Unleashing the Power of Test Box and Real-Ear Probe Microphone Measurements, in partnership with Seminars in Hearing

Presenters: Lori Zitelli, AuD, Catherine Palmer, PhD

Hello and thank you for joining today's webinar, Unleashing the Power of Test Box and Real Ear Probe Microphone Measurements, which is presented in partnership with Seminars in Hearing. It's my pleasure to introduce our presenters today. Dr. Laurie Zatele is the Managing Audiologist at the University of Pittsburgh Medical center and an adjunct instructor at the University of Pittsburgh. Her areas of expertise include amplification, treatment of tinnitus and decreased sound tolerance, clinical education, and Interventional Audiology. Dr. Catherine Palmer is the Chair of the Department of Communication Sciences and Disorders at the University of Pittsburgh and serves as the Director of Audiology for the University of Pittsburgh Medical Center Integrated Health System.

She also serves as the Editor in Chief of seminars and hearing. Dr. Palmer's research conducts research in the areas of auditory learning, post hearing aid, fitting the relationship between cognitive health and health outcomes, and matching technology to meet individual needs. Welcome Dr. Zatele, and Dr. Palmer and I will turn the floor over to you. Thank you so much for that introduction and thank you all for joining us today. Catherine and I are really happy to be here today to talk about this project because it's been a labor of love in the University of Pittsburgh audiology community for almost, almost 20 years now.

So we're excited to share it with you.

Here are our disclosures and I do just want to note that while we will be providing some screenshots and some examples from one specific piece of equipment, we don't want anyone to interpret that as us endorsing that product exclusively or any sort of indication that these measurements can't be taken with other equipment that has similar capabilities. These are just the pieces of equipment that we have access to. But the concepts and all of the measurements that we're going to be discussing can be applied to any system that has real ear or test box components. These are the limitations and risks for today's course, and these are today's learning outcomes.

To start us off, I want to provide some background and context so that we can think about why this resource we're going to be talking about was made and how it's meant to be used. There's a whole story that leads us to the point where we're at today, and it's a great jumping off point as we delve deeper into this issue of best practices as a whole. So I want to start by talking about the importance of real ear probe microphone measurements and how they can help us to set ourselves apart from providers who don't use them. Then I want to shift a little bit and talk about how we can support each other and increase the number of audiologists who are using best practices in this specific area. So there are a lot of pathways that a patient could take that would lead them to wearing on ear devices like hearing aids.

And it becomes complicated when we consider that an audiologist may or may not be involved. To varying degrees. Some patients may choose an over the counter route. This new category of hearing aid was established by the FDA in an attempt to increase access for hearing care. They're designed for adults 18 years and older with perceived mild to moderate hearing loss.

Some patients may choose a direct to consumer route in which they may order a more sophisticated device that can be programmed by them or remotely by a manufacturer, representative or other provider. Other patients may choose prescription hearing aids from an audiologist or another hearing care provider. Remember that no matter which path a patient chooses, audiologists can be involved. Patients may choose to ask audiologists for help with over the counter devices. And there are certainly services that we could provide that would increase their chance of success in using these devices, even if they're not prescription hearing aids or if they weren't purchased by us or originally fit by us.

Now let's think about why a person may want to pursue care from an audiologist as opposed to one of the other options. So in essence, what do we bring to the table as audiologists? For one, we can match technology to listening needs. We can establish relationships with our patients that allow us to learn

about all of the really important listening needs that they experience in their day to day lives. We can also think about any relevant lifestyle factors that may influence these decisions one way or another.

Research has shown us that the majority of patients who pursue hearing aids don't need the absolute highest end of technology to be successful. And there are a lot of lifestyle factors that may influence the the style of a hearing aid a patient chooses to pursue. So for example, is our patient someone who is an avid bicyclist? In that case, they may want hearing aids that they can wear under their helmet or at least will fit with their helmet. Is our patient an introvert who prefers to spend time at home and primarily watches TV and communicates one on one with a family member or other loved one?

Is our patient a tech wizard? We all have those. Or someone who wants all of the bells and whistles that are available? Knowing these things about our patients allows us to tailor our recommendations to whatever their needs are. Next, we have the knowledge we need to provide evidence based recommendations for these patients.

We can talk to our patients who use hearing aids, but may be approaching cochlear implant candidacy. About the 6060 rule, we can talk to them about the possibility of adding accessories or using capabilities that may improve signal to noise ratio if they struggle to communicate in background noise. We can integrate verification procedures into our fitting protocols to ensure that we're meeting evidence based output targets. Customization of physical fit is just another item that we can absolutely bring to the table. Some patients are fit with non custom coupling options that don't provide the physical fit and seal required to maintain the sound pressure level that they need in their ears.

Others may choose to pursue a custom mold for retention or comfort. Still others may choose to pursue an in the ear style that requires an ear impression to build the casing. Customization of the acoustic fit is the next thing on my list. And when I say this, I'm referring to our ability to measure the patient's ear canal characteristics indirectly using a real ear to coupler measurement and then applying that

information to our real ear aided response measurements. And we'll talk more about all of that.

In this way we can confirm that the output of the hearing aid is customized for that person's ear canal characteristics as well as the type and the degree of their hearing loss. The fitting is really not truly customized unless all of those components are considered. We can also provide detailed orientation and counseling teaching people how to operate these devices successfully and helping them to think about what expectations are realistic for them. This particular item makes me think of a recent case study publication that followed a 71 year old man pursuing over the counter hearing aids and he ultimately was not successful without the help of audiologist, a pharmacist and a family member. So even though a person may meet the audiologic and age criteria for over the counter devices, there's still a lot that audiologists can do to help these people become successful users and support them.

And lastly, we can offer follow up care to promote continued use of the devices and facilitate any programming adjustments that may be needed based on changes in hearing or repairs due to device malfunction. So this is a point that we want to make before we start to talk more about verification. The treatment for hearing loss is audibility. We define that as meeting evidence based output targets, whichever evidence based strategy you're using. And I'm saying that because we want to make sure everybody understands that real ear measurements are not a treatment.

They are the tool that we have to verify that the treatment has been provided. So it's not uncommon to see articles addressing real ear measurements as a treatment. So for example, they may be comparing outcomes on a group of people where real ear measurements were completed and comparing that to a group where they weren't completed. And that's really not an accurate way to think about this. So the treatment is audibility.

You could compare outcomes within subjects where you achieved audibility and where you didn't. So the way that you would know that would be to use real ear measurements. So they are the tool that tell

us whether we achieved our outcome. Now, I want to talk a little bit about the trends that we've seen in our field related to the uptake of real ear measurements and the use of them. Many of you may recognize this man.

This is Dr. Gus Mueller. And the reason that you're looking at his picture here is because over the work, over the years, he has done a lot of work to investigate how many audiologists and hearing care providers are using real ear measurements and disseminating information that's evidence based about its use. So back in 2014, there was an audiology online 20 questions in which Dr. Mueller reported the results of a 1991 ASHA survey. So in this survey, they had asked about probe mic measurements used for fitting hearing aids. And in that survey back in 1991, it revealed that 45% of audiologists reported using them.

Dr. Mueller has also conducted several surveys on this topic in later years between 1995 and 2010, with consistent use of real ear probe microphone measurements being reported by audiologists between 34 to 54% of the time and largely staying fairly consistent in that range throughout the years. I think the 2010 article was particularly interesting because it revealed that these numbers that we talk about may actually overestimate the number of clinicians who are using real ear probe microphone measurements. There was a non zero percentage of audiologist respondents who failed a validity test when they were asked if they used a real ear measurement that didn't exist, and they said that they did so. Just something to think about as we interpret survey data. So if we know that real ear measurements are the most accurate and efficient way to verify that we've achieved audibility in a hearing aid fitting.

And we just learned that half or more of audiologists had historically not used them, I think it's reasonable to ask why. So here are some commonly cited barriers that have been published related to audiologists not using real ear verification for hearing aid fittings. So something that we commonly see

cited is the high cost related to obtaining the equipment required to complete these measurements. Other items that were mentioned included space demands in the clinic, meaning There was nowhere to put this equipment, particularly if it was perceived to be cumbersome or large, and not feeling like they have enough time within the allotted appointments to complete the measurements. Some people don't believe that it will improve their patients outcomes.

Others have misguided beliefs about the usefulness of the manufacturer's first fit algorithms or the fitting software graphics, which are really just cartoons. People indicate that their training programs didn't focus on these measurements or that they didn't see them used much in their clinical rotations. Some people really held onto those habits of using sound field measurements and really doubled down that these procedures were either as good as or superior to real ear measurements. So this is what the research has shown us has been reported as reasons why people don't use them. Now, anyone who has worked with me in clinic will tell you that when someone comes to me needing help with something, the first thing I'm going to ask is what have you tried so far?

My children will also confirm this. So even though my kids hate it and they just want me to open their yogurt tube for them, I think it's reasonable to approach solving a problem like this by identifying what has been tried and what hasn't been successful so that you can focus on other strategies that might be more likely to work. So usually when I ask what they've tried before, they remember that they can use safety scissors and then they run off to open their yogurt tube. So in this context, one of the things that we have tried in as we try to help people think about increasing the number of audiologists who use real ear measurements is making guidelines available that specify that they should be used. So what you're looking at on the screen here is a SNP from the American Academy of Audiology Guidelines for the Audiologic Management of Adult Hearing Impairment.

So this has been available since 2006. And these guidelines state that prescribed gain from a validated prescriptive method should be verified using a probe microphone approach referenced to the ear canal spl. So that's telling people you should be using these measurements. Another approach is challenging people's ethics. So our own Academy past president Katherine Palmer published an Audiology Today article entitled Best Practice It's a Matter of Ethics that challenged the ethics of providers who don't use real ear probe microphone verification.

I do not recommend entering this argument with her as you will not win.

Lastly, we've already tried making research available that supports the use of real ear probe microphone measurements. We already know these things and the information has been out There. So research has demonstrated to us that using real ear measurements to verify hearing aid fitting will increase patient loyalty to your practice. It results in fewer office visits, it improves audibility in comparison to quick fit methods, it improves patient satisfaction, improves patient psychology toward audiology services and technology, and improves real world outcomes. Unfortunately, even though we know all of this, it seems that none of these things have really moved the needle much over the years.

Given that the number of audiologists who report using these measurements in Gus's surveys didn't significantly increase over time. So I told you that story to tell you this story. I would love to take a minute to introduce you to some of my dear friends. These are Spencer Cheshire on the left, Trent Westrick in the middle, and Jodi Baxter on the right. I have a lot of very tall friends.

We were members of the 2018 Jerger Future Leaders of Audiology conference cohort and we worked together on a project throughout the course of that meeting back in 2018. So at the 2018 JFLAC conference, the four of us, known collectively as Team Hurricane, presented an idea to survey the field to get some up to date information about the uptake of relayer probe microphone measurements. And you'll see in the bottom picture there, Dr. Aaron Miller, who was one of our fearless leaders for this

meeting. Ultimately, this survey did eventually become a reality by sheer luck, because I was assigned to be the chair of the 2020American Academy of Audiology Member Connect survey. So the American Academy of Audiology does regularly survey the membership to try to see what people's opinions are on things and also see how the academy can best meet the needs of their members as well as the profession of audiology as a whole.

So for the 2020 survey, we use this opportunity to focus on how as a field, we can bridge this research to practice gap. Meaning how can we try to promote the uptake of research findings that support the use of real ear measurements in routine practice? The approach that we took was what we think is a new approach to this. It's an implementation science approach. And this required us to ask stakeholders, so in this case audiologists, what barriers they experience to using real ear measurements and then also asking what they felt they would need to overcome those barriers.

Straight to the source, right? So to provide a little bit of background on this without giving too much detail, we used a model that suggested that there are five specific steps in the process of disseminating information and helping people implement strategies and changing behavior. So first is assessing how ready they are to change their behavior, assessing the barriers that are preventing them from changing, Determining the appropriate level of intervention to facilitate the change, Designing the strategies that you want to use, and then evaluating them. So if we think about applying that to this specific topic, the first step in this process was to ask the people who took this survey to assign themselves into a category by having them select the statement that most accurately reflected their behavior related to real ear measurements. So the choices were things like, I've never thought about using real ear measurements.

I have considered using them. I have the equipment, but I don't use it regularly. I sometimes do these measurements, and I use them. I use these measurements routinely. So one way to look at these

statements is as an assessment of a person's readiness to change.

So in other words, someone who has never thought about using real ear measurements probably is not as likely to start using them as someone who has the equipment already. So by separating people into these categories, it allowed us to identify, in essence, who's most likely most likely to change their behavior and start using real ear probe microphone measurements routinely. So our thought was it probably makes the most sense to focus our resources on the groups of people who are closest to changing their behavior and most likely to doing this. So if we can give them a little bit of a nudge, maybe we can get them to where we want them to be. So note, this was an anonymous survey, so we didn't really identify anyone.

I just meant for the purpose of this survey and the answers that follow, we were able to categorize people. So you can see on the bottom right hand part of the screen that 68 of the almost 300 respondents who took the survey indicated that they routinely use real ear measurements for their hearing aid fittings. And this is great. I hope that's true. So that would be an improvement from the previous surveys.

The next largest group, and the one that we really wanted to focus on more for the purposes of this consisted of about 15% of the respondents. And that's the yellow part of the pie, and included people who have the equipment but don't use it regularly. So we're going to call this group the preparation group. In essence, these are the people who are preparing to change. They're the closest to changing and the ones that we want to focus our efforts on.

Next, we asked people who don't routinely use real ear measurements about the barriers that they experience. So what is preventing you from doing this and enacting this change? We can theorize all we want, but unless we ask people themselves, we don't really know the whole story. So in this survey, people mentioned barriers that included things like, I'm not sure how to do these measurements. The

aided sound field testing that I do gives me all the information that I need.

I don't have time for this. The clinics where I did my training didn't have this equipment or didn't, didn't focus on this. And in the people who routinely do not use real ear measurements, the top two barriers that were reported were I'm not sure it will change, will improve satisfaction, and the information wouldn't change how I fit the hearing aid. I think this is interesting because as I mentioned before, we do have evidence supporting that satisfaction improves with these measurements and the, and that the information that it gives you should impact how it changes your hearing programming and all because that leads to all other kinds of positive outcomes. So this again supports that a new approach is warranted to this given that we already have the information and it doesn't seem to be impacting the behavior in the way that we want.

So then our next question was to ask people what they thought they would need to start implementing real ear probe microphone measurements. And individuals who own the equipment, again, who are in that preparation group, so that's the third stage of change, said that they want longer appointment times and equipment that's easier to use. So one interpretation of these two things are that they might need more training with the equipment. Right. So increasing familiarity with the equipment is likely to decrease the amount of time verifiting, verifying a fitting and troubleshooting when other problems arise.

Most people who do use real ear measurements routinely find that it, it makes your appointment more efficient because you can be confident with your fitting and not spending time going back and forth with how does this sound now? How does this sound? What about this? So armed with this audibility data from the probe microphone measurements, you can be confident that the signal you're providing is the one that the patient should be adapting to with full time hearing aid use over the next couple of weeks before they come back for any fine tuning. So I mentioned all of the things that don't seem to have

worked well and we wanted to make sure that, we said there does seem to be one person who has done things that I think have worked well and that person is Lindsay Jorgensen.

So Lindsay has been consistently impacting people on an individual level and she's doing this with hands on opportunities to use equipment. Every year at the American Academy of Audiology Conference, she runs a learning lab where people can get hands on equipment. With the experience with the equipment and she also heads up the verification pavilion, which is another opportunity for that. So from the surveys from those activities, we can see that Lindsey is impacting individual people and improving their familiarity with the equipment. So it's clear that Lindsey is moving the needle and that's great.

And she's also a part of these workbooks that we're going to be focusing on for the rest of today's webinar. These activities, meaning the in person activities at the conference and the workbooks that we're going to talk about, support each other and they support the overall goal of helping us to increase the uptake of probe microphone measurements. The Learning Lab and the Hands On Pavilion are events that take place at the conference every year and they are planning to be offered this year at the next upcoming conference in 2026. And the workbooks that we're going to discuss now are available for on demand use by anyone who wants to use them at any time. So as we bring part one home, and I'm going to pass the microphone over to Catherine, we really want to focus on supporting audiologists in adopting the routine use of probe microphone measurements because it improves our patients outcomes.

Providers who have the equipment that they need but don't routinely use it have told us that they want longer appointment times and equipment that's easier to use. And the goal of the resource we're about to delve into is that we want to help them achieve that. And I do want to stress that this is an open access resource that's available all the time and you don't need to be a AAA member or attend the

conference to access it. So I'll now pass control to Dr. Palmer so that she can focus on how to use it. Thanks so much, Dr. Zetelli.

So I have the pleasure of being in Clinic with Dr. Zatelli. We work at the same medical center, but also teaching with Dr. Zatelli. So we've been teaching the AMP1 and the lab that goes with it at the University of Pittsburgh for a long time and use these resources. And that's part of what inspired us to get them published so other people would have access to them. So we hope that they're helpful.

So I'm going to introduce you to the resource, really chapter by chapter, and I think that's helpful so you'll know what's in it, what might be useful to you. One, we'll talk about how we can integrate this into the curriculum for AUD students, but it's also meant to be a continuing education kind of activity for clinicians. So if you're one of the clinicians that responded to Dr. Zatelli's survey that you need more support in this, you didn't learn this in school. Hopefully this fills that. That void.

That would be the goal.

And so I want to give a lot of credit to Mead Killian, who was my professor at Northwestern, for amplification. And he had what I would call the original test box workbook. It was a test box, not probe micro measures. He was certainly doing pro microphone measures. And think about that.

But this workbook was for the test box. This is about circa 1984. He probably was doing this a couple years before that. But this is when I would have been exposed to it. And Larry Revit was the teaching assistant, so shout out to him as well.

And this first workbook really focused on the ANSI tests, and I think it was really valuable. You know, we were going through the tests. We could report data from the tests. But as I left Northwestern and came to the University of Pittsburgh, what I felt was the doing that meant we could do it, honestly. We

could push the buttons, we could make the tests happen.

But I'm not sure, like, clinically. As we moved into the clinic, we knew why we would do that, when would we do that? So I think there was a. This is. Back in the early 1980s, there was a sense of when the hearing aid came in from the manufacturer, you did the ANSI test to make sure everything was working.

And we don't really think that way at this point because the hearing aids are very different. With them being programmable, there isn't a certain way they need to be. I mean, obviously you can compare them to their measured standards from the manufacturer, but there's less need for that given how flexible they are. So we tried to rethink what students would actually need, what would be useful for them. And what we came up with is, what if the workbooks really were guided by clinical questions?

So the idea being, what question does a patient present to you that makes you think, oh, I could use this measure. Whether it be in the test box or the probe mic, I could use this measure to answer that question. And a simple one could be like, battery drain. For someone who's still using regular batteries, disposable batteries, then if that question, if the person's coming in saying, my hearing aid battery doesn't last as long as it used to be, then that chapter would be about how you can use the battery drain test. So the idea is really linking the clinical questions the problems the patient presents with, with what measures might help you attack that problem.

A lot of people helped develop these. We ended up making these class projects to develop these workbooks. And so I've just listed all the different students who were involved in that, including Lori Zatelli, who was back in 2009, a student, and then Lindsay Jorgensen, who's been mentioned. And some of her students really translated all this over to a newer piece of equipment that we were using. And as Dr. Zatelli reinforced, the workbook can be used with any equipment.

We just happened to give you the pictures of the equipment we happen to use. And then finally we just updated it right before we published all of this. So up to date at this point, this is the edition that came out. You may have seen it. This is always fun that once a year, TIMA and Seminars and Hearing teams up with Audiology Online to present one of the editions.

That QR code will get you right to it. I think Laurie has emphasized this is open access. That means you don't have to have a subscription to seminars to access this particular edition. So you can certainly get your hands on this. And if you are someone who teaches, all of your students can have their own version as well.

So this is the outline of the edition. We start with how you use the workbook. And then there are different chapters that go through. First the test box measures, then on to the real ear measures. And so I'm going to go through these briefly because I just to highlight so you'll know what you're getting into.

Certainly as clinicians, you could access any chapter, kind of go into what you feel like you need or want. I would say if you're teaching, at least we think the way we've designed it, it makes sense to start from the beginning and go through it in a fairly linear way. So chapter one, Introduction, Getting Ready for the Hearing Aid Test box Measures. So the assumption here, if you're teaching or if you're a clinician, you own a piece of equipment that can do these kinds of measurements. So we're going to figure out how do we get set up to how do we get ready to do this?

And I gave you a whole bunch of pictures to emphasize that we really worked hard. And I think this has worked out well because we wrote these chapters originally with students to overdo with pictures and explanations. So it's really meant to be something one can navigate on their own. It's not something someone has to be in front of a classroom teaching. It's meant to Be able to.

You can pick it up and you can go from there. So just giving you an example that we really lay out pictures of every single thing you should be doing. There's always an explanation of why you're doing it. Something we really emphasize at the University of Pittsburgh for the students is always ask, why not just like, okay, I'm plugging this in, but why am I plugging this in? Why am I putting the reference mic?

Where I'm putting the reference mic? So really encouraging that kind of thinking. And the book definitely matches that kind of thinking. Always explaining why and hopefully getting away from memorizing that I have to do this and then I have to do that and that it's more logical that, oh, of course I have to do this. And I know why.

Because if I don't level this equipment, I can't do other kinds of measurements. So that's what that first chapter really focuses on.

And then we go to chapter two. And again, here we go with the patient complaint. Patient question or a complaint. My hearing aid isn't working like it used to. Would be a good example of a question.

We start that chapter with the ANSI test, going back to, you know, how Mead thought about this, just to make sure everybody understands why we have ANSI tests, why we have these standards, what can we pull off of this information that is useful to us? So we start there, kind of a leveling place. Everybody can do that kind of test. Those tests should match with whatever the manufacturer has measured. But we quickly move on to our complaints.

So examples, the patient comes in and says, my hearing aid is weak. What measurements might help you with that as opposed to simply listening to the hearing aid? I don't want to minimize that. It's always good to listen to a hearing aid because it's amazing what you can realize really quickly, but you really can't tell just if something's weak, if it is functioning, how strong should it sound in your ears? I mean, I don't think your ears are calibrated to know that.

So we can. There are measures we can do. My hearing aid sounds different. What kind of measure might that be? You know, is that.

Again, is it. Is that kind of a gain measure, an output measure, distortion measure? So, you know, it gives you examples of if that's the question. Here are the measures that could empower you to help sort that out. My hearing aid is noisy.

Just my hearing aid isn't working. I have to replace the battery in my hearing aid. Every day. We use that example. Or there's a lot of static in my hearing aids.

So each section of that chapter is a question. It starts, here's the question and then the chapter is about, okay, how are we going to attack this given this tool that we have in front of us? For every question there's going to be an introduction and sometimes this reads like a tutorial. We're going to be educating here about something to further understand the question. What other questions do you have to ask?

What do you have to understand about hearing aid technology, perhaps to really approach that question? Then there are going to be materials needed for the activity. So you probably need a hearing aid, you need the test equipment, you know, you might need some other things. When we're on the pro mic book, you'd need a probe, microphone, you know, different, whatever you might need. But this really is meant to be a recipe.

So that's meant to help you if you're the instructor and you're trying to put like each section maybe of chapter two is its own kit. And so the materials here they are, all the student has to do is pick it up and it's, it's ready. They have to do all the thinking and the measuring, but they wouldn't be searching around for a certain kind of hearing aid or things like that. Then there's an activity. It's step by step

instructions so they can go through the activity.

There's pictures, as I said, of every step. And then typically they're going to be helpful hints related to actual clinical practice. Hopefully this is helpful for students. It's new to students, something they can come back to. Hopefully this is really helpful for clinicians, people who are out there doing this and think, oh, okay, this is a helpful way to think about that.

If I'm. Whatever the question might be. So every section of every chapter is going to be outlined in this same way. So it feels familiar, you can step through it.

Just an example activity here, this is saying, let's run a battery drain test. So this would be that example I used before. Their hearing aid isn't lasting as long. This of course is not useful if your person has a rechargeable hearing aid. But if you're like us, we still have some mix.

And so you're going to run the battery drain test on the hearing aid. We give you some assumptions here that they're using it every day, 15 hours a day, and then we ask some questions. So once you have that data, the student or the clinician, if they're figuring this out, can answer these questions. What do you Think the battery life would be. Do you think it would be acceptable to the patient?

And what factors related to the patient's use of the hearing aid could impact this estimate? Right. So this could be something like if they're doing a lot of streaming, so trying to get that a little bit higher level thinking, you know, thinking about these kinds of things. If you're using this as an instructor, you definitely could make these questions that they have to turn in answers for. And that is indeed what we do here.

We happen to use the canvas platform. So electronically, they're answering these questions every week because they're assigned, you know, a different section every week to keep moving through the

semester. So it's kind of bite size and they can keep moving, and then we can answer questions in lab or in class. Chapter three is setting the hearing aid response and verifying signal processing and features in the test box. So now we're getting away from.

There's a patient complaint to, okay, we're trying to fit this hearing aid and we're using a test box. So these are all the kinds of questions the audiologist might ask themselves. How can I preset this hearing aids for someone who isn't going to sit through this hearing test? That could be a baby, that could be an adult who isn't going to be able to sit through things? Well, can I, you know, verify the telecoil, the directional microphone frequency lowering?

So all the things we might want to do in terms of signal processing and fitting. And then on the right side here, there are also patient issues that could come up that we would be doing the same kinds of measures for. So this chapter focuses both on what might be your question or what might be the patient's issue as we're going through this. And then chapter four, we're moving on to the real ear system. So now we've really, you know, kind of managed that test box, understand the power of it and when it would be used.

And now we're moving on to. To real ear on ear again, first chapter, how do you set up all the different pictures to make sure you can set up and you know what you're doing and again, why you're doing it?

And then we're going to move into chapter five, setting the hearing aid response and verifying the signal processing and features with real ear measures? So pretty long chapter, again, really holds people's hands to move through things. Hopefully this gets at what Dr. Zatelli was saying of people wanting to be able to do things faster. So the more comfortable you are, the faster something goes. I will say, in my opinion, and I've been fitting hearing AIDS for over 35 years, there's nothing faster than using real ear measures because you know what you're looking for.

You get to that, you meet those targets and you're really confident talking to the patient, and you're not doing a lot of that iterative, how does this sound? Do you like it? And then making changes and back and forth when they've had no experience with the signal. So feeling confident to say the hearing aid is set the way it will give them the most benefit really actually shortens that process significantly. Even if you back off the fitting, if they're just not able to quite tolerate the full fitting at that time, is a much faster process.

And as we've seen some of the research about satisfaction all it gives the patient so much more confidence in what just happened, that there's a measurement and that there's a reason why. And we particularly see this in patients who've been fit elsewhere. We, we see a fair amount of people who've been fit elsewhere aren't doing that well come into us, and the first thing we do is redo these measures. Now, sometimes they're fit really well, and there's other counseling that needs to go on. But to be perfectly honest, that's not usually the case.

They usually have bought very good technology because all six manufacturers make really good hearing aids. And they just haven't been fit well. They've, you know, probably it's a first fit. They're very underfit, and their confidence really changes when we're making measurements. And they always comment, nobody else did this.

And once they realize that it's really intuitive, them like, wait, why would they not have measured this? How would they know? Which is a very reasonable question for a patient to ask. So, again, lots of pictures of things we go through RECD and understanding why that needs to be measured on every patient. That's not just a pediatric thing.

That's literally how we're taking our HL audiogram, making it into our SPL audiogram to generate our targets. We go through all the measurements. We go through how you interpret those measurements. You know, again, always that why did we do this and how are we using the information? A big focus

here on how will we now use this information.

One of the comments Dr. Zatelli made was the group like, pre contemplation saying, these measurements wouldn't change how I fit things. That means you don't understand the measurements. So hopefully this helps. You understand them and exactly how you would use that information, how we're going to fit cross hearing aids, directional hearing aids, noise reduction, which hearing aids have directionality and noise reduction. But how are you going to measure those features so you realize you can know what those features are doing.

There's also a chapter on why you don't use relayer measures with cochlear implants and bahas, which thinking, mostly professionals are listening to this. You understand why, because there's actually no sound in your ear canal. But for students, that's something for them again, to really think about how we're using these measures. And then chapter six, definitely my favorite chapter. I think it's by far Dr. Zatelli's favorite thing.

She's always thinking about one more thing we could do with this equipment. So it's a whole chapter on what else can I do with this equipment? Because there's a lot of power here. And that's why we call unleashing the power. And so we're actually going to go through some of the examples of how one could use the measurements.

But it's things like managing feedback. You may not have thought of that. The real ear system is a super powerful way to do that as opposed to doing maybe a feedback manager test that's going to really reduce all of your high frequency gain when your patient says they sound like they're talking in a tunnel. Helping your SLP colleagues understand what a young child with hearing aids is actually hearing of their own voice. So when they plan their speech therapy, they're, you know, making sense of what they're planning and not trying to work on things that the child can't hear.

Fitting noise protection and making sure it's really doing what we think it's doing so we can give people good advice. And it's also really useful as the system's useful for different kinds of counseling, to really help people think about family members, to think about their loved ones hearing loss. So it's a hands on setup. This is just a picture. In our, one of our teaching labs, we have a couple pieces of the equipment.

We have a setup with these files that go chapter by chapter. In that file is a Ziploc bag with, with everything they need. So if it's a chapter on testing directionality, we're going to have a hearing aid where we programmed it to have a certain setting for the directionality or noise reduction. Or we might have two hearing aids to just simplify it. One with a noise reduction feature on, one with it off.

So we really set it up for the students because they're meant to do this independently. Now that would be totally your choice, but we really push them to attack this independently. And if they have questions, we lead with, what have you tried already? Just like Dr. Satelli said. So they need that access to equipment.

We schedule time, we have really nice teaching labs so the students can have time. We tend to pair up students so they can kind of talk through things and again, give them the materials, give them probe mics, earphones, hearing aid domes, things like that. We give them a Ziploc bag and ask them to use theirs over and over because especially the probe mics can get exp of overtime if they're throwing them away. And then we do have this turned in as assignments every week and we just divide the workbook up so they're, you know, again, bite sized pieces. Really encourage the students to use the actual user manual.

This is a, we think it's a great workbook, but that doesn't replace the user manual and they can easily get that online and that helps them again, troubleshoot things for themselves. If you're a clinical instructor for us, we like to make sure you have the link, you know what the students are exposed to. You can also use some of these chapters if there's downtime in clinic and the students can practice

some of this, which can be a nice strategy as well. And with that we're going to get deep into examples and I'm going to turn it over to Dr. Zatele, thank you very much. And I did complete that workbook as a student and it was interesting going back to it the second time around.

You know, from the other side of it, there were a lot of things that I had not thought about in many years. There are some things that we don't do in clinic every day. And it's really nice to have that step by step set of items that guide you through these lesser used activities. So I want to give you some examples and some tips that I find particularly helpful in my day to day clinical activities. And we're going to start by thinking about patients who bring their hearing aids in when they weren't purchased from us.

So Catherine says this does happen in our clinic fairly often and this is one of the pathways that I talked about at the beginning of the webinar so they can end up in our clinic even if they didn't intend to or start with us. So when we have people who come in to have their hearing aids checked after purchasing elsewhere, they're not a new hearing aid user, but they're new to us because we didn't fit them. So this person may schedule what we call a hearing aid check. So for us, we have a certain amount of minutes allotted for this type of care. So in this instance, we would have a new patient who comes into our clinic with no audiogram because we wouldn't have tested them and no programming files in our NOAA system.

And we would have no idea what, if any, sort of verification procedures were completed during their fitting or how any follow up fine tuning may have deviated them from any target that they were fit to. So if you think of it like that, then the request of, oh, can you just check my hearing aid to see if it's working really is not quite so simple. So in a situation like this, when you have a certain amount of time to answer this question, wouldn't it be nice if you had a quick way to determine if the amount of gain that's in the hearing aid is reasonable for this patient? So the question that you see here is from activity five in

the workbook for this specific chapter. So in this activity you are going to be answering the question, is the hearing aid programmed with the appropriate gain for moderate input levels when compared to your patient's hearing loss?

So let's say that this particular patient had their hearing tested in an outside clinic, hand carrying their audiogram with them to their appointment with you. And remember, you could also read the hearing aid programming to pull the audiogram from that as well if you needed to. So remember, when we do real ear aided response measurements, we're looking to measure hearing aid output for soft and moderate and loud input levels. For this specific activity, we're going to measure a frequency gain curve and then we're going to compare that response to the patient's audiogram by applying a half or a one third gain rule. So remember, these rules are only going to apply for a moderate input level because softer inputs generally will have more gain, louder inputs generally will have less gain in many hearing aids because a lot of them use wide dynamic range compression.

So there's not the same level of gain for every input level. So the half and third gain rules are going to come from two evidence based fitting algorithms that we use to generate output targets, targets for hearing aid fittings. So DSL approximates a 1/2 gain rule and NAL approximates a 1/3 gain rule. Ballpark. So now I'm going to just see if anybody is still with us.

I'm going to ask you to do a Little bit of math. I have full confidence in you that you'll be able to answer these questions. So let's say that we have a patient and they bring their audiogram to us and they have a 60dB HL air conduction threshold at a thousand hertz. So if we apply a half gain rule, how much gain would we expect to see at that frequency at 1000Hz? Type your answers in the chat just so that I know you're with me.

I'll give us a few seconds. Hopefully we'll see a lot of the same answer.

If people are saying 30, that's great because that's the correct answer. Half of 60 is indeed 30. Now if we were to apply the 1 3rd gain rule to that same threshold, how much gain would you expect to see at a thousand hertz with a 60dB HL threshold? I'm hoping you're thinking 20. So 1/3 of 60 or 60 divided by 3, if you prefer to think of it that way, is 20.

And I did choose 60 because I can do the math in my head easily divisible by 2 and by 3. So by applying both of these rules, we can come up with some guardrails that give us a reasonable estimate for the maximum and the minimum of the level of gain we would expect to see for someone with a 60dB HL hearing loss at 1000Hz. So using our 1/2 and 1/3 gain rules, we can say for a moderate input level, gain somewhere between 20 and 30 decibels is reasonable to expect at 1000 Hz. You could do this at a few different frequency levels just to give you an idea of how much gain you could expect across the spectrum. And you may see very differing levels if they have a sloping hearing loss, if it's a fairly flat loss, you might expect to see the same amount of gain across the frequency spectrum.

Now let's take a look at this activity. This is activity number six in this chapter. This frequency gain curve was obtained using the multi curve menu option of the this particular piece of equipment. So to do this measurement, you want some, some sort of a broadband stimulus and then you're going to be measuring the amount of gain or you could also look at it as output. So you're looking from across the frequency spectrum from 250 to 16,000 hertz on this equipment.

So you'll want some sort of broadband stimulus. And we want a moderate input level. So ballpark something 50 to 60 DB for, for our input. So we'll run our frequency gain curve and that's what you see looking on the screen here. And in the workbook, you're going to see a table that looks like the one in the bottom part of the screen here.

And I'll walk you through how you could complete this activity or how your students could complete this activity. So again, let's say we have hearing results that the patient brought from another clinic. And on

this table you'll see both frequency and threshold in DBHL in the first two columns of the table. Table. The next column is going to be hearing aid gain.

So we'll look to our frequency gain curve to get that information so that we can fill out that column. So at 500Hz we have 5dB of gain. So to fill out this table, we would write five in that box there with the red text. At 1000 Hz we have about 7dB of gain. At 2000 Hz we have about 10dB of gain.

And at 4000 Hz about 16Db. So if you're operating this equipment and looking at this, there are crosshairs that you can pull up and get the exact values. You could also kind of guesstimate just by looking at the, the vertical axis there. So now that we have the amount of gain that's, that's provided at each frequency that we're measuring, we can apply our 1/3 and 1/2 gain rules to our hearing threshold thresholds to see if the gain that we're measuring would be reasonable for this degree of loss. So at 500Hz we have a 30dB hl threshold in the left ear.

So we're going to find our 1/3 gain rule and our 1/2 gain rule values. So if we divide 30 by 3, we're going to get 10. And if we divide 30 by 2, we're going to get 15.

Next one is at 1000 Hz we have a threshold of 45dB hr. So if we divide that by 3, that's going to give us a value of 15. If we divide it by 2 or half, it'll give us about 23 ballpark I rounded a little bit. At 2000 Hz we have a 65dB hl threshold. So if we divide by 3, that gives us 22.

And if we divide by 2, that'll give us about 33. And at 4000 Hz we have a 70dB hl threshold. So dividing by 3 we'll get about 23, and divided by 2 we'll get 35. So this gives us our reasonable upper and lower limits for gain. For a moderate Input.

So now we're going to compare that to the gain that we measured. So at 500Hz we want to see gain somewhere between 10dB and 15dB using our third and half gain rules. And what did we measure?

Look back at the hearing aid gain column, you can see that we measured 5 dB. This is less gain than we would expect given this degree of hearing loss.

So is it appropriate? We could say no, it's softer than we would expect. So if you go through the the same process at each one of these frequencies, we can see that the gain we measured at each frequency is less than the gain that we would expect to see for this hearing loss using these evidence based rules. So given this information, you could tell the patient that it looks like their hearing aid gain is a little bit less than we would expect it to be. And fixes could this be for this could be cleaning the hearing aid, replacing parts like the wax guards or the mic covers or the receiver if it's not working or if it's weak, reprogramming changes if it's warranted, if everything is working appropriately, or a manufacturer repair if you determine it's an issue with the circuitry or some other piece that you can't address in your office.

So one good thing to consider is that a frequency gain curve is really, really nice to have on hand after you finish your initial programming and do all of your verification with your real ear probe microphone measurements. This gives you a baseline to which you can compare any future curves if the patient has complaints. And there is an activity specific to that in the workbook. So just something fun that you can check out for later. And before we move on to the next activity, I do want to stress that this is not a substitute for relayer probe microphone barriers, microphone verification.

These workbooks are meant to show you lots of different ways that you can use this equipment. And this is just one of them that you could use in a specific situation when it would be appropriate.

Next, I want to talk a little bit about recd. And in this workbook we do dedicate a portion of chapter three to a discussion on the use of real ear to coupler difference, or recd. RECD is a really powerful tool that we have available to us. And as Catherine mentioned, it allows us to quickly convert DBT HL thresholds from an audiogram into a format that's useful as we measure hearing aid output in an ear or in a test

box. So when we plot hearing thresholds on an audiogram, remember we're plotting them in dbhl.

So this is a mathematical correction that makes the softest sound a human can hear on the frequency spectrum fall on that 0dB HL line at the top of the audiogram. It's easier to read because it's a straight line rather than the wiggly line we use for the minimum audibility curve. So we do run into problems when we need to go from DB HL audiogram thresholds to DB SPL comparing against hearing aid output. It's not a one to one conversion. So the DSL and the NAL formulas that we use the hearing threshold information in DB SPL to create their targets.

So we can't use these formulas unless we first convert the hearing thresholds from HL to split. And this is the beauty of recd. It lets us do that really efficiently across the whole frequency spectrum quickly. So otherwise in order to do this, we would need to be measuring audiograms in spl, which I don't think any of us are really eager to start doing. It would be a lot more cumbersome and time consuming.

So I want to look at a few examples to illustrate how three people with identical audiograms may require fairly different hearing aid output to achieve audibility. So this is the audiogram that we're going to work from on the screen, and we're going to focus on one specific frequency, just to make things a little simpler and easier to talk about. So this particular person has a 30dB HL threshold at 2000Hz. So when their hearing aid was being tested in the Booth, they responded 50% of the time at 30dB HL in the left ear, leading us to mark this with our X symbol. So now let's say that this person really truly does have an average real ear to coupler different difference.

And remember, almost no one is average. That's how averages work. But for the sake of this example, let's just say that they have average recd. So if we apply average recd to this 30dB HL hearing threshold, we can see that it converts to an SPL threshold of 43 dB. So the targets for the soft sounds, the moderate sounds and the loud sounds, all the inputs are going to be calculated based on this SPL threshold.

So let's look at the target for a soft sound based on this SPL threshold of 43. So to meet target for a soft sound at this frequency, the hearing aid output would need to be 57 db spl. Okay, now let's consider a different patient who has a much smaller ear. This patient could be Me, I have tiny, twisty ear canals. They're torturous.

So, and remember, this is the same DBHL audiogram. So again, we're looking at 30dB HL at 2000Hz, same as before. So for this patient who has a smaller ear canal, when we convert the thresholds from DB HL to spl at 2000 Hz, we see that the hearing threshold is now 52 dB spl. That's different from what it was before. For comparison, the person with the average RECD had an SPL threshold of 43dB SPL.

So this one is almost 10dB higher. Remember, smaller ears will build up sound pressure at a faster rate. So now if you look at the soft target, you'll see that you would need 61 db spl to meet this target. And again, that's a fairly different number from the patient that we saw before. And lastly, we'll consider a third patient who has a much larger ear.

So remember, again, same HL audiogram, and again, we're still focusing on that 30dB HL threshold at 2000Hz. So for this patient who has a very large ear canal, when we convert the thresholds from DB HL to SPL, we see that the hearing threshold in SPL is 35 dB. So for comparison, again, the person with the average RECD had an SPL threshold of 43. This is almost 10dB lower. So sound is going to dissipate in larger ears.

Now, if you look at the soft target, you're going to see that you would need 52 DB SPL to meet this target. Again, drastically different from the amount of sound that you would need for the previous two patients to meet that same soft target at this frequency. So I don't expect you to memorize all of these numbers. That's not the point. And I summarized everything on the chart here.

The point is, whether your patient is an adult or a child, their ear is really unlikely to be average. So when you can measure RECD or enter it based on a previous measurement, rather than using average, you should absolutely do that. So for a person who has truly average recd, if we use that average RECD to convert those thresholds, we would have fit them appropriately. This person would have needed 57dB SPL to meet that target, and that's exactly what we would have provided. On the other hand, for a person with a smaller ear, the second example, if we had used average RECD without measuring theirs, we would have underfit them.

So they would have needed 61dB spl. But we would have only given them 57, so we would have underfit them by almost 5dB. Next, for the third patient with the larger ear, if we had used average recd, we actually would have overfit them. So they would have needed 52dB to hit that target and we would have given them 57, which is 5dB more than they needed. So I want to drive home here that, as Catherine mentioned, RECD is not just useful for pediatric fitting.

We speak with a lot of students who are under this impression. We also want to customize adult fittings. And again, very few ears are perfectly average for whatever that age group is. When you use the average, it's just that it's an average, it's not customized. So RECD can be a really powerful tool that helps you to either measure things on the patient's ear or pre fit things in the test box, depending on how well and how long your patient can sit through some of these measurements.

So the ultimate take home is that measuring relayer to coupler difference and applying those data to your relayer aided response measurements is going to customize those output targets for your patients and lead to the most appropriate and customized audibility for them. Just one more thing that we can bring to the table.

So when you do that, that's really the only way to customize the acoustic response for your patient. Patients, this is a true, this is true whether it's in the ear or in the test box. And as Katherine mentioned,

there are some instances where you may want to simulate everything in the test box for someone who can't sit still or maybe can't physically be present in the office. For children in particular, this can be really useful. We also have some patients who are not mobile, some patients maybe who lose their hearing aids and need to get a replacement and, and not physically able to come into the clinic.

And this helps us to customize it for them even if they can't physically be with us. So even if you're fitting it in the test box, you'll still want to make sure that you have some sort of measured RECD when possible from a previous fitting or if you're planning to fit it in the test box in the future, you can measure RECD when the patient is in front of you. Again, really important because you're correcting those SPL thresholds, which then means the output targets are being corrected based on the ear canal characteristics on this specific piece of equipment. There is one shortcut that I think has the distinction of being my favorite. So if you can measure wideband real ear decoupler difference in one ear.

And then there's a button that you can hit. It's this, this one that I've circled here with the red and blue documents to copy the measurement to the other ear for your verification purposes. And this is possible given Dr. Jorgensen and her group's work showing that there's very little difference between the right and left ear years on a really ear to coupler difference measurement as long as the person's not had trauma or surgery or some other procedure like a PE tube. So this can be particularly helpful when working with people who can't sit still for that second measurement. And again to just copy it from one side to the other, you're just going to click that little button that's highlighted on the screen.

So measure it once, apply it twice.

Now I want to shift and talk about another tool that you can think of as a shortcut. Shortcut. Speech Intelligibility Index, or SII as a, as an abbreviation, is a calculation of the amount of the input signal that's audible based on the person's hearing loss. This can be a really efficient way to talk about audibility and help you determine if you've provided the appropriate level of audibility given the

constraints of the person's hearing loss. Susan Scully and her colleagues in Ontario do really amazing work all the time.

And of course, this is no exception to that. This group has established normative ranges for aided speech intelligibility based on pure tone averages of hearing loss for both pediatric patients and adult patients. So the work that I'm going to talk about here is related to adult patients because that's primarily who I see in my clinic. But there are a different set of values for pediatric patients as well. So these ranges that they've developed can help us to determine if, if you're fit to target for your real or aided response measurement is typical or acceptable for the degree of hearing loss that your patient has.

And as your patient's hearing loss gets more severe, you want to just remember that it's normal for the, it's acceptable for the speech intelligibility index scores to decrease. So in other words, when you're working with someone who has a more severe hearing loss loss, you should expect that less of the speech signal will be audible for them even when you do your job really, really well and return appropriate audibility. And another thing to consider there is the input level. It also follows that if you present speech at a much lower input level, it's going to have a lower SII even when you appropriately amplify it. So you shouldn't go into this expecting that your SII is going to be 100% for every input level and every degree of hearing loss loss.

That's not how it works. So on this slide you will see the setup that you would need to measure the relayer aided response with the hearing aid in the ear in the middle of the screen there along with the probe microphone. The real ear aided response measurements for this patient have been completed and you can see that on the right side of the slide. And I want to draw your attention to the green and the purple and the blue bars on the bottom half of the screen. Screen.

So here we're using DSL adult targets and that red outlined area is showing you that I have achieved 81% speech intelligibility for allowed input. So on this equipment using DSL targets, there are going to be two vertical lines that show up on this section of the screen and those are going to show you your goals for speech intelligibility index for people in this age range with this level of hearing loss loss. So in the example that I've provided on the screen here, you'll see that 81% falls squarely within those guidelines. So I should be satisfied with these results. So those black little hash marks are the upper and lower limits of where I want that bar to fall for the soft and the moderate and the loud inputs.

So to illustrate how this could be used in a real life setting, I would like to introduce you to my patient, Judy. Judy. Judy is a 69 year old female who was seen in my clinic for the first time for a hearing aid discussion. She's not a new hearing aid user, but she's the first time I was seeing her. So she brought with her some hearing aids that were very good hearing aids, pair of Oticon Ricks that were purchased at another clinic approximately three years prior.

So notably, and as you can see from the audiogram, Judy has a pretty large hearing asymmetry and this is attributable to an acoustic neuroma on that left side. And for, for that she is under the care of our otology and our neurology departments. So Judy reported that even when she's using her hearing aids, she's really struggling to hear speech when there's a noisy situation and particularly when this, the signal of interest was coming from her left side, which is the side that has the worst hearing hearing. And you'll see her word recognition scores were 100% at an elevated level in the right ear and 80% in the left ear. We did administer the COSI and we learned a little bit about some of her listening goals, which were primarily to communicate more effectively with her husband and her children and her grandchildren.

So at that time she had some questions about whether she may be a candidate for a cross system, which at the time, given her 80% word recognition score, I didn't think was indicated. Although if

something changes in the future, this may be something she decides to pursue. And there are activities related to this in the workbook that would guide you through how you would verify both a cross system and a by cross system if you want to do that. So back to Judy. She at this point was considering purchasing new hearing aids at this time.

And remember her hearing aids were only three years old. So we talked about some of her different options and the one that we landed on was to do some reprogramming of her hearing aids. So in other words, completing on ear probe microphone verification to ensure that audibility was achieved appropriately. First, before we made any changes, we measured real eared a couple of difference and applied that measured response to her thresholds to make that conversion from HL to split. And then we made measurements with the hearing aids as they were.

So that's what you see on the top half of the screen for both the right and the left ear. So just for reference, the right side of the screen is showing you with the red line hearing thresholds for the right ear. On the left side, that dark blue line are hearing thresholds for the left ear. And this graph is the opposite of what we typically see when we're looking at an audiogram. So on this graph, closer to the top is louder, closer to the bottom is softer.

So the way to think about that is when you're looking at those line of the hearing thresholds, if the response from the hearing aid is not at or above those levels, it's not audible. So the green and the purple and the light blue lines that you see on these graphs are the long term average speech spectrum response from the hearing aid. So that's the average over time of the signal for a soft, a moderate and a loud input being the green, purple and light blue lines respectively. So again on the top this is measuring what she came in with. And you can see on the left side in particular, she's fairly underfit in those low frequencies and a little bit under at 4000 as well.

Right ear not bad, really fairly close overall. And then what you see on the bottom Half of the screen is the measurements that we got after we did some reprogramming and change the coupling to a more occluding tip.

So, similarly, you can see the change in speech intelligibility index here with these programming changes. So here on the top. I'm sorry, it's a little bit blurry. I tried to blow this up to make it a little bit easier to see. On the top are the speech intelligibility index measurements from before any programming changes were made.

So you got your green, your purple, and your blue bars that we're looking at here. Ear. And you can see for the left ear in particular, we're under where we want to be for all of the input levels. So soft, moderate, and loud levels. For the right ear, we are meeting our target SII range for the loud sounds, which is the blue bar, and the moderate sounds, which is the purple bar.

But we're not where we want to be for that green bar, which is the soft level. And down on the bottom of the screen, after reprogramming, you can see that we're now right where we want to be squarely within those hash marks for all three input levels for both the right ear and for the left ear. So this made me a lot more confident in my counseling, and I really pushed her that she needed to try to accept these changes because I knew they were appropriate. She did pay for these procedures because she hadn't purchased the hearing aids in our clinic. So we have a bundled and an unbundled model that we can work from, depending on what's appropriate for each patient.

And she did pay for this conformity evaluation. And I actually do have an update on Judy because she was seen back in our clinic recently, a few weeks after these programming changes were made. And I'm really happy to report that she feels she's doing much better since we made these programming adjustments. She's worn them full time, as we recommended, and she's really happy with the sound quality. At the time that we saw her, she had not yet had any opportunities to interact with her

grandchildren, but she experienced big improvements in her communication with her husband and with her children.

And those were two of her cozy goals that we had had talked about. So a really nice outcome for her.

Next capability I want to discuss is related to the capability of the equipment to help you confirm whether certain features are working as they're intended to work. So the two examples that I want to give here are directional microphones and noise reduction. So first we'll think about directional Mics. A lot of hearing aids nowadays have the capability to have a directional microphone response that's more sensitive to sounds coming from a certain direction, a lot of times in front of the listener than behind them. And if this capability is important for your fitting, or if your patient really struggles in background noise, you may want to test this feature just to make sure that it's working as just as you think that it should.

So when you go to test some of these features, you want to, you want to access a capability of the equipment that allows you to analyze two separate response curves from two speakers. So depending on the equipment, it could be a right speaker and a left speaker. It could also be front and back, just depending on where it's configured. So if the directional microphones are working appropriately, you should be able to position the hearing aid so that one of the signals is coming from in front of the hearing aid and the other signal is coming from a speaker behind it. And then whenever you measure these two response curves curves, you should be able to see a difference between them if the directional microphones are working appropriately because the one in the front should be more sensitive.

So in terms of when and how you would do this, you could do this right off the bat when you receive the devices in the mail as a part of your check in process, or you may choose to do this at a later time point if the patient tells you they're really not perceiving the benefit that they expected to get from this feature.

Feature. If you want to make it part of your check in procedure, you may choose to do this in the test box. That's completely fine. It's a really reasonable option.

I know Lindsey Jorgensen talks about doing this and she talks about catching sometimes whenever the device isn't wired appropriately, or if the circuitry isn't quite configured correctly. Sometimes you see that the directional microphones can be flipped and the bladder response is coming from the back, so you would want to catch that. You could also measure it on the patient's ear if they're in front of you in the clinic. So one thing that's important as you're doing this is you really need to be thinking about the stimulus that you're going to be using if this is something that you're trying to be testing. So if you have a hearing aid that's set to automatic directionality, you're going to need a stimulus that's loud enough to kick the hearing aid into that feature so that it's activated.

So if you have a hearing aid that's set to be some sort of automatic or adaptive directional instrument. The stimulus level that you want to use should probably be something above 60dB. This will probably engage that automatic directional capabilities. So you really can't interpret these data unless you know and you're confident that you've activated the feature you're trying to measure. So one way to do this is to go into the hearing aid software and move the directional setting from adaptive or automatic, if that's where it was before.

This means that it's changing based on the input, changing that to a fixed directionality for the purpose of this test. So fixed directional means that the microphones are always in that directional setting and then you'll be sure that you're measuring that. So if you do that, just remember to change it back to whatever you want it to be when you're done with this test testing. So when you're ready to do your test, you're going to need to first select your stimulus. So you'll have an option to choose a stimulus level on this equipment with something that has a signal to noise ratio between off or, you know, off to 12 dB.

So something between 0 and 6 is probably going to be enough to trigger the device to go into that directional mode after a period of time. If it's automatic at or adaptive. Depending on how, how long this is, you may need to wait a period of 15, 30, 45 seconds. So just something to be thinking about. If it's adaptive, you don't want to start this measurement and then capture it immediately.

You might need to wait for it to kick it. So whenever you're ready to capture your curve, you can click on that red dot right there and it's going to take a screen, a snapshot of that. So for this screenshot with the green curves, the hearing aids were in a fixed omnidirectional setting. So you can see that these two curves, meaning the thick one and the thin green line, are fairly close to each other. In the middle screenshot with the purple lines, you can see that the hearing aids were in a fixed directional setting with a fairly wide beam.

So the sounds coming from the back, which is the thin purple line, are significantly softer than the sounds coming from the front front, which is being represented by that thicker purple line. And in the third screenshot, the contrast is even larger because this specific setting was a fixed directional setting with a really narrow beam. And you can see the thick blue line and the thin blue line are really, really different from each other. So generally, if you're Just testing to see if this feature is working. You want to have something about 3dB or more different from each other.

So if they're not and you're, and you're thinking that your feature is on, you could try to use a more aggressive D mic setting. Or if there's a concern that it's not working appropriately, you could certainly send it for repair. Following this, you can do similar measurements when you're thinking about noise reduction, just to make sure that it's working the way that you want it to. So when the hearing aids are trying to think about what's a signal of interest versus what's noise, it's going to be looking at to see whether the signals are fluctuating and how they're acting over time. So it's a good.

Noise reduction is a good strategy to make your patients more comfortable in noise. And just remember, it's not meant to improve intelligibility, it's actually reducing audibility to make them more comfortable. And again, this is something that you can measure either in the test box or on the patient's ear, however you want to do it. So in this system, there is a specific setting for measuring noise reduction. And again, you'll want to choose a signal that's loud enough to engage the noise reduction feature of your hearing aid.

Something 70 decibels or so should work. Okay, so for this example, I chose an air conditioner as my stimulus. And the first screenshot with the green lines are showing you the measurement with the noise reduction feature off. And you can see that the two curves are, are operating identically, that thicker curve and that thinner curve. So the two curves that you're looking at are.

The thicker one is the response from the hearing aid before noise reduction kicks in. And the thinner one shows the reaction of the hearing instrument in real time over time with that noise reduction. So again, the green one, they're identical because there is no noise reduction activated. The middle screen here is showing you different levels of noise reduction being activated. So the purple one is a mild noise reduction capability, blue is moderate.

And then in this yellow last example, the noise reduction capability is fairly aggressive. So depending on what the hearing aid manufacturer allows in their software or what technology level you're using, you may see different capabilities in the software to change how aggressive this feature is. So remember again that this feature does take some time to engage. So you want to wait, wait and see that it's settled before you capture your curve to confirm whether it's working or not. And as I'm wrapping up some of my examples here.

I'll leave you with two examples of how this equipment can be useful as a counseling tool. So as Katherine mentioned, there are lots of ways to do this. So remember, as, as long as you can put a

microphone in someone's ear with a probe mic, you can measure whatever is being placed aid. So it does not have to be a hearing aid. Some people may have questions about safe listening levels for music or other audio that they're hearing through personal listening devices.

So let's say that we have a parent who's concerned that their child is listening to their earbuds too loudly. We can absolutely test for this. So to set this up, you would need a probe microphone system, a headset or some sort of earbud that's delivering sound, some sort of a device that's streaming music or whatever the audio is, and then some probe sub tubes. So in this case, we are going to use the screen labeled speech map because we want to measure output across the frequency range. In this case, we don't need to enter an audiogram, we don't need to measure recd, we don't need to select targets, because we're not comparing these results to the patient's hearing threshold or measuring audibility.

We're just looking at output. And also just to note, you may, to move past the setup, screens need to enter at least one threshold. So that's why you'll see I got one threshold, the lone 250 Hz threshold on the left side. So you have to, I had to enter that to get to this screen. So you just may need to do that.

So you'll insert the probe tube into the ear and then place the earbud over top and select live speech as your stimulus. So this tells the system it doesn't need to produce any sort of sound from the speaker. It should just be measuring whatever signals are happening in the environment. Then you can have your patient turn on their music at whatever level is typical listening levels for them, and then you'll click that record button to capture the specific moment. Safe listening levels generally are below 85dB SPL for no more than 40 hours a week.

So as if they're exceeding that, you can have a conversation about the effects of hazardous noise. And hearing protection is a function of how long they're listening to those levels because the dose makes the poison. And here's my last example. This equipment can be used to help patients and their loved ones to understand the impact of untreated hearing loss, as well as discussing realistic expectations for

communication. So we can simulate hearing losses to support our efforts in educating people.

Essentially allowing family members to listen through the hearing loss of their loved ones, or using the graph on the screen to illustrate to a patient that they're missing a lot of cues because of their hearing loss. So on this specific piece of piece of equipment, I got here through the speech map screen, I entered all their thresholds and their RECD information, and then I selected the button called counseling. So you can select the loss simulator that's going to allow you to play lots of different everyday sounds filtered through the hearing loss, and you can hear what that sounds like, and you can also see the display on the screen. So looking at the example on the screen, if the patient is telling you a story about a disastrous trip trip where they missed an announcement at the airport and missed their flight and had a big fight with their wife, you could use the information on the screen to talk about, yeah, these are the speech cues that you're missing. And if you were appropriately amplified, this would have been a very different story for you, leading to a very different outcome.

So this workbook also goes through some other examples related to how you can counsel patients about the occlusion effect, or as Katherine mentioned, working with our speech language pathology colleagues to help them let them know whether a child can hear their own voice when it's being amplified appropriately, and some other fun examples. So I'm going to pass control back to Dr. Palmer and she'll review some last examples before we finish up. Thanks very much. So back to what Dr. Zatelli just said about selecting speech live speech. Then I arrow here showing you where that would be.

So typically, the equipment is working with a loudspeaker, and it's capt calibrated. So the loudspeaker is presenting, you know, your 55, 65, whatever you want that that sound to be. It could be the carrot passage, and it's all in a loop with the system. When you go to speech live, you're telling the system, I don't care about that loudspeaker anymore. That's not going to be the input.

The input is going to be whatever I want it to be. So I know clinicians use this with a patient to have, like, a loved one talk in the room, especially if there's been a complaint that, wow, I can hear everything. But my wife maybe get a sense is she's just like a really low speaker. Do you need to, you know, have a solution for that? But.

And that's a good use of it like Dr. Satelli said, measuring earbuds, things like that is great because you just have a different input. It's not going to be from the loudspeaker of the system. But this is one of my favorite things to do with the system is you is I have a patient and they're getting some feedback. Like I'm right on the edge of feedback. I've got the dome I want, or I've gone to an earmall, but I'm still have a little bit of feedback.

And one of our options is to run the feedback manager that the manufacturer supplies. And if you're like us, we use all the different manufacturers, some of them are better than others and some of them really take out a lot of amplification, which of course does make the feedback go away, but it also takes out the benefit, especially typically in those high, high pitches for them. So when I want to be kind of more surgical about this or strategic, I'm going to measure the actual feedback because then I can know exactly what frequency it's at. And if I have a hearing aid with a fair number of channels, and most of them have a fair number of channels, I can really just go after the one channel with that frequency and pull down gain. And sometimes really just the gain for the quietest input because that will be our highest gain, as you know.

And I can remove the feedback without really changing the fitting. So they're still getting the benefit. They won't even notice this change. But now they don't have feedback. So to show you that you've got your live speech and then we're going to go and make a measurement.

So what I'm doing here is I'm holding this probe by the ear where there's going to be feedback. So it's not down in the canal because I, I'm not trying to measure the output of the hearing aid, I'm trying to

measure the feedback. So I'm just holding it nearby. The reference mic is relevant now because we're not using the system with the loudspeaker. I just need that microphone near where I can pick up the feedback.

The hearing aid is going to feed back. Maybe you're going to put your hand near it a little bit, force that feedback and then on your screen again, you don't need a threshold in here, you don't need RECD because you're looking for this picture and the feedback is going to look like a square wave. And so feedback is a pure tone and you're going to see a Square wave right at a certain frequency. So it looks like this is like right around 4k, maybe a little bit above 4k. And so now with the hearing aid attached to the software, I can go in and really strategically just pull this down and often just a little bit of gain reduction, reduce the feedback.

Feedback without making a huge change. So one of those I think powerful tools. I actually do this quite often if I'm dealing with feedback. So some hopefully a helpful hint for you. So take home messages.

Our ability to customize and precisely program devices really is what sets us apart. It's why people come to an audiologist as opposed to pursuing self care. So we really want to customize every aspect of what we're doing. I think you really have very committed patience when you do this. And actually one of the studies Dr. Zatelli showed indicated that in terms of people being very loyal when they have these kinds of measurements and this kind of input from the audiologist.

So we have enough time for just us, maybe one or two questions and then we'll wrap up because we're almost at the end. And Dr. Zatelli, great question. And I wonder if we can just back up a few slides because I think you can show them. The question is how do I know? I put the probe mic in.

In a good spot, in the right spot. Very good question. So back up a little bit here. Okay, so there are a couple of different ways that you could do this. This there.

The manual also has some for your equipment. Will probably have some tips about this as well. So if you look at this picture on the screen here, you hopefully in the center of the picture of the ear will see a little black marker. So that marker slides up and down the length of the probe tube and you can determine how far from the end of the tube you want that marker to be. And it can help you to know exactly how far you are from the eardrum from.

So you can use that tool, you can line it up against your foam insert or against your ear mold or whatever it is that you're putting in your ear. And you want to see that the little black marker is on the opening of the ear canal there. Really good question. All right. And my favorite way now is if you look at this slide and I don't know that anyone can see our cursor, but, but if you look at like 4000Hz on the left hand and just go down, you can see a little ear with a little red space.

And when you do that, it's going to give you A self check of where your probe is. It's pretty cool. We use it a lot with students so they can feel really confident. So it generates a sound from the speaker while you're putting the probe in. It's going to give you a check mark when you've gotten far enough in.

So this is a fairly new feature on the this particular piece of equipment and we have really enjoyed using it. Here's another we'll wrap up with this question because we're almost this is a great question. Why are targets below threshold? Is this due to presumed dead regions? So I'll field this one.

You're on the right track there. It could be dead regions. I mean it's literally the research that has really shown when you can achieve audibility that will be useful to someone versus technically you could achieve audibility because you can make something wildly loud, but it'll be so distorted and it won't give them benefit. So really perceptive. You do see targets under threshold.

Don't think you're super audiologist by ignoring them and getting audibility because it won't be good. They'll have a lot of distortion, which is exactly ties. So we'll finish up with what Dr. Zatelli said about the fact you're not going to get 100% SII because you're not, you're going to be lower than that. And for that very type reason. Great questions, really fun to be with everyone.

Let me turn it back over to Christy. Thank you so much, Dr. Zatelli and Dr. Palmer, if you could advance all the way to the last slide. I'd like to thank you both for sharing your time and expertise with us today. I'd also like to point out to the participants that in addition to the workbook, the open access issue of seminars and hearing that they've been discussing today, they've also provided a really nice comprehensive list of reference references that are relevant to what they have presented today. And you can find those references under the Resources tab here in Zoom and also on the course page on Audiology Online.

So thank you everyone for participating in today's course. We look forward to getting your feedback on the course evaluations and we hope to see you at a future course on Audiology online. This concludes today's webinar. Have a great rest of your day.