Seminar in Applied Probe Microphone Measurements
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- Welcome everybody and thank you very much for being with us today. My name is Anna and I'm the Education Manager in Inventis. So a new year has begun and with it, the appointment with the scientific delegation promoted by Inventis Academia. The Academia Agenda 2023 is full of event directed to all those interested in disorders and pathologists of the hearing and balanced system, and managed by international respected experts. It is a real pleasure to have all of you here today for this fantastic course on Real Ear Measurement, organized by Inventis, but completely conceived by Dr. Jay Jindal, Consultant Audiologist at Audiology Planet. And lovely Nicole Da Rocha, Business Developer at Advanced Bionics. Thank you very much Nicole and Jay for accepting our invitation.

Thank you. So "Seminar in Applied Probe Microphone Measurements." The seminar will cover the scientific principles behind the probe microphone measurements as applied in hearing clinics. We will briefly discuss the theory and go through how the probe microphone measurements are performed in the clinic. So as usual, I strongly invite all of you to write down any questions in the space provided that you could see on the screen. And keep in mind, that your contribution is fundamental for me. It's fundamental to expand the borders of Academia. For this reason, after the event, you will receive a survey I kindly ask you to fill out. The survey will help us to understand your needs, to get your ideas, in order to provide the best educational support ever. And now, I leave the word Nicole and Dr. Jay Jindal. Enjoy the webinar.

- Thank you Anna and thank you Inventis for asking both of us to do this webinar. I'm Jay by the way, and this is Nicole.

- Hello.

- Not the other way around, I think you probably guess. And we're also grateful to Puretone for providing this beautiful facility here for us to organize this session for you

guys. It's delighted to be talking to you and hopefully, this session will be as engaged as Nicole and I have planned it. And hopefully, you will take out some key learning points which you can use in your clinics tomorrow, day after and forever. So, Nicole.

- Yeah, definitely. It's so nice to see you guys and happy 2023. And I think Anna, you prepared some poll questions just for the beginning 'cause we are really interested in who's on the call right now. So Anna, if you don't mind to launch the poll, the first question is asking if you are currently using REMs in your daily practice? So it should pop up on the screen. Here we go. And if you can just type in yes or no and remember there's no judgements here. Just let us know, how many you currently are using REMs? So thank you, we can see the votes are coming in. Very good. Couple more seconds. Yeah, that's good. Right, so we'll close the poll now.

- 60/40, I think that's pretty representative of the general tendency in the clinics and we are really glad to talk to both who come in the 60% as well as who come in the 40% of this. And I'm hoping the ones-

- It was 60, no, 60/40, yes. So 60% of you that are on this call are currently not doing REMs. So you're brand new and that's so exciting because I hope that you can see some exciting stuff and we can give you good tips. And then 40% of you are saying yes, you are using it, right?

- And if you're using it, can you put down which instrument do you use to do Real Ear Measurements at the moment? Oh, wow, a lot of Inventis users.

- Nice, here we go, Anna. Good, Inventis users on the call today. IA stands for Interacoustics and Natus is Natus Otometrics, so Auricals.

- Very good, so half of you are actually using Inventis. So most of the stuff in these slides will be copied from Inventis screenshots. And hopefully you'll get a good value out of those screenshots, understanding what you might not be aware at this moment in time. So that's great, thank you very much for filling that in. Our idea today is that we are going to spend about a couple of hours. The first part is just theory and once we've covered these slides that we have to, then we will cover some practical bits as well. Between vary and practical, we might, if you're very good with us, we might decide to give you five minutes break. The first slide explains what we are going to cover and that's basically all the W questions.

And you know, you could add where and when in that as well. You do Real Ear Measurements every time you do a hearing aid fitting. Now I know that some audiologists will decide to do it in the follow-up appointment, not in the first appointment depending on how much time do you have in the first appointment. Some audiologists will do it like I do at the very first time they're fitting the hearing device to the patients. So basically, the idea here is that we want to project real ear measurements as the starting point for the hearing aid fitting process. And by no means it's end all and be all. So this is not an itself is the hearing aid fitting process, which involves verification, need assessment, validation, and ongoing care really because that's where most of the hearing aid fittings fail when you do not provide the ongoing care that people need to be able to fit the hearing device, not to their ears, but to their life to improve the quality of life.

Anyhow, so here we're just going to focus on how to verify the hearing devices when people are using the clinic come to you for amplification. And in that, we will discuss why it is important in the first place to do real ear measurements and how do we do it and what do we get out of it? And hopefully it will all make sense in the coming hour. Right, before we carry on, I just wanted to introduce the idea of this guidance that British Society of Audiologists have in UK. Guidance on the verification of hearing

devices using probe microphone measurements. Not because I helped write it, but I would really strongly recommend for you to go through this guidance.

This was scrutinized by members of British Society of Audiology here in UK, which means that every single line has been looked at of this guidance with scrutiny by great researchers, great clinicians, which we all admire here in clinical practice in UK. So the end product, which was a mixture of what I and Anne Marie thought about how the practice guidance should look like and is a combination of what BSA as well as other stakeholders within the audiology profession thought, will be a good practice for people coming into the audiology clinic when you're trying to verify the hearing devices. So it's quite comprehensive and it covers pretty much everything that you need to know. Some of that stuff we'll cover today. So why do we consider adding REM to the practice?

- Right, so whenever we talk about the why, I like to use an analogy. And all of us as audiologists, you can also think of us as pastry chefs and it'll make sense in a moment. So you've gotta come to a person who's coming to you with difficulty in hearing, difficulty in hearing speech and noise. And we, as audiologists are going to create the recipe for this user. So you're gonna put them in the booth, you're gonna measure just the right, you know, thresholds, do their measurements, do your speech discrimination measurements. And what we're creating is a recipe. REMs helps so, so much with that because doing REMs is almost like having that recipe and that scale just so that you know the right amount of grams of butter, and the right amount of grams of flour to create the best tasting batter for this individual user.

Now a lot of us as audiologists sometimes stop there. Don't forget that that ear is attached to a whole person. And once you've created the good batter from your excellent testing and your excellent recipe-making with the REM, remember that that user is going to have to wear the devices and this is what I described to our patients as

the oven part of the process. So getting the brain reacclimatized to hearing sound, it's also very, very important. So that's exactly what Jay was saying earlier. Today, we're gonna talk to you about ingredients and making the right recipe and the scales to make that right recipe. But don't forget about the oven part of the process, the listening practice techniques.

And then the last part of this analogy is your user's tasting the cake, that's gonna be your validation techniques. Your questionnaires, finding out functionally how are they performing with those aids out in the real world. But today we're gonna start with the recipe, how this recipe is created and the great scales of the recipe.

- That's brilliant. And I guess one of the most important factor for any business or any clinic, government to private is whether you can be consistent in approach. Just like if you go to a cake shop, you don't want a Victoria's Sponge to be tasting brilliantly well one day.

- Exactly.

- And really rubbish the other day. And unless you can put some science into that art of fitting the hearing devices, you will not get that consistency that you require for the outcomes and the data supports that. So when we deal with people in the hearing clinics, we're dealing with lots of variabilities. Not only in the personality of people coming into you, you know, changing people in changing environment, but within the ears that we're dealing with. There's lots of variables that we need to consider before we decide what's a good fitting going to look like for that particular ear. All human ears are uniquely shaped and you know, if you look at some of the research available, they're talking about using human ears as fingerprints.

You know, because they're so unique to one another individual. So my ear will be very different than even my family members, let alone be with my friends and so will be yours. And we know that the shape and size of the ear will help the sound to be funneled in into the ear canal and that's what will give us the eardrum, the SPL at the eardrum when the sound is funneled in, in a proper way into the ear. And if the shape is different, the sound will be funneled in differently a little bit. Then the human canal, this brilliant data and graphs from Waynes Staab, will have different apertures, different ear canal volume, different diameter, different length.

They're not same, they're all very different. And that difference you can note if you do it tympanometry in your patients, so you know, adult ear canals are never 2cc as we read in our books that the average canal volume is 2cc. And in fact, I note that number quite vigorously and have been for last 10 or 15 years and I can hardly remember 10 patients whose ear canal volume be exactly 2cc, it will always be either less or more than that. So between us, we probably would've seen about 10,000 people all the time-

- Probably.

- Right, and I'm sure that you share the same experience and remember, the pressure generated in the ear from the sound will be equal to force divided by the area. So it's actually inversely proportional to the volume. So if the volume is bigger, the pressure is lesser for the same sound, 50 dB will sound differently in different ears. So if it's a child, the 50 dB will be much more because of the smaller volume, and for adults where the volume is higher, the 50 dB we will be slightly lesser, right? So all these variations in anatomy will make a difference. Eardrum compliance seems to make a difference as well as much as of 6.5 decibel,

- That's amazing.

- you know?

- So, and we can go on, acoustic coupling, so, you know, whether you have a one millimeter vent or two millimeter vent, or three millimeter vent, that can make a huge difference from seven-ish, eight-ish dB to 28 decibel of difference at a low frequency.

- Yeah, I love the study. Thank you for this one 'cause I was so fascinated by it 'cause I didn't realize, gosh, just increasing the size by two millimeters you've got complete decibel. 28 decibel reduction, at 2k, that's insane. So we're dealing exactly this. We're dealing with signs and minute changes. Those tiny changes in ear canals and in molds can make big differences for your families and for your users. Thank you for the study, I loved it.

- So the fact is that, you know, if you consider this is the eardrum which is receiving the sound, the sound is coming from the hearing device. So the amplified sound, the direct sound if you're fitting open fit devices with small domes, et cetera. So some of the sound is coming into the ear through that. And your own bodily sounds are coming through bone conducted sources as well. So the resultant eardrum SPL is dependent on so many other factors, not only what you're sending to the hearing device. And you have to take that variation into account in each and every fitting so that you can send the eardrum pressure level to the eardrum which you initially set out to send, meaning, your target level or your prescription level of the amplification.

And then depending on whether you've used the TDH headphones or ER3A earphones, the sound will be different in different ears, as much as 36 decibel of difference in some ears with the TDH and 29 decibel of different in some ear with ER3A earphones. So what do you use to measure your PTA can make a difference in how well the sound is sounding. And if you are a fan of LDL, Loudness Discomfort Levels and measuring MPO in the hearing devices, which we'll go through, then you must

know that the intersubject variability in LDL is also huge. So that lots of differences up to this point in the anatomy and the way that we actually measure the hearing.

But beyond that too, when you look at what you've set out to achieve from a manufacturer of one particular hearing aid, so let's say if you try a product A, the target generated by product A will be very different from the target generated by a product B from a different manufacturer. So NAL-NL2 fitting that you set out to achieve in a ear, will not be exactly the same across different products.

- This is wild to me. I mean look at hearing aid four. So there on the graph hearing aid four, the difference in soft from hearing aid four to the NAL prescription target to the recipe. So if you think back to that cake, you're gonna get a very different fluff of cake if you use the prescription target for hearing aid for then what NL2, the recipe is telling us to use. And I think this is a very pertinent point, Jay because as we're all audiologists and as we go on we know that hearing aid, and click in thirds and automatic REMs are becoming more and more prevalent. But there's something about these unique shaped ears that you cannot, no matter how advanced we get in terms of measurements and automatic measurements, you are the clinician, you are the one that's going to take into account all of these differences.

- So I think, you know, in the past, like at least 10 years ago there used to be a debate whether REMs are a good thing or not good thing. And I think it is just beyond that whether it's good or not. You have a patient sitting in front of you who has an X amount of hearing loss and you decide that is going to have 35 plus X of gain or amplification in his ear or her ear, for that matter. And that's what you think that you've given to that ear, whereas there's so many variables which will affect what you have actually given to that patient in that ear. So you're really shooting an arrow in the dark, when you're just relying on what's written on your software, what's written on your computer screen and not actually verifying within the ear.

So the way that I put it to my patients is that look, I'm going to use this probe-mic, is a microphone that I'm going to put in your ear with a hearing device that will tell me how much sound is there in your ear. And from the computer, I know how much should be there so I can match the two. And you know, it's as simple as that. This is what you're there to do. Otherwise, if we had to rely on the computer software, there're much better software than how the human brain works which can do things on its own. And I don't know whether you've been following ChatGPT which can do marvelous thing in the artificial intelligence.

It can actually write the whole degree of audiology, if you ask it to write. So you know things like that will be available very soon. And whether we're making ourselves redundant basically by not doing the right thing and following the science properly along with the art of making somebody to hear better and making a difference in the quality of life. But this is a great article and I recommend all of you to go onto this article on Hearing Review website and thank these researchers who've actually put it on there and have a look. Right, we should move on the nitty gritties of it.

- So now we're gonna talk about the how. So earlier, I was talking to you guys about cake, right? And there's different recipes for cake. So we have amazing recipes that we've known. It's tried and trusted and true recipes to fit hearing aids in adults and in pediatrics. The one for adult that's most widely used is the NAL-NL2 prescription formula. This is the National Acoustic Labs down in Australia. They've done immensive research, they screened, I think the initial one, they screened 174 ears and they looked over preferences as well. So to make this recipe for NAL, they did all of the screening of the ears various between males and females. And then they also did questionnaires to look at preference levels.

So they were weighing up what we do in audiology all the time, comfort versus audibility. So your now target definitely, I mean, it has so many years behind it. And the same with DSL. The DSL prescription targets are mostly familiar to you guys for pediatrics. So generally in pediatrics, we use DSL 'cause that is base practice. But just so you know, there is a DSL adult and a lot of clinicians use DSL adult as well, provides slightly different types of gain. But these two recipes, whether you use NAL or DSL, they are trusted and true peer evidenced-based recipes that we've used over the years. So if you were to use, if you are going to ask us what is the best prescription target, these are the two prescription targets that we would recommend. Anything you want to add, Jay?

- Well, the only thing is I think what Nicole said about using NL2 in adults and DSL in children may very UK-specific thinking and approach. And if you're in Canada, you're probably using DSL for everybody. And if you're in Australia, you're probably using NAL for everyone. So and to be honest, over the years, if you look at from where DSL 4 was and where NAL RP was, the prescriptions that I read when I was studying. And where they are now, they're not hugely different. They are different, they're not hugely different. They have a different philosophy, but the actual target are coming closer and closer over the years. And when you look at long-term data, it seems that anybody who has been on a validated prescription target, whether it's DSL or NAL, they end up showing the same sort of prognosis.

Those same sort of outcomes in the end given that their hearing devices are fitting properly in the first place. So I think when you use the manufacturer's prescription target, nothing wrong with that as long as you understand the limitations that they're based on a different philosophy to make sure the retention is more feedback is less. Some of the manufacturer's target will be governed by how the audiologist changed the settings in the first fitting. The patient said it's too tuney, they turn the high frequencies down perhaps and that gets recorded and fed into the software where the

gain will be reduced from high frequency targets, et cetera. So all those variations are introduced in those manufacturers target and I'm sure there's good reason for that.

But it's just that if you are using products for more than one manufacturer, whether you can have a consistent approach to amplification, which will be much more important than the target itself. Our recommendation will be using the validated targets like NAL-NL2 or DSL version 5.0. I like the fact that most of the research that I study about whether the targets work or not, they will have one of these two targets, not the manufacturer's target. Most of the detail that you get in terms of understanding what that target is doing to airborne gap, what that target is doing to the mixed losses, you know, to different sort of ages, whether the formality of language is important or not.

That information is mostly present on these two targets rather than the manufacturer's target which is kept very close to the manufacturers. So you do have to decide to use a target, that's the amount of amplification you will give to that patient in front of you. It's not one-on-one. So it's not that if somebody has a 35 decibel hearing loss, they will get 35 decibel of gain in the hearing devices, which we know very well. So whatever target you decide, our recommendation will be that you use one of these two. Okay, there seems to be a question, can I just go there?

- Yeah, while that patient's coming up just I was thinking Jay, another reason why it's important to use a prescription target is if that patient was to leave your practice or go to another practice, they're comparing like for like and that's really essential, especially in the small world that we are living in now. Patients immigrate, they go overseas and you want that patient to receive the same recipe, the same standard of care. Especially if you think of severe to profound users that have taken a long time to recclimatize to hearing to sound again. So any changes in that recipe is gonna affect the oven part of the journey. And so having that consistent recipe, that same cake as you go along, the better.

- Yeah, I think the question is around whether you can use a manufacturer's target to REM and I think most of the equipment will give you an option to put a custom target in there. So you'll have to physically enter the values.

- Yeah, so I got this question a lot. Yes, if you're in target, you can stay on target, but you're going to use that target software against the recipe. That's the whole point of doing the REM. So in your REM screen you're going to select NAL or DSL and you're going to adjust the manufacturer's proprietary target to the recipe that we know. You can do this for... You can do this for authoring, so if you are using target like target match, you have to select the right NAL to know-

- I think the question is, can you verify manufacturer's target?

- Oh yes.

- So for that, you will have to use a custom target rather than NAL or the DSL...

- If wanted to compare.

- And your equipment will have to be able to take custom target. So you can tell the equipment that I want 50 dB gain at one kHertz or if you talk in responses, response of 90 decibel SPL at 1 kilohertz, your equipment has to be able to tell that. So I think it's very equipment-specific and you perhaps would like to talk to your equipment manufacturer about that. So in this light, I'll just quickly go through the different parts of the probe microphone system. To be honest, they're mostly very similar and two of the main parts are the reference mic D and the probe mic A. So the probe microphone is the one which is connected to the probe tube which goes in the ear, that's the tube, probe tube microphone which will pick up the sounds in the ear canal.

And the reference mic is used to control this amount of sound coming into that system, right? So the reference mic is to tell the system how much sound is reaching to the probe microphone basically, if that makes sense. So we have a scale on most of them and you'll see why the scale is important. That ring is to put it around the ears and I guess we can discuss more once we do the practical aspect of it. And obviously, you need some sort of speaker to deliver the signal as well.

- Test environment. Okay, so there's a lot of new to REM users on this webinar, which I'm really excited about. So when you set up practice, there are some considerations that you need to take in place. This speaker as well as your test box if you, 'cause this is now the to do real ear measures and then you also have a test box that you can use. It's important that they're on a flat surface. So I've seen sometimes in practice that they on a couple of books that can tipple over, it's important that they're on a nice flat and sturdy surface. And by the way, that is why your test boxes are so heavy. I know in the Natus Otometrics one I saw their naked, they pour concrete into it.

And the reason why is that you can't get any reverberation from the movement of that test box. So when you do your setup your practice, you wanna have a space where there's one meter away from each of the walls. The patient is going to need to sit one meter away from this speaker. So that's why I've put that little tape measure on there. It's useful to have the tape measure taped to your desk. So if you have like reseating on these rollaway chairs, you put the tape measure onto the desk and then you measure one meter away, and that's where the patient is gonna sit away from the speaker. And usually when you do that, that's also very helpful because that means that the patient starts feeling like, oh okay, I need to sit in this exact position.

Which is extremely useful when you're doing REMs because you don't want the patient to move or speak a lot. So having that tape measure has really helped me in practice

'cause it sets the tone that this is important, the recipe, the scale we need accurate measurements. The table that you use, you should allow for the patient to be able to adjust. So the seat is usually the easiest like these rollaway seats 'cause you can lift the patient up and down, especially if you're doing pediatrics 'cause they, you know, at different levels, different heights. So you want a way that you can make an adjustment either on the table or on the seat, or both. And like I say, one meter away from each of the walls because you don't want it to be squished up against the wall 'cause what you're gonna get is a reflective surface that's going to interfere with your sound waves.

So when you do set a practice, do take these aspects into consideration. So I did take a picture of what not to do and that's unfortunately, in a lot of public health hospitals, we pile all of our equipment on top of the desk. Oftentimes you know, you've got little space, you've put your headphones to do pure-tone audiometry in front of the speaker. Be careful of what's in front of the speaker. You don't want anything in front of that speaker, but the patient. The noise of your facility also needs to be controlled. And now I'm speaking to audiologists, you guys know the importance of having a controlled environment without so much background noise. We speak a lot about it when we do pure-tone audiometry.

But also take into account that even when you're doing REMs, so even in your fitting rooms, look at the ambient noise and look at ways that you can adjust for ambient noise. So if you're in a very busy clinic, look at ways that you can put noise dampeners on, on the doors as well. Soft closed doors around you because the signal always needs to be 10 decibels above the noise floor, always. So if you have a very noisy environment, you're gonna get failed responses coming from the main speaker.

- Particularly for the softer targets.

- Yes, because you're gonna run at 55 decibel. So you've gotta be able to control your ambient noise as best as you can. And I know this is easier said than done, especially, I mean I'm South African, you can tell from the accent I worked in out the boot of my car for some of our clinics. So I do understand this is really difficult to control, but to get accurate measurements, to get the right recipe, these are things that I want you to take into consideration. Anything you wanted to add here, Jay?

- Just a couple of things. I think most equipment will come up with either a stand or a base mount, which are really good ideas. So even this equipment does, and as I said in the beginning, we're not in the clinic, in my clinic actually, I do have a stand for this equipment which works really well because I can move equipment up and down in order to position it in front of the patient rather than moving them up and down. Which is not always possible because of high restrictions, et cetera. And the second thing is when you're thinking about the reflective surfaces, one of the most prominent reflective surface that's present in every single clinic that you will be in, is actually you.

- Yes.

- So you have to make sure that you don't come in the way of the speaker as well, and you're putting yourself as far away from the patient and the speaker as practically possible for you. So be mindful that you have a body to which will reflect the sounds back to the system. Okay, so.

- This is talking now about room calibration. So when you do do REMs, your software is going to ask you to do a room cal and the room calibration, generally, most practices do a room calibration minimum once a week. But I recommend that if you've had any changes in the ambient noise or if you've moved the speaker in any way, so like Jay was saying, his is on a stand so when he moves the speaker up and down, he's going to have to do another room calibration. So immediately, as soon as you've moved the

speaker, you will need to do a new room calibration. So I don't wanna tell you prescriptively, you need to do this once a week 'cause actually I don't, and like then, you are clinicians, you know if this has moved you're gonna have to repeat your room calibration.

So what you're seeing there, the screenshot is actually an Aurical screenshot, sorry, but it's just to show you the calibration offset. So it's measuring the ambient noise in the room, it's measuring all of those acoustics and then it's got the calibration offset. And then you're seeing how far what that number that you see when it does the room calibration. You're seeing how far these are away from the speaker and it's taking that into account. Now, some manufacture software, if your ambient room noise increases to a certain level where it's going to start interfering, it's going to bring up an error, it will automatically warn you and then it won't let you carry on until you repeat room calibration.

So that's actually very useful. It's not a fault in the software 'cause I had that a few times. Oh, this thing keeps, and then when I looked at the the clinic setup, I saw how noisy that clinic setup was. So this is a very important step that you do need to do.

- Yeah, I think the software is the most idiotic thing that you will use. So it will just give you the result how it's programmed to give you the result. And if there's anything going wrong, it will most probably be something that you will need to modify rather than the software need to do anything differently. So if you buy a new cupboard or even new chairs, et cetera for your clinic, if you rearrange your sound treated room, et cetera, then make sure that you're taking that into account by doing the room calibration. I think there is a another question there. Let's see if we can take it on.

- Yes, the question is, can I do it in my sound treated room?

- That's where you should do it, if it's big enough.

- If it's big enough, that's amazing. You have the luxury of getting you know that space, incredible, yes, definitely you can do it in the sound treated room. Right, positioning of the patient. We spoke a little bit about this earlier and if you look at the guidance that Jay told you to have a look at the BSA guidance, it does also talk about all of these tips and tricks we're telling you today. But most of the time, you want the patient to be facing the speaker head on. So that's what it means, 0-degree azimuth, it means head on looking at the speaker in the vertical plane as well as in the horizontal plane. So if I show you for me, you want this speaker to be this way...

- How about that?

- About there, and you want it to be hitting the patient at 0-degree, exactly what Jay's showing you.

- And you will need me to hold it there as well.

- So that's why that stand that Jay was talking about is actually really, really useful. If you are looking to buy REM software and REM equipment, do have a look at getting a stand 'cause it's gonna make your life a lot easier to get that 0-degree azimuth. It's gonna help with getting the room acoustics right. And it's also going to help with testing at the right levels, especially for those soft and low frequencies. It's gonna get you the right amount of recipe correctly and without you having to repeat and calibrate a lot. Anything you wanted to say here, Jay?

- So I think there's lots of research on this topic, 0-degree, 45-degree. Whether 0-degree is okay, if you're slightly higher than the speaker or lower than speaker. I remember spending at least three days reading different papers and connecting with all

the major manufacturers of the equipment when we made that recommendation and we came to the conclusion that this probably will be a good compromise in all the options that we have. But your individual manufacturer may recommend a different option whether it's-

- Yeah, that's true. Audioscan does recommend 45.

- Whether it's 45 degree higher or lower, et cetera. So do follow your manufacturer's instructions because that's how they're designed the equipment to work. So have a look at that manual or find out from the manufacturer what's good for you. And the other point we've noted here is that there's no point going too far from the speaker, although you can calibrate the speaker to the distance wherever you are in the room. So you can be five meter away and you still might be able to calibrate the speaker, although it doesn't like producing very loud noises. But the point here is that if you're closer then the equipment will have to increase the levels lesser, that's a double negative say, the point is you just have to be close enough to test the lower levels without losing those lower levels to distance or overdriving the speaker.

- We're gonna speak about this practically when we talk about stored versus concurrent equalization. So we'll get to this point and go over it a little bit more. It'll make more sense in a moment. Yes, probe tube calibration. So step one, what we are trying to measure? When we do REMs, what we're measuring is that unique fingerprint of your ear, your concha and your ear canal, right? So we wanna take into account all of the resonant qualities of that cavity. The probe tube that's gonna go into that cavity, the reason why we do the calibration is for several things, but the first thing is to make it invisible because we're gonna put this into the ear so that calibration, the machine is going to take into account this probe tube and it fit of that probe tube, the size and the length of it.

So that's the first one is to make it invisible. The second thing is that although we've had amazing advancements in manufacturing and plastics, there's always a chance that even brand new probe tubes may be pinched or may have some manufacturing fault.

- Got an example here.

- Ah, there you go Jay on the example, very good.

- So I saved them for this course actually because I just randomly found them to be pinched and I only realized it after doing the probe tube calibration because they look okay, they look perfect and the calibration was just all over the place. Maybe we can connect it with that and show you that calibration from this comes out to be completely broken because the tubes are broken, not the system.

- And it's gonna depend of course, where you buy your probe tubes from. Some manufacturers might have different quality standards, otherwise, but definitely, I remember when I was in practice at least 1 in 15 was there was something wrong with it. So definitely have a look and I'm sure Jay-

- So if you buy it from Puretone then you'll be fine.

- There we go, we're at Puretone today.

- That's where we're sitting.

- Right, so you've got your probe tube, we're gonna be gonna show you how to do the calibration and exactly how to put it on. And then in terms of insertion depth 'cause this is the tube that we're gonna insert into your wearer, your patient's ear. There is different

guidance in terms of insertion depth. For adult females, the guidance is 28 millimeters. For adult males, the guidance is 30 millimeters. And then for children, Moodie in 1994 described the averages. What I found the best is, of course, each year is individual. When you're putting this probe tube in, you're gonna be guided by otoscopy. So definitely use your otoscope, have a check. And now, I mean, the software is so clever, there's even such things as guided tube, I don't know what it's called Jay, what is it called from Phonak, the guided ring tube measure?

Each manufacturer has their own thing, right? So there is manufacturer software that will tell you how deep you are in the REM. And this comes from the hearing aid software manufacturer. So if you're new to REMs, I recommend using that guiding software like with Phonak and you've got that guided control. If you are an experience with REMs, then the more practice you have, the more you'll get a feel for in terms of insertion depth and going around the bend. But best practice is always to do a double check with your otoscopy because you wanna see that you are within 2 to 3 millimeters away from that person's eardrum. And I must say in practice, especially to those that are new in REMs and even myself, if I think back this was very scary and this was one of the reasons why I was scared to start doing REMs when I was a very brand new baby clinician, was I was afraid of hurting the patient and hurting the eardrum.

I can tell you actually when I studied, the technique was called bump and jump technique, which is not advised, do not do this. But all the advice used to be insert until the patient jumps and then you know you at the eardrum, which is not what we want. But there is very little damage that you can do with this flexible probe tube. So please don't be afraid and it does get better the more that you do it, you do get a hang for it. A top tip I can give you if you are doing pediatrics, there's just a top tip from Marlene Bagatto actually, she uses a ruler and she measures because they do loads of pediatrics, she measures these different, that Moodie describes, different insertion depths and then she just leaves those probe tubes taped to the ruler on the desk, so

that as the patients come in those age ranges, you can quickly have a measurement. You don't have to remember these figures from your head. So that's just another top tip for you. Anything on insertion dip from your side, Jay?

- Well, the only thing is I think the more I talk to the audiologist, particularly in the last sort of 3 to 5 years, the more people don't have that sort of debate anymore whether REMs are necessity or not, they used in the past and I remember many such debates, very high headed debates if you like. I think most people don't do it these days in my experience, only because they feel that there will be something wrong that they will be doing through REMs. So either is the insertion which worries them or the way that the REMs are conducted, they don't give the desirable results and they're not confident enough or do not have any anybody to supervise them in the clinics.

And therefore the one thing that you would want to do, though 60% who are not doing REMs at the moment is take a very pragmatic view of what you're doing in the clinic. You know, I don't recommend it, but if you do end up bumping that tube to somebody's eardrum, it's not end of the world. You're not going to get them to bleed. You know, and I actually statistically recommend that each of you try to bump your eardrum and see how it feels.

- It's true.

- You know, it's not very pleasant experience, but it's not end of the world. When I do REMs on myself, I often end up doing that. I was telling Nicole that I was trying to take a picture of my eardrum with the tube in and it was just impossible because I just end ended up hurting my ear canal a lot in that process and the eardrum by bumping that tube into the eardrum. So it is very sensitive part of the body, but this tube is not going to be the most dangerous thing that you will put in somebody's ear. And if you take

impressions, if you do ear wax removal, you're putting many more dangerous things in the ears,

- That's true.

- than a probe tube. So don't get afraid of it. Everybody that I know, no matter whether they have 20 years experience or 10 years experience have done it that bumped a patient's eardrum at some point. So it is not that you will be the only human being, or audiologist will do it. And if you are afraid of doing probe microphone measurements because you can't put soft tube in somebody's ear, then frankly, I'm not sure this is the best profession for you.

- No, if you do impressions, that's a lot scarier, to be honest. That's like Jay saying, it's a lot more high risk. And my best advice for you is practice. The only way you're gonna feel more confident is just by doing it, physically doing it. So, you know, reserve some time out of clinic, call your cousins, call your aunt and say, okay, let's do you know your annual hearing test, your free hearing test from me and then use them as practice. Because the more you do, the more confident you'll be and and the more you'll get a feeling for it, and once you get a feeling for it, you'll be ready to go. But I do remember that's fear...

- It's a learn skill.

- It's a learn skill, yeah.

- Right, so.

- You go, Jay.

- So to be able to measure what the hearing device is doing to the speech, you do need a speech-like signal, right? We used to use rather steady signals in the past when the hearing devices weren't that advanced and they weren't measuring what the device is doing at low-level, medium-level and high-levels, you know, when they weren't compression systems, but now we do. And as you know, the human speech is a modulated signal. So there's an average around 65 decibel and there are some peaks above 65, and some troughs below 65 as well. So it modulates along the average line and therefore, the signal that you're trying to measure the response that you're trying to measure to make sure the hearing aid is performing properly, has to be modulated signal as well.

And luckily, we have it in the form of International Speech Test Signal. It's prerecorded, calibrated, modulated speech-like signal. That's what you should be using in your clinics. A minimum measurement duration is about 10 to 15 seconds. So that you know, the long-term average speech spectrum is stable and will give you repeatable results rather than picking up peaks and troughs from here and there. So it's more of a sample of running speech if you like. There are other signals present, some of them are quite good. I know some people tend to use ICRA in particular.

- There's some manufacturers that only have them. So the old FP35 tests boxes and software don't have ISTS as a signal and ICRA is the only option that is, if that's your only option then you can use that option. But it has a lot of white noise in it and we don't want that because it's going to start inducing the noise features of your hearing aid, you want something that's as alike to speech as possible as Jay said. And that's why the recommendation is the ISTS, International Speech Test Signal because that most alikes to real world speech over different languages.

- Yeah, so you have all sort of these options and some of the advanced users might want to go and try live voice and other things as well. For the purpose of this talk, this

presentation, we are recommending that you try to use the International Speech Test Signal if you can. If you can't, you need to find a modulated speech signal in order to test your hearing aids, whether they're performing properly or not. And if you don't have them, might as well not do the verification, to be completely honest.

- I know in America, America it very often it's the rainbow passage or that CARROT PASSAGE like Jay was saying. But the ISTS is really great because it's a mix. The slide is showing you here, it's a mix of six languages. German, Arabic, Mandarin, French, American English. So you've got those different languages that's in the signal. So it's jargon speech. The good reason to use it is that it's internationally recognized. So if your patient was to immigrate to another country, this is the same if we're talking about recipes, we weren't same for same, like for like. So this is one of the ingredients we're using in our recipe and this is a good ingredient 'cause it's internationally recognized.

- So we have a question about retention of the hearing devices, which we'll cover later on, but let's carry on with the International Speech Test Signal uses six languages, German, Arabic, Mandarin, Spanish, French, and American English. So it basically covers most of the main languages of the planet, if you like, in a sense. And if you look at the continent across these languages, they will probably be similar to, I guess, about 80% of the speech spoken on the planet. So it's a pretty good signal to use in that sense. And it's quite curious because every single person that you use is signal on, they will try to guess what language is being spoken by the speaker. And you know, it's a really good talking point if you want to build that rapport with your patients.

- Sorry, we tried to put the sample of it, but I see Putin has blocked YouTube. But if you wanted to listen to what the speech taken signal looks like, there is a YouTube clip just put in ISTS, International Speech Test Signal and you'll hear, but at some point, I think I know it of by heart. Hello, You'll get to know it very well. As speech therapist, I get really excited when I look at that in terms of spectography because when you use the

speech test signal, you're gonna get that full spectograph, spectrogram, woo, I say it wrong, spectrogram of the speech because you are measuring something that's, when on our screens it looks 2D, but speech is 3D, right?

There's various peaks and troughs that go with speech. So that's why it's really important to run it for 10 seconds minimum because you want to account for all of those different troughs and dips, that isn't natural speech. I have had a few customers tell me, can I run it, you know, for three seconds I need to shorten my clinic time and this is one of those times that I'd advise you not to do run it for a minimum of at least 10 seconds. Okay, now it's time to get you guys, I wanna see if you guys are still awake. We've got a quiz. So you're gonna have to go and get your mobile phones. So run out, get your mobile phone.

You can also log in to your screen, whatever you're watching us on, you can open a new tab. And what I want you to do is to log in to www.kahoot.it. So if you type that URL into your address, log in to that now, I'm gonna give you a pin. So go to that URL and we're gonna launch the pin in a moment. Thanks, Jay. So fun quiz, let's see who is going to be the winner and if you guys have been paying attention. Right, so this is our first quiz. So as you go in to www.kahoot.it, this is the game pin. You can also scan this QR code if you wanna go straight from there. There we go, we've got some players ready to play.

- Can I play?

- You are welcome, but you are not allowed to answer, Jay. You know what slides are coming up. I'll give you guys a couple more seconds to log in.

- Roll up, roll up.

- Oh, I'm loving these names, Hear 4 Life. Love it.

- That's not me by the way.

- Not JJ, not J. Jindal, but I like the JJ. I like the one that just says Me, it's Me and Abc. Now, I'll give you five more seconds. Right, let's start. So you're gonna get a quiz now, just so you know, the fastest as well as the most accurate. So that's how we calculate the scoring. There's gonna be five questions in this quiz and it's gonna be based on the topics that we've just spoken about. So let's see who is the winner for this quiz one. Now bear with... Here we go, question one coming up. Answer on your mobile or on your screen. Room calibration should be performed... What is the correct answer? So we have answers coming in, very, very good.

Boom! Fantastic. I'm very glad most of you guys are getting this one right. So root calibration is different to probe tube calibration. Room calibration is that room acoustics, so those of you guys that sit on every client, very good. I mean that's overachieving, but you don't actually need to do it on every client, you just need to do it every time you move the speaker.

- They're just showing off on there.

- They're showing off, you guys are showing off. Probe tube calibration, yes, on every client, but not the room one, very good. All right, let's see who is top of the scoreboard. SandraV and George, and Hear 4 Life, you are the top three. So this is getting exciting. Let's have a look, next question. True or false question. Probe tubes should be calibrated on each new probe tube used. True or false? Yes, answers coming in hot and fast this time. Six more seconds. Boom! Yay! 25 of you getting it right. 100% probe tubes do need to calibrated every time you change it. And that's because there are minute changes in those manufacturing faults. So even though they look the same,

individually, they could be different. You shouldn't reuse your probe tubes, so it should be a new probe tube per client. So well done.

- And I think there's another factor that if you're doing a bilateral measurement, you have to note the difference between the two ears. If you're doing a 0-degree estimates, so that if the difference is more than about 2 dB, then you have to reposition your patient and make sure they're getting similar sort of signal on each side for bilateral measurement.

- Yeah, 100%. Right, let's have a look who's on the scoreboard here? Oh, Sandra, you're still leading the scoreboard. The first top three, George, Hear 4 Life, and SandraV. You guys are leading, but watch out because Martha is on the up. Right, next question. Let's have a look-see, question three. One millimeter vent can affect 200 kilohertz output by up to... This was Jay's fantastic study.

- Not my study, my slide.

- The slide that he shared this very interesting study. So it's that one millimeter vent can affect 200 Hertz by up to?

- That's Francis Cook's data, I don't want to take...

- Boom! Yeah, sorry. This is a very trick question. It was the three millimeter one that can affect to 28 and the one millimeter one could affect up to 7 to 8 decibels. So most of you guys getting this one right, fantastic.

- They're both away, that's good.

- Yeah, very good. You guys are, oh, look at the scoreboard. What happened, Sandra? Oh no, okay. George, Surakshya, I think I'm saying your name-

- Surakshya.

- Surakshya?

- Surakshya.

- Terrible, thanks Jay. And Keeley, well done. You guys have climbed up, I'm very impressed. Okay, last one. Nope, second last one. Can you reuse probe tubes? We've already said this, so hopefully you guys all get this right. Yes, I'm liking that the answers are coming in hard and fast. And boom! Yes, most of you're getting this one right. You can't reuse probe tubes, it's an infection control risk. And also, if there's any residue on there, it's going to affect your probe tubes. So you can't reuse probe tubes on different clients. Let's have a look, who leads now? George, Keeley and SandraV, making a comeback. Very, very good. Right, let's see, last question. LTASS stands for? Have a read... Yes, sorry, this was also a bit of a trick question.

It's the Long Term Average Speech Spectrum. That's what your LTASS stands for. Fantastic stuff. Okay, let's have a look-see the podium. In third place, Hear 4 Life, you made a comeback, well done. Second place, SandraV, so close to first place. First place, who's on top of the leaderboard? George. Fantastic, fantastic. Very impressive. All right, well done. You guys are definitely awake. I'm very impressed with your scores. You've taken good listening.

- I got this.

- Let's get back to the presentation. Okay, so now we wanna go practical. So we spent the first part of this session talking about the why, the importance of REMs, and a little bit about setting up your room and setting up your patient. Now let's go a little bit into the practical elements. When you're going to do the REM, it can get really confusing. There's lots of R's and U's and E's and G's and R's. So just so you know, if the term ends in an R, it's a response. It means that it's an exact position of that ear canal in real-time, taking into account that resonant qualities of the ear canal with the output. So it's very real.

That's if the respond ends in an R. So it's an SPL response, if the term ends in R like for example, Real Ear Aided Response. If the term ends in a G, it's a calculation. So it's a input stimulus minus the gain. So you calculating that, for example, real ear insertion gain and usually that's measured in HL, not SPL. For the purposes of today's talk, we are going to be referring back to that BSA guidance that we spoke about. So for us, our measurements are going to be conducted in response in SPL because that is what's being described as best practice in the UK. It's not wrong to do it in a gain view, but it's not easy to see all of the spectral factors if you do it in the calculated response.

If you are going to measure insertion gain, then it's very, very important that you do some pre-measure beforehand because it's a calculated response. And we'll talk about this in more depth when we go into the practical element.

- Anything you-

- Now that you've tested it, maybe we should just finish it here.

- Yeah, true.

- So I guess the couple of factors here, one is that the gain measurement, REIG, that you're referring to, insertion gain measurement is probably the most hypothetical measurement of them all. It's not a quality of the ear. It's something that you get, which is the output and something that you send into the ear, which is the input and difference of those. In real world, I'm not sure whether it relates to what the hearing device is doing. What you can relate to is how much sound is getting to the end of the eardrum where it's getting into the ear. So it makes sense to use a response measurement, which gives you the output and then you compare it with different input levels where, how the output is varying with different input levels, which gives you that

- A hundred percent.

- the modulation of speech and the spectrum of speech at different levels. And I guess, particularly for the beginners, it's more tricky to do insertion gain measurements because you need to get that tube at the right place in order to get proper responses. And if you think back where it came from, you know, long, long time ago when we didn't have these digital systems and with our like log hearing devices, we were measuring functional gain. And when the real ear measurement systems came into play in 1980s, we had this fantastic objective way of measuring that subjective functional gain by just introducing a tube in the ear. So that was then, but now the hearing devices are much different and the systems are much different. The stimulus is much different. And I think we should all be just measuring the aided response

- A response, yeah.

- and forget about the insertion gain for most patients.

- Yeah, I agree. And you can see a lot more with the response because you get, you're looking in SPL, you're looking at that patient's dynamic range, you can see the

headroom that you're playing with. When you look at it in HL and the gain, if you're doing a gain, you can't see that. That's why Jay's saying for beginners it's really hard because you don't actually, you can't see what's behind that calculation and what's affecting that calculation. Whereas, if you do your measurements in response SPL, you'll be able to see all of that more easily. Right, so let's go practically, the first thing you're going to do, of course, you're going to do your pure-tone audiogram and you're gonna enter it in, and then you're gonna open up your REM screen and the first calculation that is described is the unaided response.

So nothing in this person's ear. And we're going to put the probe tube in and we're going to look at what is the resonant qualities of this person's ear canal. So the main components that you're seeing here, so there's a screenshot of an unaided response, we are measuring the natural boost that the L-shaped ear canal is giving to sound. So ear canal resonance, you see it's peaking at around 2.7 kilohertz. And the concha, the bucket of your ear is predominantly there around the 4 to 6 kilohertz. So that's that boost that you're seeing, those peaks that you're seeing there. It's really useful even if you are doing a response, if you have the time to measure an unaided response.

The reason being is that you can check if there's anything blocking the probe tube once you've put it in. So that's very, very useful, especially if you're a beginner. So it's nice practice in the beginning as you're getting used to doing REMs to actually measure this. You don't have to, you can use a predicted, you can use already measured results in most of the REM softwares, it'll allow you to select predicted results that's predicted over a number of years. But if you have the time and if you're a beginner, I would recommend doing it because it's going to give you the confidence that you've put the probe tube into the right depth and that it's not squashed against the ear or squashed against some ear wax or become blocked.

If the tube is blocked, then you're not going to see this line with the natural peaks, the natural resonant qualities. You're just gonna see a flat line at the bottom of the screen, then you know, oh no, something's gone very wrong, something is blocking my tube. Anything you wanted to add here was unaided response, Jay?

- Well firstly, you've covered the next slide as well. So thank very much.

- I went too far.

- Well, I have a very simple way of thinking in general and about this. So think about it this way, that your ear is a marvelous machine and everybody's ear has a natural amplifier. And what this unaided response is doing for you is trying to tell you how that amplifier is working. So this is the natural amplification that your ear is getting irrespective of anything else because of the size and shape of the outer ear. So that outer ear is enhancing the sounds around two and a half thousand kilohertz basically. And you know, if you think deeply about it, how it all affects your speech understanding, you can relate this to even the data that Alexander Bell calculated on the speech understanding where this band around the 2,000 hertz is the most important band for speech recognition.

So you know that's why even the modern telephones will make sure that you get hearing in this band properly. So if somebody has a hearing loss above 3,000 hertz, you will find that more or less they can hear all the landline phones and all the mobile phones perfectly well that's because our natural ear canal response is most efficient at this frequency band. So you get the hearing, the speech understanding because of this band more than any other bands of speech that you can create.

- Yeah, and it's so fascinating actually to measure this, to look at how it's consistent across different ears, but also how there's changes in the ears. So especially if you

have a patient that has, for example, surfers ear with some, you know, some bony growths in it or any unusually shaped ears, it's interesting to measure it so that you can see where are their resonant qualities. Where is their natural ear canal boosting for them.

- It's the graphical representations of the hearing that God's given you.

- Exactly, it's amazing.

- Yeah, so you measure it with a fairly steady noise. You don't need a speech noise unless you're really, really well experienced in reading the modulated signal. You want it to keep nice and steady. So pink noise is pretty good. The actual level doesn't matter, but for the consistency purpose, keep it the same every time that you do it, you can measure it in gain or response.

- So this is the exception, right? I don't wanna confuse you. Unaided response and occluded responses, we are not yet doing the measurements per se.

- So we are not doing aided measurements.

- You're not doing aided measurements.

- So anything unaided you can measure it in gains.

- Yes, it's more just for you to see.

- If you are more used to looking at it this way, you should see pretty much this shape. You mainly use it to calculate insertion again, if you are doing REIG to find out how while your probe tube is placed into the ear. So do you wanna say something about it?

- Yeah, so if your probe tube is not deep enough in practice, generally what we see is a dip at 6,000 Hertz. So that's why I've said here sometimes it's easier to look at this unaided response in the gain view HL. So this screenshot is showing you the view in HL and you're seeing the peaks at two, three, so that's the natural peak resonance we were talking about. If it wasn't deep enough there, we'd hit 0 at 6k, it usually dips by around 5 to 10. The further you are out, the more it dips. So that's just a quick tell that you're not deep enough. It's going to be different for every ear because ears are like Jay said, so unique.

So that's why look, do otoscopy, you need to be 2 to 3 millimeters away from the ear. So you might see in a very oddly shaped ear canal or very petite ear canal with sharp bends that you are 2 to 3 millimeters and you're still seeing that dip at 6k, that's okay. But general rule of thumb is that if you see that one dipping below the zero line at 6k, you're not 2 to 3 millimeters at the eardrum.

- True, and I think the other important thing it does, and it's really helpful in those occasions that it tells you whether your tube has been occluded by wax or you know, if you've introduced something in the ear. Some patients come these days with olive oil in the ear, et cetera, which can block these tube because lumen is so small, it's probably about half a millimeter wide or something. So once you've done the calibration and you've made sure that your tube is great, it's dependent on the patient's ear condition whether it remains great when it's inside the patient's ear. But just be careful once you do that measurement, some of the equipment will automatically select measured REUR for your target calculations.

And as long as it looks similar to each other, it's not a big problem. But when they're different, we recommend that you use predicted on aided gain response, the measure because ultimately when you're measuring the response, aided response, you're

measuring it at the level of the eardrum. So it doesn't make a huge difference how the natural acoustics of the auditory canal will be, given that you're going to change them by introducing the coupling device into the ear anyways. So this measure doesn't matters for the person who is wearing the hearing aid because you're going to change it in the next step when you occlude the ear with something rather.

- That's true. Yeah, so just to make a further point, there was a question here, what do you do if there's a mastoid cavity or if there's abnormalities, there's a surgically modified ear. Be very careful like Jay saying because some systems will take your measurement into the calculation and that's gonna give you a very weird looking recipe. So if you have a very strange looking unaided response, it's better to use predicted, especially for things like mastoids and things 'cause you're gonna get a lot of bass and amplification where you actually don't want it and it's easier to use the set standard recipe with the predicted. And as Jay says, as soon as you introduce this REOR, it's going to change the resonant qualities anyway.

- Just remember that some of the people who've been doing real ear measurements for a long time and have been using the insertion gain measurements for aided measurements, they will still be using the REUR because they're important to calculate the gain predictions for those fittings. So if you're using REAR, Real Ear Aided Response measurements to see whether you are hearing it is performing at medium-soft, and high-levels properly or not, you do not need to use the unaided response. Okay, so...

- REOR, so this is now the Real Ear Occluded Response. So this is now with the hearing aid OFF. So not ON, we wanna see what is this sound coupler in the resonant cavity? How is it affecting the natural resonant qualities of this ear? So what you're gonna do is you're gonna leave that probe tube just as it is in the person's ear and you're going to open up your target software or your Purefit software, whichever

hearing aid you're using, you're gonna mute the hearing aids and you're gonna place the hearing aid in the patient's ear with its mold or the sound tube and the dome that is the patient going to use. So what we do this step for is definitely for a couple of things is one to see how does it look?

Is it an open or is it a closed fitting? I think the next slide is gonna explain a little bit better. So here you see two types of occluded responses. So remember the hearing aids muted, you're gonna run it the same way that you did your unaided response. So you're gonna choose pink noise is a good one. 65 decibel, five seconds. We just wanna see the effects of this in the person's ear canal. So the first screenshot you're seeing there, the pink line is the occluded response and the black line is the unaided response. So there you can see unaided, we've got that natural resonant qualities and then we've put this person the mold into this person ear with the ear hearing aid muted and then there's the pink line.

So you can see the resonant qualities change completely now with that ear mold in the ear. It's below the line of zero, so this is what we would describe as a closed response. So this is a closed fitting that, whatever you've introduced an ear mold or a RIC, or a custom tip is completely occluding the natural resonant qualities of that ear. Now have a look at the one just below it, so the screenshot just below that top one and there you're seeing an open fit. So you've put the hearing aid into the person's ear and you've run the occluded response and the pink line is almost matching that black line. So that what it means is that what you've introduced in the ear is not affecting as much the natural resonant qualities of that person's ear canal.

So this is something that we would call an open fit. Now, I do want to warn you because in general, we think that molds will create closed fits and open domes will create open fits. But it's not hard and fast for everyone. I've had some patients where, you know, there's an open dome and the ear canal is so collapsed that even with an

open dome, it's creating a closed effect. I've also had some users with molds that I think pretty closed mold, but with the venting and shape of the ear canal, actually it's giving more of an open fit. So don't assume that because you're doing a mold, it's closed. This is very useful to measure. And when we talk about using stored versus concurrent equalization, it becomes important. So if you're not sure whether this is a closed or open fit, please do measure it.

- So the point here is the cosmetics don't tell you whether it's an open fitting or closed fitting, whether it's an open dome, closed dome, mold, doesn't matter. When the fitting is acoustically transparent, then you call it open. And the only way to know whether it is acoustically transparent or not, is to do these measurements.

- Sorry, there's no shortcut.

- So just a point here that REOR is not quite occlusion effective, is it?

- No, I've had this question before with, if you measure REOR is that occlusion effect? There are two different, the REOR can inform how much occlusion effect you will have. So what is the occlusion effect? The occlusion effect happens because we hear ourselves, right? So when we talk, when we move our mandible and our articulators, we're moving the boney cartilage in our ear canal and that creates vibrations, right? When you occlude the ear, those vibrations can't escape like they usually would. And then you get what the patients described that barrel feeling and we've all experienced that barrel feeling, we've put headphones in or noise clogs in, we start hearing ourselves quite differently. And the reason why we are hearing that is the low frequencies are boosted because of that bony movement, that cartilaginous movement. So the closed fit will of course make more of a barrel feeling than an REOR is not occlusion effect in a sense.

- Sure, so basically, with a closed ear canal somewhere or another and with an actual mass present in the ear canal. You have the systems, stiffness resonance characteristics changed into mass dominated resonance characteristics. Which means that there's more bass passing through the eardrum than it needs to be. Whether it's the bone conducted sounds through your own bones and cartilages from your throat getting into your ear or whether it's the sounds coming from outside. So the overwhelmingly transferring low frequencies give that effect in the own voice resonance. As well as some other sounds which is your occlusion effect, which is not particularly related to the REUR at all. And if you think about it, sometimes some patients with Eustachian tube dysfunction will give you similar sort of symptoms as well.

- That's true, that's very true. Okay, so now I've spoken a little bit before about this concurrent versus stored equalization and why it's really important. And we've just spoken now about open versus close fits. So when you set up your patient to do the real ear aided measurements, the speaker is going to take into account the distance that the patient is away from the speaker and the reference microphones are also going to take an account any sound leakage. So this is where it becomes really important to know whether you're doing an open fit or a closed fit. If you are doing an open fit, when you start amplifying some of those bass, any of those frequencies, you are going to get some sound leakage coming out of the ear.

So when that happens, the reference microphone can't tell whether that's coming from the sound leakage or whether the patient is moving closer towards the speaker. If you used stored equalization, meaning that it does a calibration and then runs all of the measurements, it's going to think that the patient is moving back and forth and the output of the speaker is going to increase and decrease. So you're running 55, it's going to start adjusting because that leaked sound, it thinks is the patient moving closer. So you'll think you're running 55, but actually the system has adjusted it down

to 45 because it thinks that sound leakage is the patient moving closer. This is very dangerous because it can result in you over amplifying.

So it looks like you're hitting the target, you're measuring everything okay, but actually what you're doing is over amplifying the patient. So concurrent equalization is used when you have an open fit. So that accounts for that sound leakage and way the patient, oh sorry, the other way around. Concurrent, the stored equalization is where the patient needs to be very still. So it's not going to change for those differences in hear effect. And that's why it's good to measure because you can't predict, as we were saying earlier, whether it's an open fit or a close fit just based on whether you're doing a mold or an open fit. You'll only know this by actually doing it and if you do it wrong you can over amplify the results.

- So I think if you look at it simply, you explained it really well, but I'll just repeat it because it's really important. And we were talking about it that, you know, with the use of these very technical word, modified pressure method of concurrent equalization and stuff, it sounds like a very complicated concept, but it isn't. All that's happening is that you're telling your software to send an amount of sound to this system here. Your probe mic system. Now think about it, so if you put 65 decibel sound, the speaker generates the sound, reference mic tells the speaker whether that's coming out at 65 or less or more so the speaker can adjust it so that the required sound is reaching to that system.

So that's happening in real-time concurrently. That's why concurrent equalization. But that means that reference mic should not be receiving any other sounds. But if your ear is open, whatever amplified sound the hearing aid is sending to your ear, some of it is coming out, that's where the feedback comes from. That's going into the reference mic. So reference mic is reading the sound coming from the speaker as well as coming from the hearing aid, which means that it will tell the wrong thing to the speaker how

much sound is coming into the system. And therefore, what you do is you turn the hearing aid off, put 65 decibel in the speaker, let the reference mic read that 65 decibel and then you store that calibration.

As long as your patient doesn't move from that place, that reference mic, if it stays there and the speaker, if it stays there, the sound that will be sent by the speaker will be that quantity 65. So this is what you're storing, you're storing that distance basically between these two devices and that's what stored equalization is. So consequently, if you're using stored equalization, your patient cannot move. So you can't use it, for example, on somebody like my son who cannot sit still at all, he's 10-year-old and is a punishment if I ask him to sit still for 10 seconds.

- So definitely pediatrics, but also think about your geriatric patient's, dementia patients as well. All Parkinson's or any of your patients that might not be able to sit still.

- Well, pretty much all of us who cannot be duct taped to a chair and will not be able to sit still for the purpose of these measurements. So that's why we use a concurrent measurements where if the patients moved a little bit, small amount of movements are taken into account. But if you have an open fit, you cannot have extra sound coming to the reference mic from anywhere other than the speaker. And that's the whole idea of this. So it is very simple. So you turn that reference mic off, so it's not telling the speaker at all anything. Once you've stored that distance between the reference mic and the speaker. They don't get bogged down by all the technicalities around it, it's straight concept and the reference mic is telling the system to change the sound, it's concurrent equalization and therefore, the patient can move the head a little bit.

But that freedom is not available once you've stored that distance into the system which is static or stored equalization. So you can use it for closed fittings, the stored equalization, as long as you duct tape the patient around the chair.

- But you can also use it definitely for CROS. So we won't have time today to go into CROS verification with CROS aids or BiCROS aids, but it does become very useful to use a stored equalization when you do a CROS or BiCROS verification 'cause you're gonna move the patient's head and you're gonna take into account head shadow effect. So those are the situations where you can use stored equalization.

- Yeah, if you want to learn about that, come back and hit that subscribe button.

- There we go. Jay runs a fantastic course and I can highly recommend it.

- No, no, no, I was just joking, really. Go on.

- So here what we've done is just taken some screenshots of real examples of REOR occluded and unaided responses with different models of hearing aids, as well as different sound delivery. So closed versus molds. So what you're seeing here are Phonak M90s they're RICs with a medium closed dome and you're seeing even across the ears, there's some slight differences between the REOR or which is the black line, and the pink line is, sorry, other way around. The unaided response is in black and the occluded response is in pink. So you're seeing the effect of that medium closed dome on the RIC, on that person's resonant qualities of the ear canal. So that's really interesting. Here's another example with Starkey, this is a custom one with a 0.8 millimeter vent.

So we expect it to be closed and in reality, yes, it is quite a closed fit. So you can see that pink line falling below, making it a closed fit. It's not mimicking the resonant qualities of the black line, which is the unaided response. And then this last one is a RIC with a small dome, so small open dome and there you can see they're almost matching each other. So that small open dome on the RIC hasn't affected too much of

the natural peak resonant qualities of that ear canal. There we go. So that's just some examples, real-life examples of unaided responses, occluded responses. And now we are going to get into the meaty part of why we all here today, the Real Ear Aided Response.

So what you're seeing here is a screenshot of the Inventis software screen. This is what we are gonna do, once you finish doing your occluded response, you're then gonna open up your hearing aids software again. And now you're going to unmute your hearing aids. Make sure actually, top tip, you've run your feedback manager because you don't wanna run the feedback manager at the end 'cause the feedback manager is gonna drop everything. So run the feedback manager so that you've got your dynamic range that you can play with from the get-go. So unmute, run feedback manager, then you're gonna come back into this Inventis screen, select REM and now we're gonna go aided response. So let's just talk through what's everything on the screen. And Jay's like lovely, Jay has highlighted in red some of the most important things.

- I spent time on this, you see.

- Very nice. Yeah, so the first thing that's highlights there is of course, aided. Aided meaning that we are going to now add the unmute the hearing aids and we're going to do real-time measurements of soft, medium, and loud speech sounds in that person's ear.

- So basically, those of you who don't know the Inventis software, it's a horizontal menu which works from left to right. So you do unaided response or occluded and then aided, and then rest of the things.

- Brilliant. Then you're seeing the next circle on the screen is called SPL and response. So now let's talk through what measurements you're doing. So remember in the

beginning we were talking about if it ends in G, it's a gain, if it ends in R, it's a response measured in SPL, there's where you can change it. So for the purposes of this discussion, we're going to recommend that you do your aided response in SPL and you're going to use the curve type response. Then you're going to not use aided insertion, but actually select aided in terms of gain. Underneath those options, you do get other options. Show only a single side or show only the active curves, that's up to you.

- So this is aided selected in the software. That's why it's coming up as REM.

- Oh, I got you, I gotcha. Yes, yes, yes. Oh I see, so that's selected.

- And then within this screen you get the MPO measurements, your uncomfortable loudness levels. You get your audiogram if you want it to be there. So you can select whether you want audio material results or not. You get your target in dash lines and the response, aided response in this solid line. You can make that solid line not to be average and have the full spectrum. So you can show the full spectrum, which we can do in the practical part, perhaps. If you move fast enough, we might just have time for it.

- Right, so this is just going into a zoomed up view of what Jay was saying in terms of the target versus the measurement. So you're gonna see a few lines. That dotted line is what we're trying to move the hearing aid gain towards. The solid line is the LTASS, the average of that speech spectrum. The shaded part, if you select place percentile, is gonna show you the peaks and troughs of that LTASS that you're measuring. So that solid line is the, as you run it for the number of seconds that you run it, it's calculating the average of the peak and trough of the speech spectrum. But it is very useful to have the percentile, the shaded graph, and I know some of you guys in practice have told me it makes it look messy, but I highly recommend it, especially when you're doing

ski slope type fits because the shaded parts is going to show you that you are actually hitting target in terms of spectral peaks, particularly for fricative sounds, That's good to see that percentile.

- Yeah, absolutely. And now that you've mentioned it, I'll cover one of the further slides here that you don't want these peaks of the speech to be touching your NPO line as well. So you so look at it here. So let's assume that this was the uncomfortable loudness threshold of the patient. It's not, but let's assume. Then the average speech is much lower than the uncomfortable loudness threshold. But some of the peaks of the speech are touching that threshold and you don't want that to happen because that means the speech will be uncomfortable for these frequencies. So you want to make sure that you can see all of the spectrum. These are from different software by the way, these two figures.

So don't get confused that your system doesn't look like it, although it's that system. So what you want to do is carry on the signal for 10 seconds before you measure the medium level of response, soft level of response and loud level. So measuring the whole compression range, some people will focus more on the soft speech if they can't match all three properly and others will focus more on medium speech. For me it's dependent on the person and the need assessment that you would've done. Why they require hearing device in the first place, what they're missing in their life, what they're not hearing properly. And these things should be noted if you couldn't make out, if you couldn't make every single line meet the target within the five decibel range so that you can consider it when they're coming for follow ups and telling you, oh actually, I can hear everything pretty well, but my wife is very softly spoken and I can't hear her particularly when she's in the kitchen and I'm sitting and watching something on the sofa, et cetera.

So before the target match, the curves will look like anything. And after the target match, hopefully, you'll be able to match them enough as close as five decibel to the target line. Now for some hearing losses, this just is not possible to match everything and the modern technology gives a solution for that too.

- Yes, so here, very briefly, 'cause I think we don't have a lot of time, this is where you may have heard in practice about frequency lowering. So if you're getting that ski slope loss, you fitted the patient with the appropriate hearing aid with the right receiver or right sound delivery system, you cannot go in, give them more gain in terms of that and they just not hitting that target. So Jay, if you just hover over, that everything that's in the gray. So for this person's hearing loss, what you're seeing is the audiogram, are those little circles upside down because we're in SPL. The white is the dynamic range. So that's where we've got to play. So this is the headroom that we have for this user, right?

And we are gonna amplify to make speech audible. And what you're seeing there is the response curve. So that yellow line is there, 65 decibel speech response curve. But there you see when it gets to about four kilohertz, well, just before three and a half, well, 3.75 kilohertz, do you see that solid yellow line cuts into the gray? That means everything after that it's not getting, there is no amplification there. So if you look at the speech spectrum banana, this means that this user, no matter what you've reached their maximum, you can't go any louder in terms of the gain calculations in the software, it means they're going to miss S, T, H and F, they're not hearing it no matter how much gain you put in there.

So this is where we start looking at things like switching on frequency lowering. Different manufacturers have different names for frequency lowering. There's frequency translocation, frequency transposition, and frequency compression. So this, what you're seeing on the slides is the step by step, if you are going to switch on frequency

lowering, these are the step by step guides from Susan Scollie and the DSL team that can let you make that S just audible. It's going to fall into what we call the M-A-O-F, the Maximum Audible Output Frequency. And the goal is to get that S, that purple line that you're seeing is going , it's an S, it's a calibrated S from the system. And we want that calibrated S to go upper shoulder into what we call the MAOF, the maximum, the last point that's maximally audible and the MAOF is that first where that 65 crosses the unaided area.

So that first arrow to the second arrow where you see it's on the F line just as it becomes audible. So you want the upper shoulder of the S, the red to fall into that area. So what you're seeing here is I've already done a sample for you. So the patient with frequency lowering OFF had the purple line unaided, emitted. Then I switched frequency lowering ON and slowly, slowly adjusted in the target software, the S calibration more or less, so that it would fall into that MAOF area. This is going beyond aided responses, but I thought it's important especially because more and more so we are fitting those ski slope type of losses with RICs and with open type of fitting hearing aids where it's not going to give you that gain that you can get that S audible.

Go through these slides, go through Susan Scollie, the DSL team step by step to get that. And what I highly recommend is for you to practice it. So to practice with frequency lowering on and then go through step by step all of those instructions on the screen to get that upper shoulder of the S into that MAOF. It sounds complicated because we as audiologists love to use an abbreviation, but in reality, all you're doing is you're measuring an S and you're putting that S into the last point at where it slowly starts becoming audible without compressing all of the other frequencies too much. And that is how you verify your frequency lowering strategies. Hopefully that makes sense.

- Well, the context behind it is, first of all, I wasn't sure whether we'd had time to cover it, but as you can see Nicole feels so passionately about this topic that she made sure these slides were there. But the context is that when you are using frequency lowering, you want to, that there's substantial evidence and as Nicole mentioned, you can look at the great Professor Susan Scollie's work and Ryan McCreery's done lots of work around it and there are some other famous names which I can mention here. So the idea is that you want to have the lowest level of frequency lowering threshold in any hearing and fitting and how do you find that low-level, not through the manufacturer's recommendation alone.

You try and make sure that you've verified that this is the lowest possible level which will give the maximum benefit to the patient. So that's the idea and if you can use this method then probably it will make your patient's life much easier. Now when you looked at the aided screen, perhaps we can just quickly go back here.

- Here we go.

- You get a measure of the added and unaided speech intelligibility index scores and they become very important on each of the level because we've got, again this really helpful data from these great researchers where you get a range of the score that should be there as a guide. So if somebody has a 60 decibel hearing loss, for example, when you do a 55 dB SPL measurement, the score should range from anywhere from 20 to about, what is it, 47 or something?

- Yeah, 47.

- At 60. And you can measure the performance of your own hearing aid fitting against these research-based indexes, indices. So I think it just makes your validation a little much better and more objective. So you look at the 65, the 65 dB SPL DSL score, see

whether it's falling within that range for you. You look at the 75 dB SPL score and see whether it's falling within that range for you or not. Now the SII is a great concept and it's really an objective validation of your fitting, but you have to consider that this goal here is not to achieve hundred percent SII.

- No.

- Because that will make some of the-

- Sounds terrible. It'll be awful.

- The peaks of the speech will become too loud for those patients. Because you know, we have an average speech and we have some peaks and we have some troughs. So 55 is not really 55, it will fluctuate around that 55 range. And secondly, we know that the adult users per se, will use the linguistic experience and information that they have in built in the brain for years and years. And that's why when you do something like AB word score, an 80-day AB word score via headphones on somebody who has a moderate hearing loss, they can give you pretty good results at 55 decibel and 65 decibel because they're using all this views that they're built up in the brain from the context, linguistic context, et cetera, for years and years.

So it gives you an idea, but again, it has to be measured with everything else that you're doing in terms of verification, validation. Okay, MPO, we've briefly touched before. Basically, there is data available that when you look at MPOs within the hearing software itself, that can vary to up to about 25 dB difference, right? So think about it, when you're dealing with sensorineural hearing losses, one of the major problem, with those losses, is that there is compressed dynamic range. If somebody has a 50 decibel hearing loss and your uncomfortable loudness limit is 70 decibel, 120 decibel, then your dynamic range is that 70 decibel which is squeezed from 120 decibel, 0 to 120,

right? So that's one of the major problem that we are trying to squeeze all the modulations of the speech within that compressed dynamic range.

And if you've compressed the ceiling further, we have lesser room to play with for that speech. So therefore, it's very important that you hit the NPOs as high as possible and don't, you know, obviously, they don't become uncomfortable for the patient. So you want to push that ceiling as high as possible. The peaks of speech as we discussed shouldn't be hitting that MPO line, otherwise your patients won't like you and they won't like the hearing aid. And if you are into a habit of measuring uncomfortable loudness level, which may be a good idea actually, I know some of the professional guidance will discourage you to do that, you have to make your own decision. And certainly for patients who have tinnitus, hyperacusis, possibly have a fistula, a limb fistula or a superior semicircular canal dehiscence, those guys won't like you doing UCL on them that much.

But rest of the people will be okay as long as your instructions are really well-mannered, simple and straightforward for them to understand. So I usually say that okay, I've done the PTA, which is the minimum that you can hear, but there's a maximum limit to the hearing as well. And I want to measure that too because your usable hearing is above your minimum and below your maximum, and that's what I want to note. And most people are quite okay with that, that sort of explanation.

- Very good. Remember when for NPO, you're opening up the compression knee points. So it's not like when you did aided response, you increase in gain in your hearing aid software fitting screen when you increase the MPO, you unlocking those knee points, you're making that dynamic range so you're not increasing gain. And my last point is very, very nice if you have done LDLs, even if it's just two points, do a low and do a high uncomfortable levels, loudness discomfort levels because you want your MPO sweep to be below those LDLs like Jay's saying. So it is good practice, just

measure even if it's just two points so that you know more or less how far you can lift that ceiling.

- Yep, I think we are running behind a little bit. So those of you who need to go at four o'clock, perhaps you can watch the webinar later, I'm sure Anna will put it somewhere, which is easily accessible to you and send you a link as well. Okay, the next part is live speech measurement, which is called different names in different systems.

- Freestyle in Aurical, Natus calls it freestyle. But yeah, I really love this. This is now not part of the recipe, we've gone now beyond the recipe. So as long as you've done the recipe, you've got a good fit. This is extra tools that you can use in your arsenal to do things like that are very functional for a user. So I've loved using this live speech portion of REM software for things like a musician to set their music program. I asked them to bring their guitar or whatever their musical instruments is into clinic and we'll open up their music program, and we'll use live speech, they'll play the guitar and I can make sure there's no target in live speech because it's not the recipe. What I'm looking at is it audible or is it falling into that unable areas in the dynamic range, or have we given them that full resonant frequencies?

- And I think one of the most important things that people who see you will need to hear is their communication partners voice. And how good it is to show them. So you know, on this screen in particular, you have an unaided voice level which is represented by this dash line. My arrow has just gone completely berserk. And this solid line, which is the aided voice level. So this is how it used to be and this is how it is, right? And if you can show their communication partner how they're hearing their voice and that's the most important thing for them to hear. And I often joke with them after showing this, that there is no reason not to hear you now because you've got this sort-

- Hundred percent.

- Yes. So all that makes a great counseling tool as well. And this is my ear, I measured my own response with the noise cancellation of the Airpods Pro off and on, and I wanted to see whether the noise cancellation is giving me a good result as depicted by Apple or not. The point here is that you can do lots of other creative things

- Go beyond.

- apart from just the approximate.

- Go beyond the recipe.

- Okay, the recording will be sent by Anna and her team, and I'm sure there will be one.

- Right, we have another quiz that I think I'm gonna jump this one just so that we can get all of our slides done and then we'll put this quiz at the end 'cause we've run out of time.

- Okay, so what do we get out of it? So remember the why, how and what. This is the what part. So this is the end and I'll just quickly gloss over it if you like because you know this already now. Now when somebody comes to you for hearing aid fitting and you decide that this technology is better than that technology in a premium technology or the low-level technology, no matter what the marketing jargons are around the premium technology and lower technology, the main thing that you're trying to improve is the clarity and comfort in the sounds that's coming to patients ear, particularly in the challenging environment. So the higher the technology, more the clarity and comfort, right?

And this is what fitting to prescriptive target levels will lead to. So in a way, the hearing aids are wonderful technology, but they're a piece of plastic if you don't program them properly. So you have to do that magic, follow that recipe properly perhaps. But if you deviate significantly from the target, the clarity and comfort won't be there. So the piece of plastic, the wonderful technology won't work unless you do the job properly and one way of doing the job properly, the starting point mind you, not the end point is doing those verification. Children get similar sort of benefits. Now they're reliable and accurate procedures. So don't let them tell you any other thing. I think the expenditure or the resource that you need to put into the system used to be a bar in the past, but you need to consider what you're doing is not valid unless you follow the best practice, as simple as that. And if you don't perform to a valid level, then you won't be able to perform the game for a long time.

- It costs you more money. And I can speak from real-life experience.

- Yeah and there's data-

- 'cause your time is money. And I can tell you from lived experience that before I did REMs, I would have 6, 7, 8 follow-ups, tweaking, tweaking, tweaking, trying to get the recipe right. And then I moved to a practice that had REM equipment and much further reduction in your follow-up. Your time is so valuable and time is money, and you will save money in the long run.

- So Nicole's just reading, been reading the slides so she's covered one more, but have a look at this review as well. It's systematic review and meta-analysis and done by great research team here in Manchester. And it does tell you that the REM do have positive effect, another randomized controlled trial, improved word and phoneme, I mean, I can keep going on and on, and on, and keep you here until midnight if I were to

produce all the data that's available in favor of REM. I haven't seen any data against REM that you shouldn't be doing them. So you know, this is the slide that probably re-

- This is the gut punch.

- Nicole's lived experience that you will have, you know, this is a large survey, I'm sure that all of you're aware of market track survey that they do here after year and produce this wonderful data. And if you look at that data year after year, one thing will be common that verification will result along with validation in lesser visit and produce better quality, and good quality is good business, right? So you know, just before we leave the sequence of these lights, think about it this way that if your family member has to get a hearing device or even if you, if your ears are not working properly, you need to get a hearing device. Would you rather have a hearing device fitted to you or your mom which performs like that where this is a target response, and this is a response that the hearing device is producing at the software prescribed level, or would you rather have this sort of hearing device which is fitted to the target for your mom or your dad, or yourself?

Just think closely and why would you do something different to somebody else if you don't want your own self or family members to have a properly fitted hearing devices? This is what will get you if you're shooting the arrows in the dark. This is what will get you if you're following the best practice and scientific procedures to fit a hearing device. You know, it's quite a science as well as an art. Similar thing here. So think about it, make sure you get all the benefit from the REM, which is you optimize the volume and digital features. You know, we just talked about frequency lowering. You can do lots of clever things around noise reduction, CROS hearing devices, et cetera, et cetera.

You'll make sure that the hearing is more comfortable and clearer. Which leads to finale's question which she asked in the beginning that we have data, we have experience that it leads to more retention rate, less follow-ups and you have perhaps more time to spend with the patient for counseling and validation through this. It's a really good rapport building tool as well. And now that the audiology, the profession of audiologist sort of threatened, which in my humble opinion is unjustified clearly if you're following the scientific principles, but is a reality threatened by the OTC devices, et cetera, and people who have shops everywhere and doing things that they shouldn't do. I think if you have a clear goal to help your patients with the quality of care, following the best practice, using the scientific principles that you've learned during your training, then we only have brighter feature ahead.

- True. Okay, so there's one more quiz. So for those of you that can stay on, it'll be wonderful to do this last quiz with you and see, so George is the current reigning champ and let's see if he can defend his title there. So let's go live onto Kahoot again. So here we go. This is the game pin. So you're on www.kahoot.it. There's the game pin, I'm just gonna end this game, sorry. So it's not confusing. There we go. Nice, I'm glad to see you guys are still there.

- And while you're joining by the way, remember that we both are on Twitter and LinkedIn, et cetera, so you can follow us there as well if you like. Nicole puts some lovely updates on Twitter every now and then.

- That's very true. Oh, I love these names. Keke, Aud. Brilliant. Okay, I'll give you a couple more seconds. I'm gonna start it in five seconds. Brilliant, thanks for staying on. George, I see you've come in late, let's see if you can defend your reign. Right, let's go. First question in 3, 2, 1... MPO should be performed in the coupler or test box at, ooh, and I think this is a trick question 'cause we didn't really say the level. So for those of you experienced users, is it 75, 80? Never in the text box, 90, 85? Boom! Okay, so this

was a little bit of an unfair question because we didn't cover it so much, but the correct answer is actually 90. This is from the BSA guidance.

So I was a little bit unfair here because I had chose the BSA guidance. So if you in the test box, the MPO will be performed at that level. Right, next question. Let's see the scoreboard. Oh, it's a completely different scoreboard here, US, leading the pack. Very interesting. Oh dear George, is your reign going to be dethroned? Let's go to the next question. True or false. Real Ear Aided Response should be performed with a LTASS, Long-Term Average Spectrum Signal. True or false? Let's see if they were listening in the second half. I think you are 'cause you're all overachievers for staying over time. And boom! Yes, most of you guys getting this question right, I'm very, very happy.

So yes, your Real Ear Aided Response, that's definitely, you need to have an LTASS. So you need one that's going to go across that 10 seconds to give you the best type of average. Right, next question. Aybike, I hope I say your name right. Aybike? I hope that's right. I'm very impressed. US, unfortunately you've dropped down one. Let's see if you can bring up your score. Right, next question, let's have a look. Target for REAR, Real Ear Aided Response should match to that dotted line plus/minus to which five decibels, three decibels, six decibels or does it have to exactly match? Let's see answers coming in. Boom! Yes, it's a five dB match, so it needs to be within five decibel of your dotted line.

So that thin response line needs to be within five decibels. And a lot of you guys getting that one right? The one that said plus/minus three dB can, it's not described in the guidance, but you can, I mean the closer you are the better. But the guidance allows for five decibels of deviation. Right, let's have a look at the scoreboard. Ah-aha, okay George, I see you appearing number three, but Aybike, you still leading the pack there. So well done. Right, next question, true or false. Feedback manager should be

run at the end of the hearing aid fitting. So you're gonna run your feedback manager after you've measured all of your REARs and done all your matching or before?

Let's have a look. So it's false. You shouldn't do it after. The reason why is exactly that because you've measured everything so perfectly and if you run your feedback manager at the end, it's just gonna compress all of those perfect targets. So yes, those that said false a hundred percent. You don't want to run it at the end, you want to run it at the beginning. Fantastic stuff. Right, last question. Let's see who is the reigning champion of quiz two? Aybike or Aybike? Fantastic, you're reigning. Let's have a look last one to take it all. Real Ear Aided Response measurements should be run for a minimum of how many seconds? We've repeated this a few times, so hopefully this is a nice easy one to end off with.

Yes, answers coming in. Let's have a look-see. Boom! Yes, most of you guys getting this one right. Hundred percent, 10 seconds, at least 10 seconds. Otherwise you're not gonna get a good average out. So fantastic. Let's have a look at the scoreboard, the podium. Number three, we've got Surakshya, whose name? Surakshya, I keep saying your name wrong. I'm so sorry, Surakshya. Aybike, who also I think I'm saying your name wrong. Number two, outta my way, George! Just coming in underneath, that's impressive. I was sure Aybike was gonna take this for the win. I'm so sorry, but George, you are the reigning champion for quiz one and quiz two. Fantastic stuff.

Right, I think we are gonna just... If you can stay on, for those of you that have to leave, you are welcome to leave, but Jay has just opened up the target software and if you can stay on, we're just going to do a very practical example of running through the software from beginning to end, putting in the audiogram all the way to the end. So those of you that have to leave, thank you very much for staying on longer. Those of you that can stay, let's have a look.

- So first of all, we're using the Inventis Trumpet System and does have two different probe microphone systems. One is wireless and the other one is wired. And you can select that in the software, whichever one you're using, going into REMs, device, probe connection, and whether you're using a wireless or wired. We've decided that we are going to use the wired one for the purpose of this particular talk. Now the first thing that you will do, let's see if it all works. We are not in a clinic room and test-

- Remember everything we spoke about, right? Room setup. So first thing you're gonna do is do the calibrations. So we're gonna do the room cal. What you're gonna do is put the probe tubes on your Trumpet probe with the reference microphones. It's on the reference microphones in front of the speaker.

- I don't think they can see you. You've gone too far.

- Apologies.

- That's only because of the camera that's not working from there.

- Right, so this is the room calibration. So the speaker is now calibrated to the acoustics of this room for where I was holding this reference microphone. If I move the speaker, ideally, we should redo that calibration. Now we're going to do the probe tube. So we're gonna try and make these tubes invisible before we put them in the ear and check that there's no manufacturing faults on them. Beautiful. So falling nicely within the normative range. Now we're gonna do an unaided response. So step one, you're gonna position your patient. Remember one meter away... Hopefully you can still see me, one meter away from the speaker. I might be just a little bit closer just so you guys on the webcam can see.

- You probably want to do it on me.

- I'll do it on you.

- Yeah. I've got the mold.

- Oh yes, of course.

- Is my ears still in the system?

- Okay, so first thing.

- Okay, will it come off? Will it come near me? Is it long enough?

- We're just gonna adjust the webcam so you can see us.

- Well, why don't you move slightly that side, Nicole because I don't think the wire is long enough, so. Come down here.

- Okay, so you can see Jay in the screen, that's the most important thing. So I'm gonna just take you through step by step. What you're seeing here in the screen, you've got your Trumpet, it's important that you do left for left and right for right, that's one top tip I have for you. Make sure the red is on the right and the blue is on the left 'cause otherwise you're measuring incorrectly for the screen.

- Okay, so these little plastic tubies are gonna hang over the patient's ear. Oh sorry, like this. So red for his right ear and blue for his left.

- So very cooperative patient, so you can do-

- Very cooperative, thank you, Jay.

- He's who one that help.

- So I'm just gonna show Jay, you want this not... So I'm just gonna show you a mistake. Mistake would be to push it up so that it's touching the earlobe. You don't wanna do that because it's going to resonate and it's gonna cause vibration. So it should be just below the earlobe, not touching the earlobe. Okay, now very important is otoscopy, right? So before you do anything of putting the probe tube in is you're going to measure your otoscopy. So this is the Delfino from Interacoustics. I'm really excited because I've never used the Delfino before today, so I'm really happy to be here at Puretone to check it out.

- That's a different tip.

- Oh this is, okay.

- No, not that. There's another one somewhere here.

- Forgot this one that was blurred. Clean the tip, set health and safety first. Make sure that your tips are clean. So clean your tip, let's put it on the Delfino.

- So guys, one thing to note is when you do these things live, it can never be perfect because your camera and your head cannot be in the right place unless you have five people.

- Right, so I'm gonna have to look back because this is video otoscopy. Let's have a look at Jay's ear. Oh, that's beautiful. This is like textbook ear.

- Keep going.

- Beautiful.

- There.

- Right, I've taken several pictures now. Okay, so you've done it before and now you're going to put the probe tube in. Now before you put the probe tube in, I've already pre-measured, but you're gonna use your ruler. Remember the insertion guidance. For males, it's 30 millimeters. For females it's 28 millimeters. And you're gonna use the ruler to move that little black, that little black marker so that it's at that right millimeter level for your user. Now Jay has a brilliant ear. There's no ear wax really in the way, so I'm just gonna go in nice and slowly. And another top tip I have for you is, this comes from Marlene Bagatto is you see the black elastic band of this ear hook, that's on the ear hook.

Use that to help keep your probe tube in place. So usually at this point, I say to the patient, you're gonna feel a little bit of a tickle. Try not to move your head. I'm gonna go in nice and slowly, please tell me if you feel any discomfort or pain. And see what I'm doing here, I'm using the probe, the elastic of this ear hook to help keep my probe tube in place, that's quite useful. So I'm gonna put 'em in.

- In real practice, you would probably want to do it while sitting down, but here the chairs are arranged in a funny fashion, so.

- And you wanna aim for that little black dot to be at the intratracheal notch. You okay, Jay?

- So if far so good.

- Okay, so hopefully you can see nicely what I've done there. And then you're gonna do your repeat otoscopy to make sure that it's 2 to 3 millimeters away from the eardrum.

- Wait a second. Okay, go, Yeah, it's quite close.

- Yes, beautiful. Okay, so we're 2 or 3 millimeters, did you see? Hopefully, I did that very quickly, from the eardrum.

- Oh, you didn't take a picture.

- I didn't take a picture, lemme try it again.

- Press that button to take picture.

- See I've moved it now. Also to see, if you've moved your probe tube. So Jay made a good point with the Delfino, as soon as you put something else in the ear, it's gonna focus on it. There we go, got it.

- Yeah, I think they got the idea.

- Right, now you're gonna run your unaided response. So I've only put it into the right ear, just for time purposes. So we're gonna run an unaided response on the right. You're gonna choose 65, you're gonna choose pink noise, five second duration. Okay, what am I seeing here? So we've got right side, single-sided. I think this black line is the predicted.

- It's REUG. The black line is predicted.

- Yes, the black line that you seeing on the screen is the predicted unaided response for the information that we've put into the system. And the blue line on the right side that you're seeing is the actual measurements. So you see Jay's beautiful natural peak resonance there of his natural ear-shaped of the ear canal resonating. And then from three to four those are his natural concha effects.

- Oh, what can I say? I'm perfect.

- There we go. Now once you've done this, this is where you're going to have to connect your hearing aid as well as the hearing aid software. But for now, because we are gonna do an occluded response, the hearing aid doesn't need to be connected. So for time purposes, I'm just gonna save time and I'm gonna put this mold with the hearing aid open. So the hearing aid muted off into Jay's ear and I wanna see what does this mold do to his natural unaided response measurement.

- And make sure you don't slide your probe tube

- Yes.

- as you are pushing things in the end.

- This is where it becomes so useful to have had it anchored with that elastic. So very top tip from Marlene Bagatto, she does. So try as best as possible not to move your probe tube. Here we go. Right, so now the mold is in Jay's ear. So we've changed completely his resonant qualities. So we are gonna go onto the occluded response now and then again, we're gonna do a 65 pink noise for five seconds duration. So that's his natural in the blue. Let's see what this mold has done. And see I'm in the way. So this is a good top tip, I need to move.

- So the first sound you hear with this system is a calibration sound. And then you start recording the signal with this button here. So this is what this particular to this system. If you use some other system, you might have different buttons

- What you're seeing on the screen, the green line underneath the blue line, this is Jay, the effects of this mold, of this mold with this venting and this closure on Jay's ear canal. And we can see actually, it's having quite a big effect. It's closing, it's closing that fit quite significantly.

- Post this picture, if you take the picture.

- Here we go, live. Perfect. Now the next step, after you've done your unaided response, your occluded response, you're now going to switch this hearing aid on, open up the software, unmute the hearing aid and we're gonna do an actual the REAR, the aided response measures, 55, 65 and 80.

- And of course, we were organized for this. So we actually have a hearing device in the coupler which should give us those responses to a reasonable level.

- Are you okay Jay, do you wanna take this off? I'm gonna remove from Jay because there's a hearing aid in the coupler, right? So just for time purposes it's easier if we do this, we show you the aided response with the hearing aid in the coupler.

- Seems to be turned off.

- Right, so some top tips there, all softwares have an on top mode that's really useful because you've got your fitting, your hearing aid fitting software and you've got the REM software on top of each other so you can make your adjustments as you go along. So in the coupler Jay's currently running a 55 ISTA signal, so that's what you're

seeing on the screen there. So there, the dotted line is the target, the solid blue line is the ISTAs run at 55. And we've got the hearing aid software open so now we can start making our adjustments. So we wanna be within plus/minus five decibels of the dotted blue line.

- So remember when I make the adjustments, I'm trying to use all three levels rather than just one. And secondly, obviously, you won't have somebody talking while the measurements are running Which just is not acceptable to the system. Okay, it's not perfect, it's livable. But let's do other measurements first before I change it further.

- 65.

- That's quite close to where we want it to be. So remember the dash line is where we want the amplification and the solid line where, is where it is.

- Amazing. That's really good. So you see, actually, your target matching pretty good across all of those frequencies. The exception is the soft at 3k, you're a little bit like five decibels, more than five decibels out and those louds can come down a little bit at 750.

- So I've reached the limit of the device at the 3k and therefore there's nothing much I can do with it unless I change other parameters. Whether it's the feedback manager or the mold parameters, the system won't let me exceed that level. So that's the limitation of the acoustic coupling and the programming that I'm using. Rest of them are pretty okay. If I were being pedantic, I will reduce it a little bit more from here, which I have done, let's see what we got just while we are at it. So I'll accept it here for the purpose of this tool can, not trying to exceed the time any further than it has already, but usually we'll try to get as close as possible to these lines within 5 dB which is the consensus that most of the best practice guidance will have.

- And then crosscheck with your SII.

- Yes, so the system gives you the speech intelligibility index aided and unaided. So pretty much nothing unaided through 30 in aided at the 55 or soft speech level. Medium speech is 46, which is 42 dB, 42 plus then what it will be like in unaided condition and so on so forth with the high levels as well. And you can measure them against that slide that we showed you on the research-based figures on what SII is good enough for these fitting.

- Those figures are fantastic. It's something new. They were only published in 2001 so we never had adult figures, before we only had the the foot pediatrics. So definitely that slide that Jay showed you, please download. And in that study there's a graph and a table that you can reference with the actual numbers. I highly recommend 'cause it's a great crosscheck. Jay's just run the MPO suite. So remember in MPO, 90 because we are in the coupler test box, so we are not in a person's ear so we can run it at 90 and we're looking at what head room do we have. So the hearing aid, you see that solid pink line actually we need to lift up those compression knee points. So in the hearing aid software, as much as we can, we're gonna try between 250 and 2k to lift. From 2k to 4k, it's pretty good. And then we can try lift again between six and eight.

- So two things here, when you exceed the levels of your stimulus from 75 perhaps, you have to be a little bit careful. So if somebody has hyperacusis, tinnitus, you have to warn them there will be a loud sound and make sure that you understand that loud sound is not going to affect them adversely. So be careful when you use any signals above 75. And in my practice, I usually use 55, 65, 75 gain rather than 80 that we adhere in the coupler. The other thing is, as Nicole said, you can reach 90 decibel of tone sweep with MPO measurements here in coupler with real ear, you keep it at 80 or 85 again. You use tone sweep rather than a modulated speed signal because you want a pretty steady signal which doesn't change in time.

So you get a good idea of where the peaks of the amplification will be. Now I was particularly keen on finding that this MPO doesn't touch the 3k level because then I might have slightly more room to be able to manipulate these frequencies, which I couldn't in the aided measurements there. Unfortunately, it's actually touching the uncomfortable level. So if this were the real uncomfortable threshold level for the patient, I'll be worried about these sounds, but it isn't, I just made up that audiogram. So either you reduce this or you try and figure out what's the uncomfortable loudness level is to make this fitting more comfortable. So let's quickly move on to the next tab on this software.

So in the advanced tab you can do those set calibration and you know, there's lots of other signals present here. So if you want to measure frequency.

- Here's frequency lowering S, it needs to be this S and in Aurical software, do not use the ling S, it is not the calibrated S. Always use the calibrated frequency lowering S. So in any soft software, be careful of the ling. It needs to be an S that doesn't have spectral peaks because it needs to be one that's not going to move. So you can get it into that MAOF.

- And then you can run the live speech as well to see how well... Well in fact, the live speech is not going to be much different because the hearing aid is in the coupler. Only if I open the coupler.

- As we speak, you see the peaks are moving. So the live speech, remember there's no target. The target for live speech is going to be your dynamic range or whatever these overlay options that Jay's put onto the screen. So if it's for a musician, you're trying to see that it's not, it's falling within their dynamic range. If it's for counseling for parent, I've had really good counseling sessions where they're not sure about using hearing

aids or not. It's great to use their parents' live voice to show them this is your your voice that's not being heard or this is your voice in the aided position being heard like Jay was saying earlier. And then the last screen Jay showing you here is that lovely Delfino otoscopy screen where I've got all of the pictures that I took of Jay's ear.

- Right, there's a question here. We'll cover that and then... Okay, guys I don't think I can add anything to that. These things when you do them live, I've done them a couple of times. I try to do them a couple of times, they're never perfect. So I'm sorry that you couldn't see the pictures. But we'll see whether...

- In the recording, I think you might be able 'cause the view is on the top. So there's two of us live. So it might be that the way that you've set your view screen, you're only seeing the one camera, but you can see if you scroll to the left as in another screen.

- But the more you try yourself, you know, when I learned driving, I quickly realized that I could sit on the side seat for a hundred years and still won't learn the driving myself. I will have to be in the driving seat to be able to learn driving and it's similar sort of concept here. So you must be able to foster up all the courage that you have and do these measurements yourself. You will get them wrong, no doubt, you will get in trouble, sometimes you'll run late. All of us have done when we are doing these things because in the real-life, there are so many other factors which can affect whether you are able to record those measurements or not.

But that's okay, that's part of the game and that's how you learn, and you have to learn to deal with those situations as well. Perhaps imagine them, visualize them that this is what you're going into if you get into trouble while the patient's sitting in front of you. And unless you make the effort, you know, you probably won't be able to do it yourself. You can watch all the videos that you want to. All right, with that, you've been a

wonderful audience, thank you so much. Thank you, Inventis, Puretone, Nicole, and all of you.

- Thank you, Jay.

- Anna, you're still there?

- Yes, always here, okay. So thank you very, very much Nicole and Jay for your fantastic presentation. I would say it has been an outstanding learning opportunity. So the seminar, I would say has cover all clinical important aspects of real ear measurement, which is an excellent initial reference point for you and your client to start the journey of better hearing. So REM should not be viewed as been overly technically difficult, it is not that hard, right? Okay, thank you very, very much, Dr. Jindal Thank you very, very much, Nicole and to the Puretone team. Any questions from the audience? Jay, can you please check the question one more time? I don't see any question in this moment to be honest.

- If there isn't going to be any questions. So that leaves me just to thank you Anna for all your support. I think you've been brilliant and I really enjoyed working with you and getting those emails every now and then to make sure that I was organized enough, I needed those. So thank you so much for doing it so efficiently.

- Thank you. It was a pleasure to work with you and Nicole, and with you Dr. Jindal. So we are honored to do this stuff.

- Absolutely, all right.

- Just a couple of notes for the audience. You'll receive soon a survey, I kindly ask you to fill out. So the survey will help us to understand your needs and your suggestion.

See you next February 21st with Elizabeth Thompson and a webinar "Success Factors: Efficient Integration of Real Ear Best Practices." So I normally invite all of you to subscribe from the Inventis social media pages. Thank you once again, Jay and Nicole, and thank you for the tour of our audience. Okay, bye for now.

- Bye-bye everyone, have a lovely rest of the day or night, whatever good time for you.

- Sure, bye.