology, and cranial-based surgery in the department of otolaryngology, head and neck surgery, at the Ohio State University Wexner Medical Center. He's a native of Indianapolis, Indiana, and he completed his undergraduate degree in biochemistry at Purdue University. He obtained his medical degree from Indiana University School of Medicine and completed residency training in otolaryngology, head and neck surgery, at Indiana University in Indianapolis, followed by a two year fellowship in neurotology in

the department of otolaryngology at the Ohio State University. Dr. Moberly's clinical focus is diseases of the ear and cranial base. He has a special clinical and research interest in cochlear implants and rehabilitation of hearing after cochlear implant. So I want to turn the mic over to Dr. Moberly now, and he will get started with this presentation. So thank you again for joining us today.

- All right. Let's do this, okay. Well thank you for the introduction. Let me go ahead and advance through here. So we do have some learner outcomes, and actually then I'll get to my actual introduction, but here we have three main kind of learning outcomes that I hoped for the participants to obtain. So after this course, you'll be able to describe the rationale for a comprehensive auditory rehab approach for adults with CIs, to describe additional outcomes worth considering beyond the speech recognition in this patient population, and then also discuss ways in which the rehab needs of older adults with CIs may differ from children and young adults with cochlear implants.

So I'm really happy to be participating in this. I want to thank Advanced Bionics, of course, for supporting building this webinar series. It's four, four webinars, this first one's gonna be kind of a general introduction about understanding the rehabilitation needs of adults who receive cochlear implants. Also want to thank ACIA and some of the other foundations for their support in getting word out about this, so we really appreciate that. I also want to acknowledge that I'm in my bedroom, so we used to have a really nice office in my house and then we had kids, and so now my wife and I have a playroom instead of an office, but it works just fine. So I've gotten mocked many times. I also want to acknowledge, I'm not gonna have a lot of jokes in this session, unlike many of my other talks because I'm being recorded it feels a little dangerous, so let's get that out in the open.

So I want to start with a really big picture about this whole problem and why are we interested in looking at the rehabilitation needs of adults with cochlear implants. And

first off, we know that there are enormous consequences of hearing loss, especially untreated hearing loss. First and foremost, poor communication skills that result from this hearing loss, this loss of audibility. But then downstream effects such as social isolation. People with hearing loss tend to be more socially isolated than their peers. Also, all this increasing evidence from groups like Frank Lin's group at Hopkins that is showing this connection between hearing loss and cognitive decline, and even dementia.

So we know, especially in older adults, this is becoming a much, much bigger issue. We also know that there are drastic benefits of transitioning patients who are candidates for cochlear implants from a hearing aid to a cochlear implant. Unfortunately, we only see about 10% of adult candidates who are, who went in for a cochlear implant going on to get a cochlear implant. This is a big problem in the field, especially the United States, regarding referral networks and how do we get more access to this patient population. But I want to propose here that for even those patients who do go on to get a cochlear implant, there's more that we could be doing for these folks, and this is what the focus of this webinar series is really about.

So comprehensive auditory rehabilitation is what we're proposing here, and that we can use this approach to support and optimize that transition to cochlear implantation for our patients who get implants as adults. Now when we talk about a comprehensive auditory rehabilitation approach this is sort of a term that we've come around to using that we really mean two broad things with this. One is that it's an interdisciplinary approach. This means we really try to use a team approach of the surgeon, the audiologist or audiologists, and typically a speech language pathologist to develop this comprehensive auditory rehabilitation approach and try to develop an individualized treatment approach for each individual patient. The second part of that comprehensive nature is really broadening the targets that we're focusing on. So I'm gonna spend a lot of time today talking about what is it that we really need to be focusing on in thinking

about rehab for these patients beyond just speech perception, so I'll get into that quite a bit here in a minute.

So here's an outline for today's talk, over the next 45 minutes or so we're going to talk about why should we do comprehensive auditory rehabilitation, what is it in particular that we are going to be treating with this approach, and then whom are we treating through this approach? So first, the why. So I want to start out this with a little bit of a historical perspective of how I got into this field, because that direction is really what has led me into thinking that rehab is very important, and that's this focus on how the brain interprets signals.

So we know that hearing aids and cochlear implants restore audibility, but they provide a limited representation of speech through that cochlear implant. So it's a relatively degraded input, and we depend on the brain itself to interpret those signals. Much of the focus of my research over the past five or six years has been trying to understand how the brain does that, with regards to really looking at variability in adult CI outcomes. So my initial interest in this started really when I was a fellow in neurotology at Ohio State, and we would see these older adults coming into the clinic, this is a common story, everyone in this group has probably seen these patients. They are doing poorly with their hearing aid and they want to know how they're gonna do with a cochlear implant. Or they want to know if they're ready for it, is this the right next step? And we would say yeah, you're probably ready for it. You know you meet criteria, you're probably going to do better with a cochlear implant.

But we see this huge range of performance variability afterwards, and so we need to know better about how to advise these patients, and this led into my kind of broadening my perspective of how the brain comes into play. And I want to point at four things here. So first of all, there's still substantial variability in how these patients perform on speech recognition or speech perception measures. Even in quiet

conditions, from zero to 100%, words and sentences is routine in any paper that you read you see this huge range. That suggest to some degree that even with the same device in a person's head, they may perceive or interpret those signals in a different fashion. So that kind of points to the brain to some degree.

Second thing is that some CI users remain poor performers for the long term, depending on how you want to define that, which really is typically defined as relatively poor sentence recognition, even in quiet, up to almost half of users may fit into that category. So again, similar idea, people have similar devices, maybe similar durations of hearing loss and severity of hearing loss, you put a CI in, some do great, some do really poorly. Why is that? Well, lots of reasons potentially, but the brain is probably a portion of that.

Another factor that kind of points back to the brain is that it takes two years or longer for some CI users to plateau in speech recognition performance, where some will actually plateau within three months. So again, you have the same device, and you have hopefully optimized mapping strategies within those first few months, and then over that two years there's brain plasticity that's occurring that's allowing these patients to learn to understand speech through those devices. The brain is doing something. Another fascinating thing is that people, even subjectively state that when their device is turned on, we've all heard this, it sounds very metallic or robotic or sounds like Mickey Mouse, and over two years, they start to say this sounds like speech to me again, this sounds normal. So the brain is doing an amazing job of trying to reinterpret these signals.

And then finally, again pointing back to the brain, is that even after two years of CI use, we can, not always, but sometimes see improvements with targeted auditory therapy or auditory rehab. So again, same device, same patients, but you can do some things to try to enhance their perception of speech, even after two years we see some

benefits. So we do know from a lot of clinical studies and some very large series of even thousands of patients that there are a number of demographic and audiologic measures that do seem to relate to this variability, and explains some of the variability and outcomes.

Again, focus here pretty much entirely on speech perception. Age is one of these demographic measures, meaning older adults tend to, overall, do a little bit worse than younger adults with cochlear implants on speech perception. Socio-economic status seems to come out from this as well, that may be related to better language, better education status, that kind of starts these off, these folks off at a better point when they get their cochlear implant. They're better able to make use of some of that language knowledge. Some of the audiologic factors that have really been focused on recently, or in the past 20 years, first being duration of hearing loss. Duration of hearing loss is actually very hard to accurately assess, nonetheless it seems to matter. Those patients with longer duration of severe to profound hearing loss tend to perform worse than those who have a relatively short duration.

The severity of the hearing loss before getting an implant, we know seems to relate to outcomes. So that may be a proxy for the status, the health status of the peripheral auditory system, so if you have a relatively health ear versus a less healthy ear, when you put a cochlear implant in and stimulate it, you know, perhaps that's explaining why people with less severe hearing loss actually do a little bit better. And then also prior use of a hearing aid. So maybe a similar fashion here, that if you're continuing to stimulate that deaf ear to some degree, hopefully that kind of primes it for doing well with stimulation through an electrical device, through a cochlear implant. But even all these measures taken together only explain less than half of the variability in the speech perception outcomes, so there's got to be a lot more that goes into this. And this really led me into that initial direction of trying to explain this variability. I came up with this very simple model, it's colorful but it actually doesn't tell you a whole lot,

except I like the idea that I keep coming back to of sort of breaking down factors that contribute outcomes into four main categories, and these are auditory sensitivity, perceptual organization, language skills and cognitive factors. I'm gonna spend a few minutes talking about each of these, 'cause this has been kind of a focus of our lab here at OSU.

So the first and most obvious one is auditory sensitivity, and we use this term generally just to mean how good is the signal coming through that cochlear implant? And not just through the implant, but through the whole auditory system. So how well is someone encoding the frequency or spectral information, and the temporal information that's presented through a cochlear implant. So again, even if two individuals have the same device that's delivering these signals some people may be better able to encode the frequency and timing information than the other person, and that certainly is going to impact how well they can perceive speech. More specifically with the implant, the electrode array position also seems to matter. So there's some studies that show the proximity of the electrode array, or the individual electrodes to the modiolus seems to make a difference. It's not a huge difference, but it's something.

And again, then, that residual hearing. Again is maybe a proxy for the health of the peripheral auditory system. So if it's really, overall, healthy, you're implanting in a pretty healthy ear, you would expect that to do better than a, a less healthy peripheral system. So again, auditory sensitivity clearly plays a big role, how good's the signal coming in? Our lab has really spent more time focusing on sort of the other side of this. What happens downstream of the signal, how do people actually use that sensory input that's coming through the device. So the first one is kind of a broad category called perceptual organization, or perceptual closure. And this is really the way that someone is able to use degraded sensory input to create a meaningful form from it. So a good example that I like to show is this visual example of this guy. So if you're from the United States you probably do not have any trouble identifying this as Abe Lincoln.

But what you can see is this is a very degraded, pixelated image. So it's a similar type of idea when you're talking about listening through a cochlear implant, you have a degraded sensory input, and some people are probably just better in general at turning that into a meaningful form than others.

And this, there's some evidence for this using some visual analogs of speech perception. So one that came out a few years ago is called the text perception threshold measure, so this is essentially sentences that are placed up on the screen very briefly, but they have bars, or they have other different types of things that can block them, but they're, they're essentially blocking off portions of the words of the sentence, and the participant is supposed to read that sentence as well as possible. So has to use the surrounding context and sort of pick out the meaningful form from that degraded sentence.

We have a similar one that was developed at Indiana University, called the fragmented sentences test, very similar type of measure. And what we find, we have found and others have found, that these, performance on these measures relates to people's speech perception thresholds. Especially patients with hearing aids or moderate degrees of hearing loss. And we're also finding better performance in CI users who do better on these tasks. So again, the idea here is they, some people tend to be better at performing this task of perceptual organization than others. Another broad area is language skills. So we know that a number of language skills contribute to how well adults can understand speech through their cochlear implants.

I do want to mention, most of our studies, if not all, I guess all of our studies so far and most of the work that looks at adult CI outcome variability is really focused on post-lingual adults. So these are patients who developed language, relatively normal speech and language skills and then they lost their hearing progressively or suddenly over time, as adults. So that's sort of implied in most of the work or discussed in the

work that we've done. And that's really the group that we're focusing on and it's the bulk of the patients that we see in adult CI programs.

So, back to language skills, first one, we've looked at some of this, is phonological sensitivity. So this is how well is someone able to tap into the speech sounds from the sensory input. In other words, how well, what are the representations that people have of speech sounds of phonemes. And that seems to play a role, so how well can people take that signal that's degraded and match it to some sort of representation in long term memory. Another one is the ability to use semantic contexts. So this is a very simple thing of if you hear a meaningful sentence, but you're missing some of the items, some of the words within that sentence, you can kind of piece it together. It's kind of like a puzzle.

So if I'm making sense, which is hard to say, but if I'm speaking here and I'm making sense and you miss every third word, you could still probably get the gist. So we think, we know that there's some relationship between people's ability to make use of that context and their performance on speech recognition measures. Particularly sentence recognition. And then the final broad category is what we call cognitive factors, and we've spent a lot of time in our lab kind of looking at these different measures, taping into these information-processing skills that we think and we know underlie perception. And I'm gonna spend a little time just running through some examples of these measures.

They're pretty simple measures but they're actually pretty good predictors of speech recognition performance to some degree. So working memory, inhibitory control, verbal, verbal learning and memory, information processing speed, and then nonverbal reasoning. So I'll show you some examples of some of these. So the first one is working memory, so this is how well can you take sensory input in and store it and

manipulate it in your memory over a very short amount of time. So this is like remembering a telephone number would be a good example of working memory.

Often times these measures also require you to manipulate it more, so maybe we're remembering a digit, a string of digits and then reversing it, repeating it back in the reverse order, that'd be also another working memory task. So one that we use is called a visual digit span. This is shown on a computer screen and individual numbers are popped up onto the screen, one at a time, and then at the end there's a grid shown like this and the participant has to touch, on the screen, in the correct serial order, those digits. And the number of digits that they can do is used as a measure of their working memory capacity. And again, I'm showing each of these because in some, not all settings, but in some settings, scores on these different measures relate to performance of speech recognition either in quiet or noise with cochlear implant users.

Go to the next one. So inhibitory control, the idea behind inhibitory control is that it requires you to inhibit some prepotent or natural response to something. So a classic measure that looks at this is called the stroop measure, and we use a computerized version of this. This is the color word task, where you're presented with a color word on the screen and your goal is to tell what the color of the word is. So in this case the correct response is going to be red, I have to inhibit my natural response to read the word, which would be blue, I have to inhibit that response and I give the right response which is red.

And from this measure you get measures, you get times of processing speed, concentration, as well as inhibitory control. And again, measures from that seem to relate to how well people can understand speech with a cochlear implant. Next one is something called information processing speed, really basic, maybe efficiency or speed of processing. And the measure that we use, or have used, is called the TOWRE, which is the test of word reading efficiency, and it's, it's a very simple

measure, a list of words and a separate list of non-words, and the individual is given 45 seconds to go down the list and just read these as quickly and accurately as possible.

And what's interesting is just that simple measure of timed reading of words, actually relates to how well people can understand speech through an implant. The last one I'm gonna mention here is measure of nonverbal reasoning, or you could think of this as nonverbal IQ. Another classic measure that has just been turned into a computer version is the Raven's progressive matrices. In this case you see a pattern at the top of the screen, and you have to complete that by selecting the correct option from the bottom. In this case that would be this one. Again you're given, in our lab we give about 10 minutes to complete as many of these as possible and performance accuracy on that relates to speech recognition across a number of measures.

Okay, so I go through all of those, again, to sort of focus on the point, again, of how important the brain is in interpreting these signals, and so these direct visual measures help us to get at some of the functioning of information processing in the brain. I'm not sure if I mentioned that all of those are visual because we want to exclude the confound of audibility. So if you have people with varying audibility, or in this case, varying auditory sensitivity, then we want to tap into some of those processing skills using visual measures. And of course we measure people's vision, near vision, make sure that it's normal or near enough normal for them to be able to perform these tasks.

So again, the central function of the brain in all of this. And I bring this up in this, this webinar not just to give the history of how I got interested in this, and the direction of variability, but also this then lends itself to thinking that potentially all of these different areas could benefit from rehabilitation and training. Now we don't have a ton of evidence for that yet, we're trying to do studies of auditory rehab and training to demonstrate some of that, and there's promising results and a lot of people tried to do some therapy and rehab trials to demonstrate this, but again the, it's reasonable to

assume that if all of these areas contribute to variability, they should potentially be targets for rehabilitative approaches.

The other thing is that this comprehensive model, we can really utilize speech-language pathologies, speech-language pathologists, and their skill set to assist both in measuring and potentially treating and training some of these functions. And I'll get into that a little bit more later, but one of the positives there is that SLPs can actually bill for some of these services and some of this time that is spent during this rehab approach that our audiologists just don't have the time, from a billing standpoint, to perform. Okay, so that's a broad overview of sort of what interested me in rehab, why is the brain so important, how do all of these functions contribute to speech recognition. But I'm gonna move on from that and look a little bit more broadly, what is it that we're actually treating?

So as you can see from that previous 10 minutes of discussion about variability, that was all focused on speech recognition, with this. Speech perception performance and that's, that's really because that's what we focus on in the clinic, at least historically. We have this traditional focus on speech perception using typically CNC words or HINTs or AzBio sentences Sometimes we add noise. But that's really been sort of our benchmark measure of one, when is someone a candidate for a cochlear implant, but then how are they doing with their cochlear implant. But, recent information, recent studies have really shown that there is not a strong correlation between speech perception performance, either in the clinic or the lab, and patient-reported outcomes. So there are two good studies, or one's a study one is sort of a blog that I think are worth looking at if you haven't run across this disconnect between speech perception and patient-reported outcomes.

So McRackan and his group did a meta-analysis looking across a number of studies and they found very weak, if no, significant correlations between speech performance,

speech recognition performance, and patient-reported outcomes of quality of life, self-efficacy, you know other types of things that were across these different measures. So again, they're not the same thing. So just measuring speech perception doesn't get at that. And then Camille Dunn from Iowa has this nice blog, I've got the link at the end of the presentation, but it was called What is Success with CIs, and there she really kind of points out this issue, and I've heard her talk about this and it's interesting, it was almost like it was an eye-opening experience when she realized that people who perform really well with their implants on speech perception may still really be struggling from a communication and quality of life standpoint.

And vice versa, you may have a patient, an older guy that comes into your clinic, and he gets tested in the booth with his implant, he's scoring 20% and you're thinking this is, this is a disaster, but the guy's thrilled because he's back to functioning, he's back to interacting with his grandkids, he's happy with how he's doing. So again we need to broaden how we look at this. So I, we are claiming in this group that we need to reframe our conception about outcomes and success, and instead of focusing just on hearing loss and audibility, meaning we restore audibility we're good, we need to be thinking about these patients as having long term communication impairment, and all the downstream effects that come from those. So that's what I'm gonna get into with this. The other thing, this is a nice study that I just think outlines this whole, this whole issue for is, what is we are really treating?

And McRackan and his group also developed this CI quality of life questionnaire, this is a new, patient-reported outcome measure of quality of life in a broad, broad sense. I like this for two reasons, one was their approach to developing this tool was very methodical, which is really needed. A lot of quality of life measures are not developed as, using strict methods I guess. But the other one that I really care about for this purpose is that they incorporated focus groups of adult CI users to get their input, and to confirm what were the important domains of function that people care about. So

they came up with six independent domains. These included communication, emotional, entertainment, environment, listening effort, and social. So you can see speech perception probably fits within a couple of these, but it's clearly not the whole picture. If I can hammer in any point here it's that we need to be thinking much more broadly than just speech perception.

Here's a little word cloud. So we gave a luncheon for our research participants a few months ago, and we flashed this question up on the screen, how do you define success with your CI? And people typed in their responses and they came up into this little word bubble which is real trendy I guess. But what's cool about this is you can see this really echoes what I showed on that previous, that previous slide. That people are focused on, yes, communication, but also acceptance, you know, they put grandchildren, so sort of the social impact. Comfortable, people want to not feel stressed and fatigued all the time trying to communicate. So you can just see all of these really touch on this idea that this is much broader than just speech perception.

So, when we talk about a comprehensive auditory rehabilitation approach, we want to be thinking much more broadly. This is along the laundry list of items, and it seems a little bit daunting to think that we could tackle all of these, and potentially you're not tackling all of these for any individual patient, which I'll come back to later at the very end of this. But what I want to point out here is that these are well beyond just speech perception. I'm not gonna go through each of these, let me check my notes. I wanted to just touch on a few of these with regards to our CI patients. And some kind of anecdotes, there is some evidence for some of these, but a lot of this is sort of early in the process of studying aural rehab and what should be our targets, but I think these will resonate with most of the people who are viewing this.

So the first one's listening comprehension that I want to touch on. So even if someone is able to repeat words or sentences back in the audiology booth, and they can do that

effectively, that doesn't mean they're comprehending that information or long strings of information very well. And you can think about this just anecdotally where you have a patient who stops and says, "What?" all the time. Or they just, you can tell that they need extra time to catch up, and there's a lot of studies, a guy named Matt Winn who's done some work looking at listening comprehension and listening effort, or more listening effort with pupillometry and looking at how effortful it is to understand speech.

And a lot of time people need extra time to be able to kind of back up and process this information that's coming in. So even if they can perceive speech, maybe they're not understanding it to the degree we expect them to, and maybe rehab could help with that. The second one is this motivation issue, and everyone who's a clinician in here, or researcher, has seen this variable degree of motivation, how well motivated are people to come to their appointments even, or go through with rehab practice. Some people are incredibly motivated and some people just don't seem to care or they won't accept that that's a key portion of the rehab process. It's hard to measure motivation, we spent quite a bit of time trying to really identify good measure of that. Actually, if anyone has any, let us know at the end.

But, in principle this is, it's very clear that different degrees of motivation are contributing to how well people do with their implants, and ideally rehab, comprehensive rehab, where you're having people in repeatedly, week after week, can help to increase that, or stabilize that motivation. Another one's device knowledge. So this seems to be particularly important for the patients who are coming through comprehensive auditory rehab where we've seen some patients just need a lot of time spent on rehashing, understanding their devices, and understanding their accessories and when and how to use them. So, again, this speaks back to this idea that audiologist are spending a lot of time doing programming and mapping, and they spend a lot of time troubleshooting with their patients, but they can't effectively bill for it, so it's just limited, and we hear this complaint all the time that our audiologists just

don't have enough time to spend with these patients and keep it sustainable, I guess, from a financial standpoint.

Luckily the speech pathologist can take on some of this to reinforce these behaviors and this knowledge. And again, doing that week after week after week can really provide some benefit. And we've been surprised, you know, initially when we started our program I remember having a lot of discussions about training, focusing the whole rehab process on auditory training, and it turns out a lot of the real meat of auditory rehab is some of this more psycho-social and device knowledge connection between the clinician and the patient that the SLPs can spend more time doing. The last one I want to mention on this slide is executive functioning and cognition. I mention this because executive functioning is sort of a, a bigger, broader sort of cognition, if you will. So this is goal-oriented behavior, what are the functions, the cognitive processes that work together to allow someone to complete a goal or a task, or stay oriented to a goal.

So that's more than just these simple, isolated measures, or cognitive functions that I mentioned earlier. But that stuff seems to come into play, that may be a barrier that really connects more to quality of life and people's daily perception of how well they're doing, because these are daily skills that people are needing to be doing. So, again, the idea here is these cognitive functions really contribute to overall goal-oriented functioning, not just speech perception. Okay. So, the last little bit of this, I have about 10, 10 or so minutes left, I'm gonna really kind of focus on, well whom are we treating? So what is it that's unique about this older adult population? Or just adult population in general. And again I want to reemphasize here, we're really talking about post-lingually deafened adults, primarily. I think when you're talking about pre-lingually deafened adults, it's a little different picture. But with this adult population that I've been talking about, it's worth keeping in mind that the needs for patients undergoing adult hearing rehabilitation may be different from those for kids who are going under, undergoing

hearing habilitation with a cochlear implant. So you have a deaf child who gets a cochlear implant, they are really learning to develop speech and language skills with that device. And this is where auditory-verbal therapy just takes a huge role of these therapists who are working with these patients to really learn speech and learn communication strategies.

In contrast, the adults need some of that same sort of orientation, but we always think about these people as they already have established speech and language skills before they lose their hearing, and then once you put the new device into their ear you're trying to get them to remap that new signal onto known, existing, representations of speech and language functions. So that, you would expect, because of that, that some of the approaches to doing that are going to be different. You can also sort of reflect back on what they knew before they lost hearing, you can use context that they probably continue to see through reading. Lots of different things that may be slightly different from the pediatric side.

The other thing I want to mention here is you have this assumption in the field that these post-lingually deafened adults who have relatively normal speech and language development that after their hearing loss, that continues as, in a stable fashion, and there's actually growing evidence that some of those language processing functions may be declining during that period of hearing loss. And I'll give two examples. One is some older work from back in the 90's that really showed that some of the phonological skills seem to decline with hearing loss. And not just because the signals coming in, but the representations of phonemes, the representations of sounds, speech sounds, in someone's brain tend to decline or become more fuzzy. So instead of having these really sharp representations of different phonemes in general, they may become fuzzier.

So trying to tap and remap to those, tap into and remap to those old representations may be a challenge in some of these patients. Another example is, we use a measure of verbal learning and memory, and we see that even if you use a visual measure where people are repeating word lists, the performance of the patients with hearing loss is actually worse than the performance in patients with normal hearing. So there's something that's happening to the way people process speech and their language skills, that may be changing over time because of hearing loss. So we need to think about those things when we're trying to rehabilitate these skills.

The other big point here is that we are implanting a lot of older and older adults. So this is a rapidly growing population of patients who are getting cochlear implants. We did a study of our sample, just a clinical review. Our media, medium, mean age was about 61 years. Another group reported over a quarter of theirs were over 70, and some more recent reports even show higher, so each year it seems like we're implanting people who are a little bit older. And that's because patients are living longer, we're really sure that this is a safe approach for older patients, they tend to do well in general, and so that continues to expand. We need to keep in mind that they do tend to do a little bit less well than younger cochlear implant users. Again this speaks to some of the brain functions, speaks to some of the other considerations that are unique for this population.

Some of those considerations include comorbidities, so what's the cardiac and pulmonary status of this patient, is it appropriate for them to have surgery. Vestibular function is a big one, I'm not gonna talk about too much in this program, but we always have to think about the balance function of the inner ears in each patients who are getting cochlear implants. And there are a number of studies that have shown that cochlear implantation does impact vestibular function, so we always have to keep that in mind. I also want to mention hearing aid access. The reason I mention this here is that we know that Medicare does not cover hearing aids, and if we think it's important

for people to be aided up until the time of their cochlear implant, or even after maybe, through bi-modal stimulation, then this problem with Medicare and insurance not covering hearing aids, can really be an issue.

So we may have patients who come in who qualify for a cochlear implant, but they haven't been wearing a device for five years. So now you're dealing with less stimulation to that ear over the last five years. You're also dealing with someone who may not be as equipped to manage a device because they're out of practice, they haven't been using a hearing aid for awhile. So those are some additional concerns with this older population. And then finally, social isolation, which I'll talk about a little bit more on the next slide, but that seems to be a particular issue for older adults. And then I have this little diagram, I want to just always keep in mind with this older population this, these connections back and forth between aging and hearing loss and cognitive decline. So with these older patients who get implants we always need to be concerned or thinking to some degree about their cognitive function, again speaking back to the whole brain issue.

Okay, so again, when we're thinking about older adults, I want to propose that this group of older adults is at an even higher risk for impairment in some of these functions. This is that same list that I showed on the other slide of things that we need to be thinking about for a comprehensive auditory rehab approach. And I'm making a point here that I think older adults across many of these, older adults may be at more risk for not doing as well. I want to touch on a couple of these here. So psycho-social function in particular, we know that older adults with hearing loss tend to show higher levels of depression. So that's, that's another we need to take into consideration. It's probably not our role necessarily to be treating depression and anxiety as a result of hearing loss, but making sure that we understand how that's contributing to their overall performance, or also getting them linked up with the appropriate resources for that is really important, and that seems to be especially true in this older population. I

think the listening effort thing is something that, again, anecdotally, we all have experience with this where we see a patient who just talks about the end of the day, they are just fatigued, they're just beat, and how can we help them with this? And we don't know a lot about how to really rate high listening effort. It could be that if you do some training where people actually get better at speech perception maybe that will help, maybe there's development of strategies that can help people to cope with that in a better fashion.

Another one that is social participant, social participation and isolation, kind of along the lines of what I talked about with psycho-social function with the withdrawing. You know the hearing loss, potentially depression and isolation from the social network, there's a couple issues here. One is these patients, these older patients may not necessarily have that social network from the standpoint of helping them with coming to their clinical visits, coming to their rehab sessions. But also, sort of the homework exercises that they need to do. So having them engaged closely with the clinician on a weekly basis may help with that. We also know that more access to speech through an implant, through data logging, does seem to relate to how well people do with their implants.

So I think we all have these stories of people potentially in a nursing home who get a cochlear implant and they just don't thrive because they're just not getting that social participation, even after their implant. So maybe we can encourage that more through a little bit more direct contact and frequent visits with an AR program. The other thing I want to mention again here is down to the executive functioning and cognition. These are things that people have started looking at, can you actually train some of these in this population. There's a lot of work that's looked at can you do computerized training of things like working memory and inhibitory control and processing speed, and the results are really mixed. We've done a little bit of that, I would say that it's kind of a mixed bag.

However there's sort of a move in, in auditory training to incorporate cognitive training within auditory training. So maybe you use some materials that require cognitive functions to come into play. So maybe you do longer sentences or you change the context or, there's a lot of things that can be done that will be gone into in the additional webinars on this. I think it's always worth thinking about, maybe you don't directly tackle cognition, but you need to know how it's, how it's contributing to performance and then maybe you can kind of tackle it along with your speech perception training through a variety of techniques.

Okay. So, this slide is my last slide. I just want to provide another kind of big overview about this. So when I started out kind of defining this comprehensive auditory rehab approach I said that our interpretation of that, at least, or what we've developed is it's, it should be interdisciplinary and multidisciplinary. The surgeon, the audiologist and the speech pathologist. I also mentioned that when we think of that as a comprehensive approach, we are thinking of broadening the outcomes, we're broadening what we're assessing and we're broadening what we're targeting. But along with those we also need to think about this as a patient-centered approach. So it needs to be holistic, we need to really look at the whole patient.

You know, that laundry list I mentioned before of all those items that we need to be thinking about, it's unrealistic to think we can hit on all of those, but we really want to kind of identify the factors that are most effecting that individual patient and make a patient-centered, targeted, rehab approach for them. Self management is a really important thing. So improving patient's knowledge, both of their devices and how to manage their listening environments, how to use those accessories that they get that often times they just put in a drawer 'cause they don't know what to do with them. Those self management skills are really important, and having weekly visits with the clinician can help with that, and help with adherence to treatment, and encourage social support as well. As far as the assessment goes, the other, the rest of the group

is gonna get really into this in the next few webinar sessions, but obviously we have auditory processing skills that we need to measure, but again, then these cognitive and linguistic skills also.

So our group has sort of taken some of the findings from the lab and tried to find similar types of clinical measures that we can apply so we can really get a better understanding of the cognitive and language functions of these patients. And then these patient reported measures are becoming really important. Again, back to that initial message that speech perception and patient reported quality of life really do not overlap very much. So what is it that we do care about? We need to be assessing these things like communication confidence and self-efficacy and social participation. If we're not then, you know, it's, you can't treat something unless you have a good assessment for it, or you can't treat it effectively because if you don't know what you're trying to treat it's very hard to come up with a comprehensive plan for that patient. And then finally, it's really important for us to develop, in partnership with the patient, the goals, the things that they really want to target during the therapy and during the rehab approach.

And so using measures where, or identifying very early in the process, what is it that the patient, he or she, cares about the most is gonna be really key. And that's pretty much all I have, so we're gonna open up to questions, but I want to acknowledge, especially the top three folks on this page, this is the rest of the crew that you'll be hearing from on the rest of this webinar series, a couple of them are here today also to help with questions. The rest of this long list is all the people who've kind of supported our lab and our clinic over the past few years. This is the references, hopefully you can see some. I do want to point out this Camille Dunn one is this neat blog and it's called What is Success with CIs, you can go online and Google it, but I like it, it's not overly academic, it's just like her perspective on how she sort of came around to identifying this, this gap between what we care about in the clinic typically and what the patients

care about. So I really I want to thank AB again for supporting this, I also want to thank ACIA for their support. And yeah, I'm very happy to take any questions that you people have. Thanks for listening.

- [Valerie] Thanks Aaron. This is Valerie and I am going to encourage the audience, if you have any questions for Dr. Moberly, or any members of the team today, please just type your question into that chat box and we'll read those questions out loud and we'll get those answers. I want to thank you, thanks Dr. Moberly, that was an excellent presentation. I think some of the things that you pointed out, to our audience are going to be particularly valuable. Looking at just that comprehensive model, to really refocus on what are those variabilities in the patients, and then being able to take that information, think about how it effects that information processing in the brain, and I love the way you really helped us to think about broadening and reframing the definition of success. So it's not just a speech perception, but really that key to establishing that communication confidence. I love the idea of motivation, and I think a question, you know, that maybe the audience is thinking about that came to me while I was listening as well is when we think about that motivation, how do you think that we can use this knowledge that your team will be sharing today and throughout this webinar series to really motivate our patients to believe in this AR process? I don't know if you have any thoughts about that.

- So the first thing that I would say about that is, we have sort of taken our approach at OSU to lay it out at the beginning, especially with having the surgeons on board, of sort of saying, I don't know if it exactly ties in to motivation but I think it does, that we expect this. We expect you to at least do an initial evaluation with the speech pathologist where she can do this kind of baseline assessment of cognitive and language functions even before implantation. And if it's built in as sort of an expectation then the patients don't really question it, and obviously that means that the clinicians all have to think that it's a worthwhile pursuit. So of course we do because

this is, this is a program that we feel very strongly about. But if it's presented to the patient in a way that, you know, the clinicians are convinced this is important, you know, they're going to jump at it. And people, people really enjoy it, so I think once they start doing it and doing some sessions they find it to be very valuable. So that encourages motivation. But I think it's, it is really key getting buy-in from your audiologist and your surgeon that this is necessary. If it's thought of as sort of an adjunct, an oh we don't really think it's a big deal, then obviously the motivation in the patient is gonna be lower. Otherwise, in terms of, I think motivation itself, once they're established in this program, you know, probably the most important part, at least on a perceptual training side of rehab, is doing the homework. You know, going and practicing listening, doing different types of listening exercises, whether they're official, or you're just putting yourself in a listening environment that challenges that brain. If you're seen an SLP every week and you're getting homework and you're getting feedback and you're troubleshooting together, I mean there's no way that people's motivation doesn't increase by going that way. Not sure if anyone else from the team has anything to add there.

- [Valerie] Okay, Christie or Kara, I don't think you've turned on your microphones so I think, thank you that was a really comprehensive answer. We do have another question from the audience. The question from Michelle is, this may be addressed in the next parts of the series, but curious, when would you plan the SLP in the CI process? Do you have them assessed as part of the CI eval or post activation?

- Yeah that's a great question. So that will come up, I think that's gonna be in a lot more detail, you know, this is the broad overview, so hopefully you're not missing too many details today, but that's definitely gonna come up in the next, second and third session, but in general, like I just mentioned there, we do start early, we start pre-op to try to establish that connection with the SLP. From a logistical standpoint, we are usually set up that we have a cochlear implant eval with the audiologist, see the

surgeon, and then if they're deciding their working towards, moving towards surgery, they may go ahead and schedule, and then they have their device selection appointment with audiologist on the same day that they come and see the speech therapist. So that seems to work pretty well. One you're not overwhelming people on the day of the CI eval, and two they've already decided they're gonna go ahead and proceed, they're just coming back for that device selection with the audiologist, that's a good time for them to also meet with the speech pathologist. And sometimes there's communication back and forth there on well what actually makes the most sense for this person? Or if they've picked this device, let's start thinking about this accessory because that could go with that. So we start early is the bottom line. When we were starting to develop the program though we really started an issue with experienced CI users, but was to start developing studies of AR. But I think from a clinical flow standpoint getting them in, getting patients in early to this process is really important.

- [Valerie] Great, thank you. We have another question from Warren in the audience, he's asking is CI programming different for older adults, given all the issues of age that you mentioned?

- So, you'd be better off asking an audiologist, but what I can tell you about what I understand from our previous discussions is the programming itself, sometimes you have to go a little bit slower in terms of adjusting the thresholds. The other thing is, and many people in this room will probably know this better, but some, in some circles there's thought of changing the rates, so slower rates may be more important because that temporal information cannot be encoded as well by an older auditory nerve. I think the verdict's kind of out on that, but there's certainly things that people adjust the rate to see if that's, that makes an impact. That's the best I could answer on that.

- [Valerie] Kara, do you want to add to that?

- [Kara] I would agree with you Aaron. I think in certain cases those two can be useful. But programming, I don't think is inherently more difficult due to age, I just think it really depends on the patient and whether they're struggling in any other areas. So that's a really broad answer to your question but as an audiologist I do, you know, collaborate with the SLPs who do the aural rehab, so if we're seeing a particular area of need where we think that programming could improve a particular situation, like a certain environment that they're having trouble in, or some testing modifications that might need to be made, then those can be really helpful in an audiology appointment.

- [Valerie] Thank you Kara.

- [Christie] Can I also chime in? If that's okay Valerie? This is Christie.

- [Valerie] Go ahead Christie.

- [Christie] From a speech pathology standpoint that pre-op eval, and this ties back to Valerie's question as well and the previous question about the timing. So, you know, we see people and we do this assessment of their cognitive linguistic function before they get a CI, and a big part , a big way that that's helpful is in managing expectations. So we do know about certain factors that predict outcomes, not perfectly, but we have a good idea. And we see older people, or we actually see people who have like known dementia or known cognitive decline as well and when we test those things it gives us specific areas that we can talk to the patient or their families about pre-operatively as far as how that might impact their outcome, how that might impact their outcome, we can explain what we know and, especially in the areas of deficits. Like I see you have a weakness in this area, you know you have strength in this other area, and this may play into your outcome in this way. And I think for older adults that definitely comes into play, especially patients who have dementia. Managing those expectations is a big part of the pre-op visit.

- [Valerie] Thanks Christie. We have another question from Kevin, the question is do motor skills or drawing ability have any influence in CI speech reception outcomes?

- Yeah that's an interesting question. So the best I can answer, generally I wouldn't say we necessarily know that, but with some of these cognitive test, and people have looked at things like the clock drawing task or essentially the motor type of stuff and visual motor processing, visual-spatial processing, seems to not impact performance very much, from a speech perception standpoint. So things that are along the lines of processing speed and memory and working memory and really manipulation, I guess I would say mostly, manipulation of language and linguistic materials seems to make a bigger difference than more visual or visual-spatial types of stuff. I don't know about motor, like fine motor skill as much, I haven't seen that studied very much, but I would say, you could kind of say that the stuff that's most related to verbal or language processing, those cognitive functions seem to contribute the most to people's ability to understand speech with an implant.

- [Valerie] Okay great, thank you. Another question from the audience. Rachel asks, do you have a suggestion for encouraging patients we see who could greatly benefit from a CI but are hesitant?

- [Christie] I can chime--

- Yeah and it's that's a good broad--

- [Valerie] Yeah go ahead.

- Oh. Someone speaking.

- [Christie] I can chime in there if you want.

- Oh, oh go ahead.

- [Christie] So again I think it goes back to the thorough, comprehensive, pre-op assessment. You know, one we want to find out why they're hesitant and really get at that. One things that we do, and we'll get into this in a later webinar, is give a, a series, like a battery of patient reported measures and we get an idea of what, what are their goals? What are their difficulties? And then I can take those goals, specifically out of their mouth, or they write them down, I can take those goals, we can talk about them and I can give them an indication of how a CI may help them in those situations or not, or what kind of work may be they would have to do to be able to meet those goals. Again we can't predict that with like 100% accuracy but we can get a general idea in taking that time pre-operatively to know what their goals are, why they want or don't want a CI, and those other cognitive risk factors as well.

- Yeah and I think, I mean, I would agree with all of that. The other thing is, and you mentioned this to start, you have to kind of understand, spend a little time understanding, trying to understand what is the hesitation. So if they're just scared about surgery, I mean, we, I think surgeons we can very easily sort of say this is a very safe procedure. Here's the risks but that's very unusual. If it's concern about loss of that residual hearing, you know, often times it's a matter of just pointing out how much they're struggling, well not pointing out but discussing that they're currently struggling and we expect them to be this much better, and if we can come up with a profile to better predict how they're gonna do that's useful, which is one of my long term goals, then that's also helpful in sort of saying, you're doing this well here, here's how we expect you to do. And that's, again, maybe too focused on speech perception but it's at least something we can point towards.

- [Erin] If I can chime in. I think it can be really useful to refer the patient to another CI user as well. Our manufacturer routes are helpful with that. Like Carrie Singler mentioned in another question here, we have a really great support group network in Ohio and I know they're really spread all over the country. So those can be really useful so that the patient can talk to another CI user who has really been through that same journey and often helps to quell some of the fears that they're having.

- [Valerie] Okay great. Another question from Dixie, she says that many CI centers used to only refer adults for AR when the struggled with, when they struggled with their implants, and were not expecting progress. Is that view still current?

- You know, I would, that's a great question. So we debate this all the time, and actually this is one of the things where Christie gets on my case for calling people poor performers for a couple reasons. One is what's the cut off? What's good versus poor performance, that's one issue. But bottom line yeah, and we see that all the time that it's sort of like a last ditch effort, and the reason I guess I mention the poor performers thing is that even people who are actually performing very well in the booth, they may still have a lot of communication deficits and issues that they need help with. So that, that's kind of an old fashioned look at it, but I think it also comes from the lack of resources, lack of a lot of people who do this type of work from a speech pathology standpoint or a specific AR standpoint that you send the people who are most struggling. But it's probably more realistic that everyone should be getting some degree of this and that it could benefit them, even if maybe their long term outcome isn't different, maybe the process of adapting over time is gonna be improved. There's a lot of questions we just don't have answers for with that, but I would say, I think we do as a field, probably do need to move away from that last ditch effort perspective, partly because, you know, that may also limit the benefits that we're able to demonstrate in particular in studies and get better coverage, you know, for audiologists who wanna be doing this or, you know, from a reimbursement standpoint.

So I think that's sort of an outdated perspective but it's understandable based on sort of limited resources. So, but the bottom line is I think, we think it's very important to really, systematically get people through into this type of approach and there are benefits to be had for the high performers and the--

- [Valerie] Great, thank you Aaron. Carrie asks, do you have any experience with CI support groups and impact on increasing motivation, communication ability, and confidence? So Aaron or Christie, I feel like one of the two of you could probably answer that.

- I would say, I mean, I think Kara sort of touched on that, you know, especially some of the industry-sponsored support groups that are really useful and make these connections among the patients is really, really valuable for understanding... I mean it's interesting if you go to some of these meetings, some of the, just the discussion between the patients and they're showing each other how to use their accessories, or they're talking about when's the best time to make use of this or use this processing, you know, mode. So I'm not sure if that's getting at the question, but I think those support groups are really huge. I mean obviously, listening to a clinician tell you something may come across differently from listening to a peer with an implant that has been through that same struggle.

- [Valerie] Okay. Thank you. Angela is asking what tools does your team use for measuring and working on listening effort?

- So that's a hard one. Maybe Christie can comment on a little bit more on that and particularly in some additional webinar series too, but it's really hard to measure that appropriately. You know if you look at the literature on listening efforts the subject of questionnaires don't necessarily seem to line up with these behavioral measures. There's like dual task measures that require kind of multitasking and you see how

performance suffers on one task versus the other. Then there's pupillometry which is really not something that's very easy to apply in a clinic. I don't know if any groups have that in a clinic setting. So probably, so far, that's more something that we would get through questionnaire. Not sure if Christie has a good questionnaire that she uses for that. I, but like I mentioned during the talk, I think it's, that's a hard thing to assess.

- [Christie] Yes I, one thing you mentioned is that you don't see strong relationships between subjective and the objective. But I think what matters, again like defining success, is what the patient thinks or how the patient feels. So the questionnaire, and actually the CIQLL that Dr. Moberly mentioned earlier has a domain, a sub domain within it for listening effort and specific questions that get at that subjectively. And that's mainly what we use.

- [Valerie] Okay, thank you Christie. There's a question from Michelle. What she's asking is what cognitive linguistic standardized assessment does the SLP administer, and is this standard for all aged adults or just the geriatric population? So maybe Christie you could address the question?

- [Christie] Yeah, so we, I think it's the third webinar in the series, so that would be August, we'll go into that in a lot of detail. There, we use currently the R-Band, a visual version, so there are a couple of studies looking at this visual version in CI users of the R-Band, so you can contact me if you'd like and I can send you our PowerPoint. It's just the stimuli and the instructions on PowerPoint slides. But there are many others, the TOWRE Dr. Moberly mentioned earlier is quick, easy, commonly given by SLPs for other populations, particularly pediatric, but it's good and it relates to outcomes and it's quick. It's a good clinical, good for the clinic because it's quick, easy, and gives a good amount of information. And there are some others, there's a hearing impaired MoCA, if you wanted to do like a screening, a visual version of the MoCA, and some others and we'll talk about those in more detail in the third webinar in August.

- [Valerie] And then Christie can you just comment, the other part of that question is, is this standard for all aged adults or just the geriatric population?

- [Christie] In a clinic this is our standard of care for all CI candidates, so people who are gonna go, who have met CI candidacy criteria and are planning on moving forward with a cochlear implant, everybody gets this pre-operatively. And we also do it post-operatively as well, after about six months.

- [Valerie] Okay great, thank you. There's a question from Lois, and the question is can your hearing actually decline after getting a CI?

- Yeah, there's a number of reasons that that could happen. So one is the, you know, the surgical insertion itself could damage the inner ear. If you're talking about the ear with the implant, that residual hearing can decline, or you could have progressive loss where, if you're talking again about the residual hearing that's in that ear that's been implanted that may decline over time. Obviously the, putting an implant in one ear is not gonna effect the trajectory of hearing loss in the other side. Luckily, from a CI standpoint, most people are relatively stable for a pretty long duration of time in terms of their electric hearing. So that's good. There may be, I'm not sure if there are consistent changes in processing, like thresholds that people need to adjust, you know if you've have a CI for 10 years, that I'm not sure about. But yeah, certainly, certainly that's a risk with surgery but it's luckily relatively stable, hearing standpoint after cochlear implant.

- [Valerie] Okay thank you and there's one last question from Lauren.

- [Valerie From Speaker] Okay thank you and--

- [Valerie] Asking, would any of the test results support implantation, like working memory via contra-indetation for implantation?

- Yeah that's a really hard question, we've, I've wondered about this, you know, a lot of clinical centers are also starting to just implement things like the high MoCA or a very quick cognitive screens. And what do you do with someone who fails that? It's interesting in our lab, you know, we try to only, so far, include people who pass cognitive screens for our studies, not in the clinic but in the lab, and you know very frequently though we'll have people who come in with just not quite normal scores on these measures. I certainly don't think it should impact the decision to implant, it needs, it probably has a big role in terms of counseling and the expectation that maybe this person's gonna struggle a little bit more, or they may have some issues with using their device, you know, manipulating it, potentially, and using accessories and having to reinforce a lot of those instructions more. But in the end you still have someone who's severe or moderately to profoundly deaf in both ears typically in this situation and that's probably only, you know, that cognitive function may just continue to decline. So if you can do something that may impact that, you don't know that, but may impact or stabilize that, or provide at least better quality of life then I think your proceed regardless. But it's, that's a great question, I don't think we have a good answer so I tend to say, you know, it's good information to have but I don't know that I would not implant someone because they showed sub-normal scores on working memory or something like that. I think it's more valuable just to know that going in from a counseling standpoint, and potentially that needs to be considered more in the training approaches.

- [Valerie] Okay thank you. I don't have any further questions from the audience at this time, so I want to thank Dr. Aaron Moberly and his team at the Ohio State University Cochlear Implant Center. I appreciate your time today answering the questions and really bringing this important topic. I want to remind the audience to join us on July

22nd at 12 pm eastern time for our second webinar in the series which will focus on adult auditory rehabilitation clinical models. We'll be talking about that feasibility for audiologists and speech language pathologists. And if you have any colleagues that missed our webinar today ask them to come visit Audiology Online and watch the recording, and we look forward to seeing everybody next time. Thank you.