Real Ear Measures: A Deep Dive

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- Hi everyone and welcome to today's course. My name is Dr. Amanda Wolfe and I'm really excited to be here with you today to discuss some real-ear measurements and how you may implement them into your clinical practice. We have three learner outcomes for today's session. The first is participants will be able to explain the benefits of utilizing real-ear measurements in their practice. Describe how to prepare for real real-ear measurements and describe the real-ear measurement process. Now let's finally get into the content. So we know that performing real real-ear measurements contributes to higher patient satisfactions since it does tailor the fitting to individual ear differences. And it has actually been noted as part of best practice guidelines in verifying hearing aid performance from organizations like the American Academy of Audiology and the American Speech Language and Hearing Association.

The most recognized goal of performing real-ear measures is to verify the audibility of a speech signal and the output of the hearing aid with the ultimate goal of ensuring patient benefit. Some professionals who are unsure of the value of real-ear measurements say that patient report is really all they need to verify audibility and comfort. And yes, those reports are highly valuable. However, real-ear measurements may be used to obtain an objective measurement of hearing aid efficacy and can be used in conjunction with patient report. Real-ear is really helpful in determining if soft speech is audible. Average speech is comfortable and loud sounds are loud but not uncomfortable. But you may be wondering, how do I know when I'm doing real-ear measurements if soft sounds are audible, average sounds are comfortable and loud sounds are loud, but not uncomfortable.

Well, there are many independent fitting formulas that have been developed by independent research labs that do generate characteristics called targets that are based on your patient's audiogram. Then the goal when you're running real-ear would be to match the hearing aid response in your patient's ear to those specified targets. These are all very well researched and really give your patients a nice starting point

since they all prioritize audibility, most real-ear system manufacturers do provide clinicians with the ability to choose from a variety of these fitting rationales. So let's just do a quick high level overview. NAL-NL1 stands for the National Acoustics Laboratory Non-Linear version one. This was created for non-linear hearing aids and is a rationale that maximizes speech intelligibility and keeps overall loudness at a level no greater than that perceived by a normal hearing person.

NAL-2 has been around for quite a while now. So some of you may recognize it. It is basically an updated version of NAL1. It does provide a little less gain than NAL1 and the modifications made to that formula were based off of patient comfort findings. So NAL-NL2 is a fitting formula that is supported by the Verifit system, the audio scan Verifit system that I'll be focusing on today. So the NAL-NL2 is a selectable fitting formula within that system, and I'm sure many others. DSL is a prescriptive formula out of the University of Western Ontario and stands for desired sensation level. It originally started as a pediatric formula but has been updated to include adult targets and is correlated with data on preferred listening levels.

And really the goal here is to provide maximal audibility. So this is another fitting formula that is also supported on the Verifit system as a selectable fitting formula to do regular measures. And the last one I'm just gonna provide a high level overview for is NALR, which stands for National Acoustics Laboratory Revised. Now this is a prescription that indicates how to fit a linear hearing aid. So there's many fitting formulas to choose from, but there is actually limited data to suggest that one fitting rationale is better than the other. Some patients may be fit with a certain formula the first time they start wearing hearing aids, and so their brain kind of acclimate to those settings.

So that's the fitting formula that they prefer the remainder of their hearing journey, whereas some professionals such as yourself might already have a favorite fitting

formula based on what you learned in school, what you've had the most success with in your clinical experience. So there's really no right or wrong answer when it comes to which fitting formula to use for your patient. But with that said, I would recommend based on my clinical experience and that of others to use a linear fitting formula such as NALR. If you already have a patient who is used to linear amplification. If you have a patient, excuse me, that is used to linear amplification and fit them to a fitting formula with compression such as NAL-NL2 that might not yield the best acceptance.

Now as you all are probably aware, different hearing aid manufacturers have their own proprietary fitting formulas that are often based off of these independent fitting formulas, and those are integrated into each particular manufacturer's software. So now that we've covered some background, let's start talking more about how you can actually integrate these measurements into your practice. So I wanna go over three stages of the patient hearing journey where you can start to set up your patients for success by running real-ear measurements. Those stages are the hearing test, the fitting and the follow-up. So right from that initial hearing evaluation, you'll really wanna keep your end goals in mind. It might be a good idea to measure your patient's UCLs if you don't already do so.

So even at 5000 and 3,000 hertz will be helpful so they can be entered into that real-ear system to help generate those fitting targets. If you don't do this, don't worry about it. The system will likely give you an option to choose average values. As we fast forward to the hearing aid fitting, this is where performing the measurements will establish what we call a measured baseline for you and your patient. And at the follow-up the measurements may help in actually troubleshooting some patient complaints help with fine tuning the hearing aid and patient counseling as well. So we'll talk about how to integrate real-ear real-ear measurements in the fitting and follow-up in detail a little later on in the hour.

But before we go into any further detail about real-ear measurements, I do wanna pause and talk a little bit about some real-ear measurement terminology that we'll be kind of throwing around throughout the presentation today just to make sure we're all on the same page. So if you're just getting started with real-ear measurements, there is a lot of information out there and if you do even a basic search of what real-ear is, you'll likely be inundated with a slew of terms that you need to be aware of. In fact, with real-ear it can be easy to get lost in a sea of acronyms. So before we get to how you perform them, you really need a basic understanding of the terminology associated with these measurements.

Almost all real-ear measurements begin with RE, that stands for real-ear of course, and they're followed by two more letters that describe the type of measurement being made and how that measurement is displayed either for gain or response. Now I don't have time to review all of these definitions or measurements today. An hour goes by quickly, but these are, these are easily searchable on the internet if you would like to learn more. But let's just jump into a few quick definitions. So if you notice on the slide before some acronyms ended with R and some ended with G. Those are important designations that stand for response and gain respectively, and they're basically two ways of viewing the same information.

The term response, also known as output, indicates the clinician is observing the absolute measurement of sound pressure generated in the ear canal or the output of the hearing aid. As we all know, the amount of amplification provided to the patient is called gain and is expressed in decibels and that's your output minus your input. Practically speaking, out of all the acronyms I just showed you, you'll likely mostly perform what we call REAR in the clinic, Real-Ear Aid Response. This is a measurement of the SPL in the ear canal created by the hearing aid when it's turned on and placed in the ear. REAG is the REAR minus the input signal. In the last term I'd like to quickly review is the SII.

The SII stands for the Speech Intelligibility Index and is a measure ranging between zero and one that is highly correlated with the intelligibility of speech. The SII score is a way of quantifying the likely intelligibility of speech based on the proportion of speech cues that are audible. It's really a quantification of the proportion of speech that is both audible and usable for the listener. So basically to put simply an SII of zero implies that none of the speech information in a given setting is audible or usable to improve speech understanding. An SII of one implies that all or a 100% of the speech information in a given setting is both audible and usable for a listener. So as the SII value increases speech understanding generally increases the method for calculating the SII is actually described in an ANSI standard ANSI 3.

5 1997 titled "American National Standards Method for Calculation of the Speech Intelligibility Index." If you'd like to learn more specifics about that, we'll talk a little bit more about SII later as it is a great counseling tool that you can use when you're running your real-ear measurements. So now that we have some basic terminology under our belt, I wanna switch gears and start reviewing how to run real-ear measurements on your patients. For the purposes of just keeping things straightforward and simple, I'm going to focus on the audio scan Verifit two measurement system today, specifically the speech mapping test within that system, this is the test used for real-ear aided responses using a speech signal. Now in my clinical experience and that of other professionals I've interviewed, speech mapping or its equivalent on other real-ear equipment is really the primary measurement done in clinical practice.

Now while I'm going to be focusing on this verify fit two system, know that if you use another system, the steps may differ slightly depending on which real-ear equipment you are using. So it isn't important to read your respective user manuals before using your system. Now before I move on, I do wanna say to just let you know that Starkey

nor I endorse the audio scan Verifit system, it's just the equipment I personally am most familiar with in my clinical practice. So with the Verifit system, there are a few setup steps that need to be done prior to running any real-ear measurement. First of course is calibration. You would enter the patient's audiogram, you would select the fitting formula you'd like to use, select the type of hearing aid the patient is wearing, the type of stimulus like a speech stimulus that you'd like to use, place of course, the patient in front of the speaker of the system, put the probe tube in their ear, make sure the hearing aid is set up appropriately and prepare the patient.

So we'll walk through the details of each one of these steps, starting with calibration. Calibration is extremely important in measuring real-ear. It compares the frequency response of the probe tube, which is the tube that sits in the patient's ear and picks up the signal in the ear canal to the flat frequency response of the external reference microphone, which maintains the appropriate stimulus level at the ear and compensates for this difference in all subsequent measurements. So by calibrating, we're basically making the probe tube and the microphone acoustically invisible. So we're just truly measuring the real-ear response. Now some equipment will have you calibrate before each patient and some will store the calibration. In other words, excuse me, you could calibrate every day or every week and that data would be stored so you don't have to calibrate before each patient.

Now for the Verifit, calibration may be conducted either daily or weekly, which can be selected by you in the calibration menu. This makes it really nice so you don't have to calibrate prior to each patient. You can just get up, do your calibration once a day, once a week, and be good to go. To set up for calibration, you would simply align the external microphone with the probe microphone like you see in this picture. Then hold the probe dock about six to 36 inches away from and directly in front of the equipment speaker with the microphone to be calibrated facing the speaker and select the button that says Calibrate. So you would calibrate both the right probe tube and the left probe

tube independently, or in some cases some systems can calibrate both at the same time.

This will elicit a stimulus from the speaker and a trace will appear on the string that you can compare to the expected response, which is most likely displayed in your respective equipment's user manual. For the Verifit, the resulting curve should be similar in shape to that shown here, but maybe shifted by plus or minus 5DB. So next, you'll need to enter in your patient's audiogram in order to generate prescriptive fitting formula targets and then you would select your fitting formula. So I recommend for the most accurate results, either matching the fitting formula you have selected in your fitting software, or if you're choosing to use the manufacturer's proprietary fitting formula, select the one that most closely approximates it knowing you're likely not going to match directly onto target because there are some differences in those proprietary fitting formulas to the standard fitting formulas that are built into those systems.

So if you're unsure of the proprietary fitting formula that you're using, kind of what it most closely approximates to, you might have to reach out to the hearing aid manufacturer and see kind of what they base their fitting formula on. At this time, and to my knowledge, no real-ear measurement systems include hearing aid manufacturer's proprietary fitting formulas. So after that's done, you would then select the type of hearing aid your patient is wearing and whether they're fit, open, or occluded. And I'll get to why this is important next. Sound field equalization corrects for the inherent instability of the test environment due to movement, sound reflection and diffraction in the environment. The type of equalization that occurs will depend on your fitting and whether you have selected open or occluded.

For open fittings, there's sound escaping from the ear, right? And that sound might be detected by the reference microphone, which actually could alter the measurement. As

you recall from earlier, the reference microphone actually adjusts signal at the ear accordingly. So the intended presentation level at the ear is accurate. So if openness selected the reference microphone is actually turned off during your measurements to prevent this potential underestimation of hearing aid gain due to leakage from the ear canal. For the first measurement, you'll be prompted by the Verifit to mute or turn off the hearing instrument, you would click an equalize button on the Verifit screen. It actually won't run the test measurement until you select Equalize. So don't worry about missing this step.

This will elicit a stimulus, like a calibration stimulus. Then you can unmute or turn the hearing aid on and continue with your measurement. Excuse me. Now, because the reference microphone is off during all measurements, it's important that your patient remains still to keep the stimulus level as consistent as possible. And when occluded is selected, the sound field equalization is concurrent, which means it occurs automatically between each test measurement. So while it's important your patient remain as still as possible during the measurement, the reference microphone will remain on. So it will be adjusting the stimulus level as needed throughout the measurement. Next, you'll need to choose your stimulus from the list of options your equipment provides. I recommend using a speech stimulus.

Here are the most popular stimulus available on this slide, and they're all intended to represent the average speech spectrum. I personally use the ISTS, the International Speech Test Signal for my aided responses. It was developed from recordings of six female talkers reading the same passage in some different languages. The segments of speech were then kind of spliced together and filtered to match the average female spectrum. I use this stimuli because it has certain dynamic properties that make it very similar to real speech. The carrot passage is another popular stimulus to use. Some of you might recognize it. It's basically a ten second long audio recording that just simply talks about a carrot. Now, your real-ear measurement system will likely recommend

positioning the patient directly in front of and facing the speaker at a distance of about 18 to 24 inches with the speaker at the same height as that of your patient's head.

Ideally, the room you have your liter equipment in should be conducive for acoustic measurements as much as possible. This means that the room should be quiet with minimal hard reflective surfaces, which I know is a little bit hard to come by in a clinic. So just do your best. Also the equipment and thus your patient should be as equalist as possible from the walls and other large surfaces to minimize any standing waves in the environment. Again, do your best with what you have, recognizing that your environment is probably not going to be perfect. Once your patient is positioned in front of the speaker, you want to hang the external microphone over the ear with the probe tube attached to the probe dock as you see here.

Now you'll need to put the probe tube in the ear. So the probe tube is used to measure the response of the hearing aid at the eardrum. I always recommend, excuse me, doing an endoscopic exam before putting the probe tube in, even if you've already done it. This will help you get the lay of the land as far as how the ear canal is kind of laid out. Also, it's a good gut check to make sure there's no leftover cerumen or ear wax in the ear. It doesn't take much ear wax to plug that probe tube. So if there's a little bit in there that you feel confident taking out before doing real-ear, I suggest you just take it out to avoid any potential issues or troubleshooting you'll have to do later if that gets plugged up.

I do wanna say while we're on the topic of probe tubes, please do not use the same probe tube on multiple patients. They are meant to be disposable. Even if you sanitize, even if you rub them within a wipe, always please just use a new probe tube on each patient. Your patients will also appreciate knowing a new probe tube is being used because it's a tube, you never know what's made it inside the tube. So even if you sanitize on the outside, who knows what has made it inside the tube, as you're moving

that into your patient's ear? As far as how deep to put the probe tube in your patient's canal, it's generally recommended that the probe tube sits between two to five millimeters from the eardrum to avoid standing waves and just really get the best signal possible.

To help you with insertion, the probe tubes that ship with your equipment should come with usually a little black marker that you see here on the screen that indicates kind of a premeasured amount. Generally speaking, the marker should be placed approximately 28 millimeters from the end of the probe tube for adult females that goes up to 30 millimeters for males and about 20 to 25 for children. Keep in mind all of these positions may be modified based on endoscopic examination or patient comfort. So check your probe two packaging also, it might have a measuring tool that can help you measure the right millimeter length that you need for your each individual patient. Once that's measured, you would put the probe tube in gently and really that black rubber piece should be sitting right at the intratracheal notch or even slightly deeper.

It's really important to be careful when inserting the probe tube. Be careful not to have it be pinched by the ear mold or earbud and really be careful not to hit your patient's eardrum. It's extremely uncomfortable and just not comfortable and that might not make them want to do the measurements if you poke their eardrum. I always make sure I have some sort of hold on the device as well when I'm inserting the device like the earbud, the receiver into the ear canal once I have the probe tube placed, just so when I'm inserting it, it's not accidentally pushing that probe tube in further. So also keep in mind there's a nerve that runs through the ear canal.

So as you're putting this probe tube in, some patients may start to cough, some patients may start to, I once had a patient who had a teardrop just leak from her left eye as I was inserting the probe tube and she wasn't in any pain, it was just a a reflex that was happening as I was entering in that probe tube. So just be aware of those

things. Some patients can be kind of jumpy, so just be aware and make sure you don't let that probe tube go if they do jump or cough and whatnot. And then again, after you're done making your measurements, please be sure and throw away that probe tube and use a new one for every single patient.

So now on to hearing aid setup, it's most real-ear equipment is equipped to run real-ear using modern hearing aids of course, but it's always a good idea just to jump into your programming software quick and make a few adjustments such as setting the hearing aid to omnidirectional mode, turning off noise reduction features, and even the feedback counselor if you can. Pretty much any adaptive features your hearing aid manufacturer has turned on should be turned off. And this is really just to ensure that although unlikely, the hearing aid isn't doing something to the stimuli that would alter the response and give you inaccurate data. And you also wanna be sure that the input levels from your fitting software match.

So if you have soft, average, and loud curves in your fitting graphs in your software, make sure that those levels match what you're using in your real-ear equipment or closely approximate. Typically, I'll say this a few times, we want to measure multiple levels. So a soft level, an average level, and a loud level. And then running an MPO curve, a maximum power output curve will also help ensure that the hearing aid output will stay at or below your patient's UCLs. If you didn't measure again UCLs at your patient's hearing tests, you real-ear equipment again will likely have an option to use average values, which are just fine. And the final setup step I always recommend is just simply instructing your patient to remain quiet and still while the test is running, to really get the most accurate data and make sure that probe tube doesn't move from where you put it in.

Provide simple instructions to your patient on what they will be listening to and remind them that they don't need to repeat back anything or respond in any way unless they're

uncomfortable. If they do get a little uncomfortable with particularly the louder sounds simply like you do with the dentist, just raise your, just have them raise their hand and you can stop, excuse me, stop the measurement. I've sometimes had to do this with the louder measurements and sometimes that MPO measurement. So you can either change the level of the loud stimulus that you're using so it's a bit softer or just choose not to run it at all and go off of more patient report. But generally speaking, I've rarely had any instances where I couldn't run all my curves.

So the steps we just reviewed will need to be done every time that you do real-ear, regardless if it's at the first fitting or the follow-ups and also the order of those things can be moved around. It doesn't need to be the one through nine like I laid out. That's just generally the most efficient way to do it. So now let's walk through what you are looking for at the initial fitting. Of course, I do want you to be aware that everything I'm gonna talk about today are just suggestions. As you get more comfortable with doing real-ear measurements, you can obviously adjust your protocol to fit the needs of you and your practice.

So today we're going to focus on running speech mapping within the audio scan Verifit system. Simply put, this is using a speech stimulus as a signal of choice for your real-ear aided response. Within the Verifit system, you have many test choices off the main menu as you see here, but we will go ahead and select speech map from the on-ear menu of choices That will bring you to a screen that looks like this. So to keep things easy to see, we're just looking at the left here, but you do have the option of seeing both sides if you want to. You would enter in your patient's audiogram manually. To do that, you would select audiometry in the upper right.

This is also where you would select your fitting formula and other items. If you have the ability to transfer the audiogram automatically via your fitting computer and the audio scan module, the thresholds can be transferred with a click of a button, but you would

still need to go here to select your fitting formula and those other options. So let's take a look at how you would entered an audiogram manually in closer detail. Okay, so pretty self-explanatory and you saw me click a few options that you have. But basically real simple just to enter in manually the thresholds for each of your patient, for each ear, and that'll generate the targets that are necessary that you'll need to approximate.

So after you do that, you'll hit play, which will start that recording, which you see indicated with number two, that play icon. And you'll automatically generate the fitting formula targets. Those will automatically appear on the screen based off the fitting formula you've selected. So those are the magenta cross like symbols you see here on the screen. You'll also see the aided speech banana appear showing the peaks and values of the long-term average speech spectrum. And the aided curve is a solid line, which is the output of the hearing aid at the eardrum. The blue line is your patient's audiogram and SPL. So it is flipped based on what you're used to looking at on the audiogram.

Everything above the line is audible, everything below is inaudible. And you'll also notice here that there are four play buttons you could press. Generally, again, most people run a few different levels. A soft and average and allowed, so soft could be 50, 55, average 60, 65 and a loud speech like 75 or 80. Then once you hit Play, you will then have the option to select your input levels. I usually start with soft first and then I work my way up the difference to the louder curve, excuse me. And then each curve will be a different color. So it's easy to tell the difference between the two. So once you see the curves populate, the goal here of course would be to increase or decrease the gain of the hearing aid in those different frequency regions to match the target for that input level.

So the image on the screen is a perfect match to target of course, this was taken from the audio scan Verifit manual, but generally your goal would be to match within three to

five DB, keeping your patient's comfort in mind, of course. If you find that they are uncomfortable as you increase gain to match target, really retain that feedback and just keep in mind that it might be best just to stop there and work off of patient report. Remember, keep in mind the best hearing aid for your patient is the one they will wear, right? So doing real-ear and matching the targets really is a balancing act between that comfort audibility and sound quality. Now there's a few other things I wanted to point out on this screen and that is what's numbered four and five.

So within the speech map display screen, the predicted unaided and aided speech intelligibility index for SII scores appear for each of the tests that you may be doing. For ease of understanding the Verifit displays these values as a percentage, the predicted unaided SII is represented by number five here on the screen for each input tested. And the aided SII as a result is below it. Number four and that is that, and that appears after you run each measurement. So for this screen, example of test one where the input level is 50 DB and the predicted unaided SII is nine, the aided SII right below it is 39. So as you run real-ear measurements, you can really quickly see your SII score and relate that to the predicted speech intelligibility.

So this figure on the right of the screen shows expected percent correct speech recognition scores for SII values for normal hearing individuals when using a variety of speech recognition materials, the various lines are showing that, excuse me, are showing that small improvements in SII score yield pretty large improvements in actual word recognition score. But at some point there's going to be kinda little gain where we reach a point where further improvements in SII have pretty little impact on word recognition. We hit our maximum performance. So this is where you can see where those slope of the lines kind of level out. Now for the word discrimination test that begins, that leveling out kind of begins around a 70 SII level.

So looking at the corresponding table to the left is just a bit easier to read. So if you're kind of wondering, I always get ask, well what's the best if the Verifit shows SII, what should I shoot for as far as that value? Really it's worth trying to get as close to a 70 for a conversational speech level so you're at 65. Because up until that point any improvement in SII will have a positive impact on word recognition. But if you try to push it past 70, that word recognition is just going to level out anyways. I do wanna preface this though by saying SII is a great tool to use. It's important to keep in mind though that it's not the end all be all.

Keep in mind your patient is going to have visual cues in the real world. They're going to have contextual cues and other cues of what's being spoken about. And so say your patient has an SII of 40, that doesn't mean they're going to go home and only understand 40% of the conversation. So just something to think about, but really as close to 70 as you can get it is ideal. So switching gears a little bit away from SII, I wanna look at the rest of the information that's available on the speech mapping screen. So as I've said a few times today, it's encouraged to run multiple levels and an MPO curve. After you run those multiple levels, you'll see a screen like this with of course those different colored curves.

So starting with what's labeled number one, those are your MPO targets that are actually automatically generated. Number two are the estimated uncomfortable loudness levels from the Verifit but again, you do have the option of entering in those measured UCLs under audiometry. Number three is the measured MPO curve that I typically run last. Again, your goal with MPO is just to ensure that MPO is between the loud curve and magenta and the UCL values. And number four is the average curve for this measurement. So in this case a measurement at 65 DBSPL. Number five is the soft curve at 50 and number six is the audiogram in SPL, which again looks upside down from what you're accustomed to. So now in the real, in the real world, you might find

that everyone does real-ear differently and that's why I said everything I talk about today is just merely a suggestion.

But I'll tell you how I was taught to do it and how I have observed many other professionals do it just so you have some baseline knowledge. So at the initial fit, I generally recommend setting the device to its initial fit response programmed by your hearing aid manufacturer's fitting software, and then running measurements to see how close you are to target's right off the bat, I call these the pre adjustment measurements. So let's take a look.

- Now with that I can adjust the hearing aids for each input level in my fitting software and rerun the measurements. You can always do this while the curves are running before finalizing your measurement, but sometimes it's just easier to see kind of where things line up right off the bat and then making those adjustments. So there's no right or wrong if you wanna do each line independently altogether, do overall gain, et cetera. It really just kind of de depends on how much gain you need to add or decrease. My goal in the end is to match within three to five DB of target though within 500 to 4,000 hertz. So get as close as you can keeping your patients comfort in mind. So now that we've made adjustments, I wanted to place some post adjustment measurements.

- So now that I matched the targets as closely as I could, let's get a closer look at those SII scores that the Verifit predicted. So first I wanted to point out that we see the unaided SII scores were, as you may expect for each input level, but then after running the measurements we see the aided pre adjustment scores. Then after we make the measurements to better match to target, we see a further increase in SII scores. So keep in mind here, even at Target, we still aren't reaching that 70% SII score at soft and average inputs. But again, the goal here is there should just be improved speech recognition. We still need to keep our patients comfort in mind knowing that these are

just a prediction and your patient will likely do better in the real world with those contextual cues and facial cues.

Now in my experience with seeing other audiologists run real-ear at the hearing aid fitting each of course, have their own protocol and what works well for them and their personal fitting philosophy. I've seen professionals match the target at the first fitting and then not make any hearing aid adjustments at all and just really encouraging that their patient get used to the gain settings over time between the fitting and the follow-up and then at the follow-up that make adjustments of as needed. And then I've also seen professionals who will match to target and then after speaking with the patient for a bit, we'll then make hearing aid adjustments at that same appointment based off patient report.

So some people may ask, well, real-ear measurements just kind of seem like a waste of time because what's the point in matching to target if I'm just going to move away from target based off patient report anyways? And that's a valid response. But really the point is matching to target first is great because that will give you a research based starting point for those gain settings that then you can then adjust based on off patient report. So let's look at an example. So let's say your patient's primary motivation for getting a hearing aid is to hear her grandchildren better. So during the hearing aid fitting, you program the hearing aids and you match to a prescriptive target.

Afterwards, if the patient reports, excuse me, that it's too loud and maybe too tinny, your first response may be of course to reduce the gain until she's happy with the sound. But if you were to set her up and run real-ear again at these new settings, you may see something like this where perhaps you decrease the gain too much. Overall, and her SII actually decreased dramatically indicating that her audibility may suffer with those changes. So you have a few options as far as counseling and some adjustments. You can use the real-ear aided screen to visually show your patient that her

grandchildren's voices won't be audible at the volume that she's requesting. So you can encourage her to try those higher gain settings in real world environments while providing her with a volume control so she knows she can turn it down if needed, or perhaps you need to work on a middle ground and still provide some adjustments, just not so aggressive and encourage her to try those settings.

You could also give her two programs with different gain settings, one with a lower gain and one with a higher gain. Then you can encourage her to flip back and forth and compare how she does when she's around her grandchildren and when in other environments. Or you could keep things simple and keep her at lower gain settings and then at, excuse me, at each follow-up appointment, increase her gain about 2DB until she's at or close to prescriptive target just to give her more time to acclimate. So really this lends itself to how important counseling is, right? And to illustrate that real-ear, while it is best practice is not the end all, be all. Hearing aid counseling and listening to your patients is extremely important as well as how you have the hearing aids, otherwise programs.

So whatever you decide to do in your clinical practice is up to you. But just keep in mind that real-ear does give you a great research based baseline to start your hearing aid gain off with and then of course, you can deviate from that a bit based off your patient satisfaction. So now we're going to fast forward from the fitting and talk about real-ear measurements at the follow appointment. So as I mentioned earlier, some professionals match the target at the first fit for everyone and keep them at these settings until their follow-up visit. And then at the followup appointment, once the patient has some experience under their belt, then they'll make adjustments. So I'm not here to confuse you by being too wishy-washy or tell you what you absolutely need to do.

I'm just simply trying to illustrate to you that you can use real-ear measurements multiple ways depending on your own comfort level and experience. Remember, you can always try one way of doing things and change it up if it's not working for you. So either way, the follow-up is generally focused on ensuring good sound quality while not losing sight of audibility. It's really that balancing act. So it's important to remember that in conjunction with real ear measures, you also need to utilize other tools at the follow-up visit to help you understand your patient's needs for audibility and sound quality. So to do this, you can use questionnaires, you can simply chat with your patient.

Really as hearing professionals, we have to make sure that not only is speech audible, but that our patients are satisfied with their hearing aids at the end of the day, right? So the best way to do this is that to make sure that we're reaching that balancing act between audibility and sound quality. So let's look at an example. Your patient comes in and reports sound quality issues, and the first curve is what you measured at the hearing aid fitting. You match the target at that time and then you just left her at those settings. Now given your patient's report the follow-up, you decrease gain in the high frequencies and your patient reports things are sounding better.

You run real-ear because you wanna see that your patient, excuse me, is still getting access to that full spectrum of sounds. So the second curve is the real-ear aided response after you made those adjustments. But looking at the image here, it seems that the louder settings may be preferable if we're just thinking about audibility. But again, real-ear measures might not be painting the full picture here. There could be other factors like dead regions and distortion to take into account. So in this situation, it's possible that that additional high frequency gain is over amplifying dead regions in the cochlea and thus the added gain is not really serving your patient well. So really situations like this remind us that while real-ear measures are useful, they're not the only thing to be taken into account.

And it's really important to understand that while prescriptive targets are research-based, it's important to also be mindful to not get caught up in matching the target, it's about what you do with that information. So it's just really another tool in your toolbox that can be used to set your patients up for success and really get you started with that balancing act of audibility and sound quality. So at this point we know the utility of using real-ear measures and we know that every patient is unique. So just because we're making speech audible doesn't mean that the patient's going to interpret it right, but if it's not audible, then there's no chance they're going to understand it.

So we're really working on this balancing act of making speech audible but also making it sound good. And we also need to balance the time we have for the fitting with the time we have for counseling. Performing real-ear gives you that real-time view of hearing aid output in your patient's ear. So it may actually save you time in the long run counseling since it may take some of the guesswork out of the equation. So like our profession in general, all of this is really not only a science but also an art. But that balancing act can pay off. I know that most of you joining me today likely already are convinced of the benefits of breather measurements.

Some of you may be questioning and that's fine, you had a nice review of how to run them. But I wanted to reiterate quickly as I wrap up and I wanna get to those questions, the why behind real-ear measurements. So there is research to support the idea that patients do report greater perceptual benefit when their hearing aids are adjusted according to real-ear measurements as compared to when real-ear is not utilized. They also report reduced listening effort, improve speech understanding, and come back for fewer follow-up visits. Now I wanted to quickly switch gears a bit in the next few minutes. We've already discussed kind of the basics of real-ear, how to run them, et cetera, the benefits, but we all have had those times, right?

When you have a patient in front of you and you're doing a measurement, maybe you're doing a hearing test, you're programming hearing aids and software and something goes wrong and you need to troubleshoot. So I wanted to go through a few basic troubleshooting tips that you might need to utilize when you're running real-ear measurements. And the first is being maybe you start a measurement and the output curve almost looks flat or you just can't believe that you're not getting very much benefit. There really could be multiple reasons for this. First thing to check is the probe tube. Make sure it's clear of cerumen, make sure it's still inserted. They have a way of making their way out of the ear.

Or just replace the probe tube if you're not sure what's going on, check that the hearing aid or ear mold is also clear of cerumen. Do a quick listening check or maybe do some test box measurements just to do a gut check that it's working. And then also just make sure you have the real-ear system set up appropriately. You have everything selected correctly and that your fitting formulas match or closely approximate. Another troubleshooting tip is, oh my gosh, I'm clicking in the software to make gain changes and nothing's happening. The curves aren't changing on my real-ear system. Again, there's multiple culprits for this. Really, again, check the connection. I was once doing real-ear as a student and had this issue and it turned out the hearing aids had lost connection to the software.

So I wasn't actually making any gain changes with the software. Check the probe tube again, that's kind of your number one for every one of these. Confirm that your adjustments are being made correctly. So for example, if you're trying to make gain to soft, make sure you're not accidentally clicking the average curb in the software, for example. And then again, check that ear mold for a hearing aid. So for those of us who want to begin incorporating real-ear measurements into our practice, or for those who just want a fresh perspective, there are a few key takeaways. I would say that the most

important thing to keep in mind is the why that, why are you running these measurements?

How do you want to use them? How do you want them to be meaningful to you? And remember that verifying audibility is so important, but also can just be the starting point in the fitting process. Your patients, as you all know, are extremely unique and your ultimate goal is to balance, find that balance between speech intelligibility and patient acceptance. So by combining real-ear measures with reports of real-ear performance or real world performance and other validation measures such as questionnaires, you'll really be able to provide the most comprehensive care for your patients. And I will get to those few questions that have come in, but I wanted to thank you first and foremost for your time today.

If you would like more information on real-ear, there's plenty of information online at audiology.org or through ASHA or of course, just simply reading the user manual of your real-ear equipment. So I do wanna get to some questions here, so excuse me while I read this real quick. It's kind of long. So someone's asking, what's the main reason to use real-ear if you can't actually benefit from your findings? I mean this kind of goes back, maybe I answered your question. You know, really, if you find that real-ear just isn't meaningful to you and your clinical practice and you find success with patient report, then use patient report. If you find, you know, again, I keep going back to that research based baseline that it provides you at least match to target and then you can veer from that if your patient prefers that.

So really that would be my suggestion is just to at least match the target. But if honestly, just to be frank, if you don't find them useful and you really find success in that patient report, then use patient report. So an another person is asking that I recommended turning feedback cantilever off and noise reduction off. Wouldn't the hearing aids feedback during the real-ear measurements? It's possible. It depends on

your patient's audiogram. So if they have more of a mild to moderate loss and you can turn the feedback cantilever off without feedback, then turn it off. If you find that you get feedback when you turn the feedback manager off, then leave it on and just know.

I mean, again, most real-ear equipment is built for modern hearing aids with the type of processing that all the manufacturers use. So I honestly wouldn't be too concerned about it. So just kind of take it on a case by case basis and if you need to leave it on, you need to leave it on. All right, well those were all the questions that came through today. I hope I them sufficiently for all of you. Thank you again for your time. And again, don't forget to complete that quiz to get your one hour of CEU credit. Thank you so much.