Optimizing Patient Success with Real Ear Measurements

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So My name is Dr. Keeley Layfield and I'm here today to discuss how you can optimize your patient's success using real ear measurements within your hearing aid fittings and your follow up appointments. So we do have three learner outcomes for today's session. The first one is to explain the benefits of utilizing real ear measurements within the clinic. The second is to make appropriate adjustments to the hearing aid based on your real ear measurements.

And then then the third is to identify one key learning so that you can implement in your clinic and improve your patient's outcomes. So we know that performing real ear measurements contribute to higher patient satisfaction since it tailors the fitting to individual ear differences. And it's been noted as part of the best practice guidelines when verifying hearing aid performance from organizations like the American Academy of Audiology and the American Speech, Language and Hearing Association. But there have often been a few very common barriers to implementing real ear equipment in your office and in your clinic flow. So if your clinical experiences are similar to what mine were, you may spend less than an hour for a hearing aid fitting and a half an hour for a hearing aid follow up.

And that's if you're lucky. We've all had those experience where if anything happens during the appointment that interrupts your flow, it can really, really set you back or knock you off course. So adding one more procedure in your typical protocol may not be very easy to do at first, but in some cases, taking the time to run the measurements could end up saving you time because you can visually see what the hearing aid is producing in your patient's ear. This leads to faster fine tuning or more pointed counseling. And then I often hear from providers that they lack comfort with interpreting the results that they get from real ear measurements.

So I'm going to share some information that can be applicable across all systems, such as common real ear terminology, the integration of how to move this into your clinic, and more. So hopefully after today's course, you'll begin to feel a little bit more comfortable with real ear measurements. And lastly, I

know that equipment costs can be a huge barrier. On average, a new real ear measurement system will cost between 14 and $20,000, depending on the manufacturer and any extra equipment that you may need. And that's just for one system.

So if you need one for every fitting room in a busy clinic, that is not a small cost. However, investing may prove beneficial in the long run for reasons we're going to touch on in a moment. So if that price tag is still a little bit shocking, for you, keep in mind that oftentimes you can find used real ear equipment that you can purchase for a discount.

So, as we all know, with amplification, we want to ensure first that soft sounds are audible, average conversational speech is comfortable, and loud sounds are not uncomfortable. Some professionals who are unsure of the value of real ear measurements say that the patient report is all that they need to verify audibility and comfort. And yes, behavioral reports are very important. However, we've all had those patients who are either not really strong advocates for themselves, or they're just not very good at verbalizing their experiences with the hearing aids. So real ear measures offer you an objective verification of the response, and this can be used in conjecture with patient report.

So it really can be an invaluable tool in which to use with your patients. Now, you may be wondering, well, when using real ear measurements, how do I know that soft sounds are audible, average or comfortable, and loud sounds are loud but not uncomfortable. So, independent fitting formulas have been developed by independent research labs, and they generate required characteristics called targets, and these are based off of the patient's audiogram. These have been very well researched and they give your patient a very nice starting point since they're going to all prioritize audibility. Most real ear system manufacturers provide clinicians with the ability to choose from a variety of these standard or independent fitting rationales.

Then there's also proprietary fitting formulas, and these are developed by a specific manufacturer to maximize the performance of their specific hearing aid. So, at Starkey, our proprietary fitting formula is E stat 2.0, and it was designed specifically to complement our compression architecture and provide more gain for soft speech. So, typically, a prescriptive fitting formula generates its targets by measuring the required amount of gain to amplify a defined speech spectrum to a desirable level or your patient's mcl. Then the goal would be to match the measured hearing aid response to the specified targets. While there are many different fitting formulas to choose from, I wouldn't necessarily say that there's a best one.

There are limited data to suggest that one rationale consistently outperforms other when applied across the multiple types and degrees of hearing loss. Though I will say that I personally am a huge fan of proprietary fitting formulas. You know, all research, verification, and claims made by a manufacturer are verified with their proprietary fitting formula. So I believe that they lend themselves to optimizing the hearing aid performance and audibility, again for that specific hearing aid. So when running real ear, it's important to consider what type of measurements are you looking for?

Do you want simulated measures or true on ear measures? Simulated real ear measurements are made with a coupler in the test box. These measurements assume the microphone location and those real ear to coupler differences. Average transfer functions are already applied to the measured data. So in a general sense, a transfer function is the difference in sound pressure at the source versus the tympanic membrane.

Coupler measurements might be performed when a clinician checks devices in for the first time. So for example, you want to make sure that the device is up to specs or matching targets before the patient even comes into your office. Test box measurements would help to differentiate a hearing aid versus test measurement error. For example, you know, maybe your probe tip is up against the canal wall. In

situ measurements are made on the actual ear.

So with these measurements there's no need to add transfer functions because you're using the patient's ear and their ear canal. However, equalization is required before making the measurements to calibrate the signal. So on ear calibration compares the frequency response of the probe tube to the flat frequency response of the reference mic and then it compensates for this difference in all subsequent measurements. And then when it comes to actually running your real ear measurements, there's the decision of what type of measurements to perform. So you're most likely going to perform rear, which is the real ear aided response.

This is a measurement of the SPL or that sound pressure level in the ear canal created by the hearing aid when it's turned on and placed in the ear. The Verifit system refers to rear as speech mapping and it will give you very valuable information about your hearing aid fitting. So with speech mapping, you will be able to see that speech envelope of the test signal and the long term average speech spectrum, which is what you're looking for to meet the specific targets that you're using for your fitting. These targets are going to be based on the fitting formula that you're using for your verification. The real ear to coupler difference is the difference in decibel level between the SPL measured in the real ear and in a 2 cc coupler from the test box.

The RECD is obtained by making two measurements, one from the ear, one in the test box, and then these measurements are subtracted from each other and the result is the recd. And this is applied to hearing aid measurements in the test box system. So you can estimate the hearing aid response in the ear because the 2cc coupler now has the acoustic characteristics of the ear canal. Now, typically, recds are referenced a lot when talking about pediatric hearing aid verification because it's faster than traditional real ear measurements, which can take about five to 10 minutes. And while that may not be too long for a lot of infants or really small children, it's too long for them to sit through.

This can also be used in the adult population, though, such as those that maybe have special needs or who are unable to sit still for an extended period of time. And then the last term that I would like to review with you is the SII or the Speech Intelligibility Index. And this is a measure ranging from 0.0 to 1 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. So it's a quantification of the proportion of speech information that is both audible and usable for a listener.

So basically, an SII of 0 implies that none of the speech information in a giving setting is audible or usable. An SII of 1 implies that all of the speech information is both audible and usable. So as that SII value increases, speech understanding generally also increases. The method for calculating the SII is described in the ANSI S3.5 standard that's titled our American National Standard Methods for Calculation of the Speech Intelligibility Index, if you want to learn more about those specifics.

So when it comes to interpreting SII scores while running real Earth, many systems convert that zero to one score into a percentage. The various lines that you see here are showing that small improvements in SII score can yield big improvements in actual word recognition. But at some point we do reach a point where further improvements in SII have very little recognition on wordreq. So we've hit our maximum performance performance. This is where you can kind of see those slope of those lines start to level out.

So for the word discrimination test, that begins around a 70 SII percentage. So looking at the corresponding table to the left, it's a little bit easier to read this data. So if you're wondering what SII to shoot for, it's worth trying to get close to 70 for a conversation conversational speech level, because up until that point, any improvement in SII is going to have a positive impact on word recognition. Now, while SII is a great tool for you as a professional, it's important to keep a few different things in mind. 1.

Each fitting formula prescription has been designed and evaluated to provide comfortable loudness and good speech recognition and fitting higher than the Gain targets in order to get a higher SII may make things too loud for the patient. Also, as hearing loss becomes more severe, your SII expectations need to go down. Think about a real world context and how speech recognition in the real world will likely be better with contextual cues, facial cues, things of that nature. So take your SII with a grain of salt and think of it as a good starting point, but don't get too caught up in increasing gain to reach a specific value.

So now that we have some of that terminology basics under our belt, we need to talk about the basic setup steps that you need to perform real ear measurements in your clinic. All of these setup steps will help ensure accurate measurements which allow you to base your hearing aid adjustments off of now keep in mind this is going to be kind of a general overview as setup steps may differ slightly depending on which specific real ear equipment you're using. I strongly encourage you to read the user manual of your respective real ear equipment before using it. So I've already mentioned it, but the first step is to calibrate the machine. So calibrating the probe tube removes the acoustic effects that the probe tube and the microphone introduce during real ear measurements.

So by calibration, we're essentially making that probe tube and microphone acoustically invisible. This step can be performed without the patient being present, and it involves aligning that external microphone with the probe micro so you can compensate for any differences between the two. A stimulus is played and a trace will appear on the screen that you can compare what is likely displayed again on your respective equipment's user manual so you know what it should look like. Some equipment will have you calibrate before each patient. Some will store the calibration so you could calibrate every day or every week and that data can be stored.

So hopefully you don't have to calibrate for every patient. But again, your user manual will explain what your specific equipment supports. Whichever method is done, I highly recommend that you confirm the equipment is either already calibrated or set up for calibration before your patient comes in for their appointment. There's nothing more aggravating than getting your patient all set up to run real earth and then you see the equipment prompt you that calibration needs to be completed and you gotta disassemble everything.

So once your patient is positioned, it's time to insert the probe tube, which is used to measure the response of the hearing aid at the eardrum. I always recommend doing an otoscopic examination before inserting the probe tube. Even if you've already done it earlier, this just helps you get that lay of the land as far as the ear canal is concerned. Make sure there's no cerumen that you need to take care of before putting the probe mic in or anything of that nature. Cerumen can plug up the probe tip very easily, so if your patient has some that you feel can be removed, go ahead and do that.

You will hang the external microphone over the ear and the probe tube will be attached to the little box. And you'll need to put the probe tube into the patient's ear. It is recommended that that probe tube sits between 2 and 5 millimeters from the eardrum to avoid standing waves. So to help you with insertion, that probe tube that ships with your equipment should come with a little black marker around the tube. And this indicates a pre measured certain amount.

So generally speaking, the marker should be placed approximately 28 millimeters from the end of the tube for adult females, around 30 millimeters from the end of the tube for adult males, and then approximately 20 to 25 millimeters from the end of the tube for children who you're able to get to sit still long enough to perform on ear measurements. Your probe tube packaging may also have a measuring tool included so that you can very quickly and easily measure that correct length. Once the black marker is measured, you can insert the probe tube in the ear and generally that black rubber piece

should be sitting at the inner tracheal notch. Now, it's very important to be careful when inserting the probe tube and to make sure it doesn't slip in deeper. When you put the hearing aid, that ear mold or earbud in place, it already is sitting pretty close to the eardrum, so it doesn't take much for it to slip in deeper and poke.

So I make sure to hold the probe tube in place when I'm inserting the device. I also want to share a few other tips while we're on this topic. Some patients may start to cough seemingly out of nowhere during the probe tube placement. This is due to a nerve that runs through the ear canal. So sometimes the probe tube can irritate the nerve as it's being inserted and it can cause your patient to cough.

So just be forewarned for that. Other patients may experience some tickling with the probe tube insertion. They may be a little bit jumpy. So just again, all things to be aware of and ensure you have a good hold on that probe tube. The one other thing that I want to mention here is that sometimes with that Probe probe tube inserted the ear mold or the hearing aid may be a little bit too tight of a fit and it could potentially pinch your probe tube so your measurements won't be accurate.

In these cases. If your fit is too tight, it is okay to put the probe tube through the vent if there is one. After the measurements, be sure to dispose of your probe tube as they should only be used once. It's very important you use a new probe tube for every single patient and if you're ever unsure if one's new or not, maybe your colleague has some loose ones laying on the counter. I would just be safe and toss them and start fresh.

So next you need to choose what stimulus from the list of options your equipment provides. I do recommend using a speech stimulus, so here are some of the more popular stimuli available that are intended to represent the average speech spectrum. I often use the ISTS or that International Speech Test signal for real your aided response. This was developed from recordings of six different female talkers reading the same passage in different languages. So those languages are American, English,

Arabic, Chinese, French, German, and Spanish.

The segments of speech were then spliced together and filtered to match the average female spectrum. I use ISTS for the rear because it has a certain dynamic property that makes it very similar to real speech. The ICRA stimulus comes from the International Collegium of Rehabilitative Audiology and it is a distorted speech signal which is a random type noise modulated by real speech. And then we're probably all very familiar with the carrot passage, but this is a 10 second long audio recording that, well, tells a story about a carrot.

And then it's also a good idea to go into your programming software and adjust the hearing aid settings depending on which real ear measures you're running. While REAL Ear systems should be compatible with all forms of hearing aid processing, it's recommended to limit signal processing during the testing. So for rear, I set the hearing aid to be omnidirectional mode and I turn off noise reduction features and even the feedback canceler if possible. So pretty much any adaptive features your hearing aid manufacturer has turned on should be turned off for the purposes of Real Ear. This is just to ensure that while unlikely, the hearing aid isn't doing something to the stimuli that would alter the response and give you inaccurate data.

The way these advanced features work can alter the frequency response of the hearing aid in different situations, so you can get as close to possible to see ideal gain and output of the device without the influence of these advanced features. So turning these off for verification gives you again that really good starting point to determine what the device is truly doing in the ear. I'm going to go into this a little bit more later on in the talk, but if you do use Starkey's integrated real ear target match system, we automatically do all of these things for you while you're using it.

And then you also want to ensure that the input levels from your fitting software match or are approximate to the levels you're measuring with your real ear equipment. So, for example, let's look at

Starkey's profit software. Our profit default response curves are 50, 65 and 80 db spl. So therefore, when using a real ear system, we would want to run each curve at these same levels. If your real ear system doesn't have the same levels, then feel free to change these to the level that most closely matches.

Typically, we want to measure multiple levels to again ensure soft speech is audible, average speech is comfortable, and that loud speech is loud but not uncomfortable. Running an MPO curve or that maximum power output will also help ensure that the hearing aid output will stay at or below your patient's ucla. If you didn't measure ucls during the hearing aid test, your real ear equipment may have an option to use average or estimated values.

And then the final setup step that I always recommend doing is instructing your patient to remain quiet and still. We want the most accurate data possible so we don't need other inputs coming through the hearing aid other than our chosen stimuli. And we don't want the probe tube moved from its position. I always let the patient know that they're going to be listening to a speech signal at different volume levels, and all they have to do is sit still and look straight ahead. Now, because our patients have experienced hearing aid tests before, they may be apt to repeat back what they're hearing.

So I like to try and remind them that they don't need to repeat anything back for this and they don't even need to be understand what's being said. This is especially true if you're using the ISTS signal. As you know, some patients are more sensitive to louder sounds than others. So I do always let my patients know that if at any time a signal gets uncomfortably loud to just raise their hand and I'll stop the measurement. I've had this occur during my loud measurements and sometimes with my MPO measurements.

So we could either change the level of the loud stimuli so it's a little bit softer, or we could choose not to run it at all. That's going to be based on your clinical judgment. Generally speaking, though, I've never

had much issue getting all of the measurements that I want in.

So we've talked about setup, we've talked about terminology, and we know our goals of real Ear. So let's look at running that speech mapping on a VeriFit system or a VeriFit 2 system and then how you can interpret the information that you gather. So selecting speech mapping on the VeriFit 2 will bring you to a screen that looks very similar to this. Now, to keep things easy to see, we are looking at the left ear, but you do have the option of seeing both sides if you want to. These screenshots that I'm using on the next couple of slides are pulled from the Verifit user guide and they do have NAL NL2 targets selected.

So just a heads up there. So enter your patient's audiogram manually and you would select audio. You would select audiometry in the upper right corner. So this is where you would also want to select the fitting formula and a few other items that you want to set up. If you have the ability to transfer the audiogram via your fitting computer and the audioscan module, then those thresholds can be transferred, but you would still need to go here to select your fitting formula.

When it comes to selecting the fitting formula, you need to think about your setup in the hearing aid software as well. So for that true apples to apples comparison, the fitting formula should be the same in both, which would necessitate you away from fitting a proprietary fitting formula since those are not accessible in standalone real ear systems. If you're wanting to use E stat 2.0 as your fitting formula of choice, I would recommend not selecting any targets within your real ear system and again instead focus on your aided versus unaided SII scores. When using NAL1 or NAL2 targets, you will see some variances within the higher frequencies, and this is to be expected due to the slight difference between the fitting targets. Targets were created to give you the professional guideline on how to interpret the appropriateness of the hearing aid output, but these are average statistical values, and it's perfectly okay if what you're seeing in the patient's real ear deviates from them.

So the ultimate thing that you're trying to achieve is to ensure audibility and ensure that the output limits are comfortable for your patient. So comparing the rear to the patient's audiometric thresholds and their UCL values will help you achieve these goals. Whether you're using Targets or not.

Now, there's a few things I want to point out on this screen, and that's where we see the numbers 4 and 5. Within the speech mapping display screen, the predicted unaided and aided SII or speech intelligibility index scores appear for each of the tests that you may be doing. So for ease of the understanding, the verifit displays these values as a percentage. So the predicted unaided SII is represented by number five. And you can see that for each input being tested, the aided SII result is going to appear before it, and that's what's number four.

And then it appears after you run each measurement. So for this screen example on test one, where the input level is 50 dB, the predicted unaided SII is 9 and the aided SII right below it is 39. So as you run real error measurements, you can see pretty quickly and easily you can see how your SII scores and you can relate it to their predicted speech intelligibility. Now, as I've mentioned earlier in the talk, if you're wondering what SII to shoot for, it's worth to try and get as close to 70 for a conversational speech level. Because up until that point any improvement in SII will have a positive impact on word recognition.

But if you're trying to push past 70, word recognition scores start to level out. If your SII is near at or above 70, there's no need to adjust and you're ensuring that you're hitting close to maximum speech intelligibility for your patient.

So when running real ear, you will see the aided speech banana appear, showing the peaks and valleys of the long term average speech spectrum. And then you see the aided curve is that solid line which is the output of the hearing aid at the eardrum. The blue line is your patient's audiogram in spl. For the right ear it would be red and it's flipped based on what you're used to looking at. On a traditional

audiogram, everything above the line is audible, everything below the line is inaudible.

Now you'll notice here that there are four play buttons that you could press. Generally, when people are running real ear with a speech stimuli, they're interested in seeing multiple loudness levels like a 50 or a 55 for soft speech, an average speech which is around 65, and then a loud speech level which is around 80. Once you hit play, you will have the option to select your input level. Usually I like to start with the soft level as a first test, then do average Then do loud. Each curve is going to be a different color, so it's very easy to tell the differences between them.

Again, I try to match up my input levels I'm selecting on my real ear system with what I'm fitting in the hearing aid fitting software. So if my software is using 50, 65 and 80 as their soft, average and loud inputs, I'm going to try and make that match on my real ear system as well. Once you see your real ear aided response curves populate, the goal here would be to increase or decrease gain of the hearing aid in different frequency regions to either match the selected targets for each input level or to ensure audibility. The image on this screen here is a perfect match for NAL2 targets. But generally your goal is going to be to try and get within around 3 to 5dB and again keep your patient's comfort in mind.

If you find that increasing gain to match target is uncomfortable for your patient or feedback is occurring, it may be best to stop where you are. The best hearing aid for your patient is one that they're actually going to wear. So doing real ear and matching the targets is a fine balancing act between comfort, audibility and sound quality. Keep your patient's comfort in mind as you do that, especially as you get into these louder curves.

Generally, it's best to run your three different speech levels at varying intensities and then run an MPO curve to again ensure that that maximum output of the hearing aid is not encroaching on your patient's UCL levels. If you don't enter UCL data, the real ear software could potentially estimate UCL values for you. So on this visual, curve number one is the MPO targets that are automatically generated. And then

curve number two is the UCL levels. Curve number three is the measured MPO curve, and I do highly recommend running this curve last.

Your goal here is just to ensure that MPO is between the loud curve in magenta and the patient's UCL values. Running an MPO curve is a great opportunity to get the patient involved. When you're presenting that sweep, you can instruct the patient to raise their hand if any of the sounds are uncomfortably loud. That will clue you into whether or not you need to reduce their MPO in certain frequency regions within the fitting software. Curve number four is the moderate speech curve, which for this purposes is 65 dB spl.

Curve number five, which is the green one, is that 50 dB curve. And then curve number six is the audiogram in SPL for the left ear. So now that you're prepared for what you're going to see, let's take a look at what real ear measurements look like. So for the example that I'm about to show you, the audiogram that we're going to be using moving forward, our particular patient has a moderate sensorineural hearing loss bilaterally.

So at the initial fit, I recommend setting the device to its initial fit response programmed by the hearing aid manufacturer's fitting software and running initial measurements just to see how close you are to targets. So I'm going to show you a quick little video of this in action so you can see how to run that initial soft, Moderate, loud and MPO curves on a VeriFit2 system binaurally around them.

So I recommend that while you have the patient set up for real ear measurements, you also have the hearing aids connected to the fitting software. So that way you can make the adjustments for the hearing aids for each input level in the fitting software and rerun your measurements. You can always do this while the curves are running before finalizing your measurement, but sometimes it is easier just to see how much of an adjustment is needed. So you can capture those pre adjustment curves and your post adjustment curves and then rerun. You know, to feel free, but feel free to do it.

However, it works best for your system and your office flow. So my goal when trying to match to target is to maintain within a 3 to 5 db of target. And I'm specifically looking at that 500 to 4000 Hz frequency range. Get as close as you can, but again, keep your patient's comfort in mind.

So one thing I want to point out is I'm sure you saw in the video there was this little mant that kept popping up. That was Verifit's binaural sound filled assist feature. So essentially, I had my Verifit system set up to run both ears at the same time. And the verifit is going to tell you when your patient's head is not centered to the speaker. So it guides your patient to let them know they need to move either to the left or to the right to recenter themselves.

Once they're recentered, that test resumes automatically, as you saw. Now, if you choose not to recenter your patient, or maybe they can't, you can skip this and then the verifit will just run each ear individually. Now, that's not the focus of today's talk, but I just wanted to share it with you in case it pops up. If you use this machine so now that I've matched my targets, let's take a little bit of a closer look at the speech intelligibility scores that the verifit predicted. So we see that those unaided SII scores, and they're probably pretty low what you would expect.

Then after running the measurements, we see our pre adjustment scores. We got a little bit better. This is now with the hearing aid on and in place, but no adjustments made. Then after we make adjustments to better match to target, we see a further increase in SII scores. Now keep in mind here, even at target, we still aren't reaching a 70% SII score at soft and average inputs.

The goal here should be improved speech recognition. And we still need to keep our patients comfort in mind knowing that these are just a prediction. And are patients likely going to do better in the real world when they get context clues such as facial cues. So keep in mind with sii, even if your patient has a little bit of a low one, that doesn't necessarily mean that they're only going to hear x amount of speech.

Realistically speaking, we can, you know, all go into a noisy restaurant, hear very little of what is being said, but we can still fill in that message with those context clues.

So you don't necessarily need that 100% value for every single input level.

So to reiterate what curves you typically run when performing real ear measurements or speech mapping, you want to test a soft speech curve, an average speech curve, a loud speech curve, and your MPO value. And then most professionals would agree that shooting for maximum audibility between that 500 and 4000 Hz range leads to maximum speech clarity and intelligibility. So again, our primary focus when we're using our real ear measurements to optimize our patient fitting. So I've mentioned to you many times today that although real ear is a really great tool, you've got to keep your patient preference and comfort in the front of your mind. So, for example, let's say your patient's primary motivation for getting a hearing aid is to hear their grandchildren better.

So during that hearing aid fitting, you're obviously programming the hearing aids and verifying audibility afterwards. If the patient reports that the hearing aid is too loud or too tinny, your first response may be to reduce the gain until your patient is happy with the sound. But if you were to run real ear again with these new settings, you may see something like this where you've decreased gain overall and their SII has decrease dramatically, indicating that audibility may suffer. So at this point, you've got a few different directions that you can take in terms of counseling and adjusting. So you can use the real ear screen to visually show your patient that her grandchildren's voices won't be audible at the volume that they're requesting, and perhaps even explain that her SII score so that she can see for herself that her audibility is potentially compromised.

By realizing these tangible improvements, she may be more motivated to stick with the original gain setting or be pushed to try and acclimate. Or maybe you need to work to find a middle ground, still provide some adjustments, but maybe ones that weren't so aggressive and encourage your patient to

try those. Or maybe in the end you're going to end up going back to those preferred lower gain settings. But now you and your patient have realistic expectations. So the patient knows they won't have access to all of the speech sounds because you're giving them less gain.

Whatever it is, you've been able to demonstrate the hearing aid benefit both to yourself and to your patient, and you're working to keep them satisfied. I also want to point out that these real ear curves are not the end all, be all. Hearing aid counseling is extremely important, as well as how you otherwise have the hearing aid programmed. So maybe you can encourage the higher gain setting, but give your patient a volume control. Or maybe see how they do in a different hearing aid program with lower gain settings, and they can flip back and forth and compare, you know what they need, or maybe just use the louder one when they're with their grandkids.

Or maybe this is opening up counseling and candidacy for a hearing aid accessory. So there's a lot of different things you can do with this information.

Now, I've talked a lot about different real ear curves, but you can also use your real ear system to verify your cross and bicross fitting. I'm going to go over these steps very briefly, just in case you do any of these fittings in your clinic. So, for a CROs system, the idea is to first measure the response in the better ear. So you would have the reference mic and the probe tube all in the better ear. With the speaker positioned on that side.

This response should pretty much look like a normal real ear. Unaided response. If not, that patient's ear canal may not be fully open. Next, you want to move that reference mic and the speaker to the poorer ear, but you want to keep the probe tube in the better ear. So the measurements from the first two steps should be pretty similar.

If not, adjust the cross system and repeat Step number two. Until that poorer side measurement matches the better ear measurement obtained in step one. The final step is to position the speaker directly in front of the patient and check for a smooth response in. An irregular response may be the result of reflections from nearby objects or it may indicate a phasing problem in the hearing aids. So this is a quick visual of what this looks like.

And again, all measurements should be conducted with the same stimulus at the same level. Steps one and two curves should be pretty close to each other. Step three should be consistent with your previous measurements as well. So again indicate that everything in the system is working as intended.

Here we have the verification steps for a bicross system. So the first step is to have the reference mic, the probe tube and the speaker on the better ear side and make the measurements with the bicross system. On following the measurement, you would adjust the frequency response to approximate the real air targets. The next step is to keep the probe tube in the better ear, move that reference mic and speaker to the poorer ear and measure again. These steps should approximate what you get in step one.

So again, here's another visual for that. We do have this as a quick tip guide as well if you want these visuals for usage in your clinic.

So now that we've talked about how to run and interpret your different real ear or speech mapping curves, let's discuss some different scenarios of how you could potentially integrate using real ear into your normal clinic flow. So verification and validation are both very important parts of the evidence based practice for fitting hearing aids. Real ear measurements are an excellent tool so you can objectively measure what the patient is subjectively reporting. So I've mentioned previously the importance of taking patient comfort into account when programming, because again, the best hearing aid for your patient is one that they will wear. So doing real ear and matching to target are that

balancing act between patient validation as well.

There are many different types of verification techniques that are available to us as hearing healthcare professionals. The most comprehensive and efficient verification measures have proven to be real ear measurements and an objective measure of the patient's audibility to discriminate speech and noise. But here you can see other types of verification that could potentially be used as well. But for this talk, we're primarily focusing on real ear and speech mapping measurements today. So typically a hearing aid first fitting appointment follows this general flow.

You go over the different paperwork associated with the hearing aid, you fit the devices, you counsel your patient on how to use those devices, you validate them, and then you schedule a follow up appointment for either one week or two weeks out.

Working with average numbers, most fitting appointments are scheduled for an hour. From that hour, roughly 30 minutes is spent counseling your patient. This leaves you about 30 minutes split between the actual fitting and all of those extra things that you need to do at fitting appointments, like pairing accessories, setting up your patient's phone or other, again, other things. So typically when you're initially programming hearing aids, you allocate around 15 minutes for that so that you can run feedback, adjust the aids for patient comfort, set up any user control, set up any programs that they want, and demo the indicators that they may hear while actually wearing the hearing aids. So running real ear can easily fit within this time slot as well.

On average, real ear can take around 10 minutes to run. But if you have your real ear system set up in the same space as your fitting software, you can do both simultaneously. Having the patient set up for real ear while also having the hearing aids connecting to the fitting software really streamlines this process for you. Plus, if you have calibration and the setup done before the patient is in the room, I. E.

You already have their audiogram input into their real ear system, you've done calibration, you have the test and ready to go. Short of putting the probe mic in their ear again, this saves you even more time when you're live with the patient. So if you're looking to add real ear into your flow, it could look something like this. Run your feedback cancellation initializer first, then run your real ear, then move through your normal fitting routine from there. You could also potentially run real ear at that follow up appointment versus running it at the first fit to give the patient time to acclimate to the hearing aids for a week or two before trying to get them to that full prescriptive fitting.

At that initial visit, look at the different timing of your appointments and think about where it makes the most sense and has the best flow to plug real ear into your office. So when you are fitting a device, running feedback is often one of the very first steps of the fitting. If and when you run feedback, you see that there could potentially be feedback potential due to the curves that you've attained. So you may determine it's best to change the acoustics of your fitting to eliminate the feedback risk. So in doing that, it's important to make sure that the acoustics that you have in the software match what you have selected on the device and you want to run real error measurements with the actual fit acoustics.

Now, Profit is going to update your fitting targets based on the acoustics that you have selected, so again ensure those are accurate within the software. With your new acoustics, you can rerun feedback and ensure that feedback potential is eliminated anytime you're switching acoustics or if you remake a custom ear mold. Rerun your Real Ear measures to make sure that you're still meeting targets even with your new shells. If you're changing device styles, rerunning Real Ear measures is equally important as well. So say you initially fit and verified the patient with a custom device, but ultimately they decide to move forward with wearing a rig that is a completely different acoustic configuration with different fitting targets and therefore you need to re verify your Real ear curves for this new fitting.

If there's a 10 decibel shift at two or more frequencies, then that's considered a significant shift in the patient's hearing and this results in you needing to reprogram the patient's hearing aids. I would also recommend that you input that new audio into your Real Ear system and rematch to these new fitting targets using again a previously discussed Real Ear protocol. Doing this adds value to your service because it shows you are truly updating the aids to meet the patient's new audiogram. Now, some clinics like to do Real Ear every six months to ensure that the hearing aid is still meeting specs and still meeting audibility. If this is something that you're looking to do, you can either use the patient's SII score or use those selected and preferred fitting targets to ensure that this is happening.

Not everyone has time to run really or every six months. So if that implementation doesn't work for you, I do recommend though at least doing it when there is a significant threshold shift. And then you can also use Real Ear as a validation tool for patient complaints. So if we remember earlier in the talk we discussed that that patient we were seeing, they wanted to hear their grandkids better, but we said but setting those aids to their prescribed targets was much too loud for them. So you can use Real Ear to help the patient visualize that you turned the hearing aids down to where it's going to provide them the most comfort that they're seeking.

But you can also use Real Ear to look for weird peaks or valleys that be leading to specific patient complaints that you may not have been able to fine tune out of the hearing aids. So using Real Ear at follow up appointments is really great because Real Ear can either prove or disprove that there is an issue and this allows you to know what your next step needs to be as far as fine tuning and Counseling and we've talked a lot about Real Ear so far. But I do want to hit a few features within the Profit software that it can assist you with verification. Either maybe you don't have a Real Ear system or you don't have time for the full Real Ear setup. So speech mapping is a tool within Profit that allows you to see what the hearing aids are picking up from the environment.

It's similar to Real Ear but there is no probe mic so you are relying on information from the hearing aids alone. Speech mapping is available through that Quick Fit or fine tuning screens or it's on that fly out menu. The Pause button is going to pause that live input. The Record button is going to take a 10 second average recording. You can also use that camera icon to take an instant snapshot of the input within the hearing aids.

If you have multiple captures, you can choose which ones you don't want to visualize anymore or maybe delete the ones that you don't need at all. From the flyout menu you have full access to the capabilities of speech mapping. So this is the view that you would see in the software accessing it that way. Verify Comfort is also a tool within the software that is similar to MCL and UCL Data. Again, through the hearing aids you're going to run a sweep of beeps at 50dB to ensure soft sounds are audible and then you're going to run a second sweep at 90dB to ensure that loud sounds are loud but not uncomfortable.

You can pause the sweep at any time to adjust the specific frequency up or down as needed and these changes will apply to your hearing aid frequency response automatically. Now this is a monaural test, so if you do use it, you do need to run the right ear and then you also need to run it in the left ear and you'll do those individually. The last tool I want to discuss is our integrated Real Ear Target Match. This is a fantastic tool that allows you to run your speech mapping curves without ever having to leave Profit. So Real Ear Target Match is fully integrated into the workflow via our Real Ear Target Match wizard and it follows a very simple four step process to achieve matching targets which allows you to seamlessly incorporate this into your fitting.

This will also allow you to truly match to estat 2.0 targets since it's integrated within the Profit software. In our initial study of Real Ear Target Match, we wanted to compare it to true traditional Real Ear measures. So you can kind of see the setup of our study here. And what we found is we were Looking

at timing and we were looking at accuracy, we found that using Real Ear Target Match wizard, you can complete real ear curves in under 5 minutes when compared to the almost 10 minute average of doing traditional real ear. So we know we can complete it quickly, but how accurate is it?

So when looking at SI that SII for different styles of hearing aids, different input levels, and again, traditional versus integrated, we found that whether we fit to targets using traditional manual real ear methods or using our real ear target match, both measures were accurate and provided comparable audibility. So but you're still able to do real ear target match in about half the time. So you should feel confident that this feature is not only quick and efficient, but it is accurate as well.

So to wrap up today, again, let's think about our timing allocation. Real ear measures can perfectly fit within your hearing aid fitting if you combine it with the time that you're already in the software to program the hearing aids. So verification and validation are both an important part of the hearing aid fitting process, and real ear verification can fit within your flow with a minimal shift to your normal fitting procedure. I hope I've given you a good amount of starting information so that you can begin the process of integrating real ear into your fitting flow today. If you're kind of looking for a sort of cheat sheet on different real ear protocols for your Starkey products, consider this hierarchy first.

I can't stress using the real ear target match as much as possible so you can fully match your fitting to E stat 2.0 targets. But if you're a big fan of traditional real ear measurements, then consider not selecting any targets in your real ear system. Setting the hearing aids to E stat 2.0 in the software and then compare your aided versus unaided SII scores to maximize audibility. If you're more comfortable with targets to match, then set the Hearing aids to ESAT 2.0 and set up either NAL or NL1 or two targets. But you're going to see some variability in the high frequencies.

So real ear curves are great, but you got to balance your patient's comfort with that. You can use your real ear system in so many different ways with your patient and it can really bring great value to your

clinic and your hearing aid fittings. I didn't have time to get into all of this today, but Real Ear can also be used to verify advanced features in the hearing aid like your directional mics and your telecoil. So this is a really great tool that can bring a lot of benefit to your clinic. I have thrown a lot at you guys today and I thank you for taking the time to sit with me.

I hope that you feel more comfortable with real ear. But if you have got any questions, don't hesitate to reach out. Thank you guys.