REM Workshop Part 1: Scientific Principles Underlying the Common Verification Techniques
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Anna Scala: Welcome everybody, and thank you very much for being with us today. My name is Anna Scala and I'm the Education Manager here in Inventis. It is a real pleasure for me and for Inventis Academia, which I represent, to have all of you today for the first course on real ear measurement organized by Inventis but conceived by Dr. Jay Jindal, Consultant Audiology at Audiology Planet and Miss Nicole Da Rocha, Business Developer at Advanced Bionics. Thank you very much, Nicole and Dr. Jindal for accepting our invitation. Thank you very much. It is a great opportunity for us and for Inventis Academia to have you here today. With regards to this course, this is a complete practical course in the verification of hearing device teachings. Our experts will cover all clinical important aspect of real ear measurement which is an excellent initial reference part for you and your client to start the journey of better hearing.

The course will be completed in a two separate sessions on separate days. In this first session, our experts will talk about the scientific principles underlying the common verification techniques. In the second session, which will take place next June 28th. The second section will cover bisecting and verification of the values of fitting parameters via real ear measurements. As you dwell, I invite all of you to write down any questions in the space provided that you should see on the screen. Our experts will answer all your questions during the seminar not only at the end of the event. Now, I leave the world to Miss Nicole and Dr. Jindal. Thank you very much and enjoy the seminar. See you later.

Jay Jindal: Thank you so much Anna for the lovely introduction and hello and welcome everyone. Hello from sunny Britain, something that I can only seldom say , but the temperature here is 28 degrees and I hope you're all well wherever in the world you are. I know that we've just gone through a terrible pandemic which doesn't seem to stop but so does our enthusiasm and motivation to learn and do the right thing in our clinics. In that quest, hopefully, you'll get some ideas from today's presentation. Then what we'll do on 28th of June in order to get you ready to do the real-ear

measurements. I have lovely Nicole Da Rocha with me, my partner in crime. The plan is for me to speak for about an hour and then Nicole will takeover. In-between, we'll do a little quiz on a system called Kahoot which Nicole we'll talk all about and it's very straightforward and really good fun. I hope you enjoy the next couple of hours and learn the best in real ear measurements and then more importantly implement it within your clinics.

This is the Session 1. As Anna said, we're going to talk about the scientific principles underlying the common techniques that we use in the clinics for verification. Today, we'll just cover how and why we do the real ear measurements. Just quickly touch on the prescription targets, particularly NAL-NL2. We will also be revisiting the basics of the verification parameters. Any other Nicole will cover very well for you, including getting the acoustics of the fittings right. Whether it's closed acoustics or open acoustics stuff, area of real ear measurements, then Nicole will cover. Now, I guess before we start on, we'll do two things. We'll acknowledge these star lords in audiology, who's written so much and done so much work within the area of verification in particular but also the wider world of audiology which is pretty much given us everything that we need to know about real ear measurements. From left to right, there's Harvey Dillon, Gus Mueller, Marlene Bagatto, Professor Susan Scollie, and our own Kevin Munro, Manchester in UK. Now, before I go on, I guess this is a good time to conduct some polls so that we know each other slightly better.

I think the only thing that we miss in the online webinars is greet because you can sit in comfort of your home and clinics and you don't have to travel in this heat anywhere and still learn a lot of new and exciting things about audiology. But we miss that human touch that we all like. I just want to have some semblance of that human touch to try and get to know you a little bit better. I launched some polls. If you can click the appropriate buttons on your clinics, that will give us some idea of who we're talking to and how to pitch this presentation. Here's the first one. If I do it right, you should see it

on your screens. Brilliant. Yes. Some of you can because you're already clicking on options. Keep going. You'll have to hear me as little as the time that you take in taking these polls. If you do it quickly then I'll finish quickly. Keep going. Just few more minutes. Sixty nine percent of you are awake and have voted. The other 33 percent or 32 percent.

I'm going to stop it now and share it with you so you can see your fellow audiences. Most of you have greater than 15 years of experience. Most of you have considerable experience in audiology, which is pretty good. That's great. Let's go to the second poll. Do you have access to REM equipment within your clinic? If you have any additional comments, you can always type them in the chat or the question box because these pools have to be the MCQ type and you won't be able to write anything in that. Many of you have REM equipment at the moment, which is a good thing. If you don't have it, do you know the reason why you don't have it? This is an interesting question and I heard at the end of 2.5 hours, it will become clearer why we ask that question. Because one of the things that we want to discuss is why and how and what's the reason behind all this shabang if you like you have to do a lot of things in order to be able to be run ready, not only buy the equipment, but have the appropriate training to be able to do it as well, and why is it necessary? That will become clearer. I'll share that with all of you. Its look like most of you don't have it because of either cost reasons or the business choice that you've made.

Do you perform REM routinely if you have the equipment. People who don't have it, they don't need to answer this question. Don't answer this question if you don't have the equipment, because that's a given if you don't have it, you don't perform it routinely. That's very interesting because most of you actually don't perform the REM despite having the equipment. I'm hoping we can picture to both who don't have the equipment, but may be looking into it for one reason or another and whether we can

give them a convincing evidence why having a REM equipment is so important to the audiology practice.

That will be a test of our skills, Nicole, and people who don't do it. Whether we can train you to be able to perform REM at first day after our next session. That is a practical in REM. If you don't do it on the first day, you will never do it , so 29th of June is a target for you to start doing REM in your cleaning routinely. There two more poles which we can leave to the next session. Let's move on to the actual presentation. We're going to introduce the REM in the first session. But before I start, I would acknowledge this book. If you want to know anything about probe microphone measurements, please pick up a copy of this book.

This is brilliant and it's got everything that you can learn about the REM in the contemporary settings , this is arguably the second best resource, particularly because I was the main author of it. That's the practice guidance document for British Society of Audiology that I wrote with a colleague of mine. In UK, we follow these guidelines to be able to perform REM. I've given you a tiny URL here for this document, you can take a screenshot, but I'm given to believe that this presentation will be available afterwards so you can pick it up from there.

It's quite comprehensive and step-by-step document which has got pretty much everything that you need in terms of developing your local guidance or protocol in how you or your team will perform REM, after doing this course. We first going to talk about why do we even want to consider buying this in relative terms an expensive equipment. This is the inventor says trumpet equipment, and that's the drum for couple of measurements. Why would you want to consider an add probe microphone measurements to our clinical practice?

Now I'll keep using those terms interchangeably, although I feel that the probe microphone measurement is a much comprehensive term because that includes both the real ear measurements that you do within the ear with the probe mic and the measurements that you do in the coupler as well. PMM is a broader term than the REM. Now, we want to do it because we're dealing with variability all the time. If there are 100 people coming to the clinic. Let's pick up one parameter. What is the average size of the ear canal versus the individual patient who comes into the clinic. What is the size of their ear canal that will vary and therefore the sound that's getting into the ear will vary.

The physical properties of the ear will make the sound different depending on the size, shape, and the compliance of the ear canal, so if the ear canal is big, if the ear canal is small that will makes some difference to the same amount of sound. If the shape is different. Some of them are pretty bendy. You won't be able to see the eardrum properly in some ear canals because the ear canal is so bendy and the interior recess of the bone above the ear canal comes in the way. You don't have a very good view of the eardrum, but some of them are brilliant. Compliance of the ear canal, so have soft or hard the bones and cartilage are within the ear canal. It's not only in the childhood that this variability is there in successive age groups, but also within the adults.

No adults has the perfect two CC ear canal volume and same amount of impedance values every time you see them. They will vary. In fact, they vary between the ears as well. The compliance of middle ear will make a difference. There are papers about it, very old paper now, but still relevant. But even when you find the compliance within the normal range, that is between 0.31-1.20 CC or millimoles, that can result in as much as 6.5 decibel difference between the insertion gain and functional gain. It was done in the times of functional gain, that is 78. Imagine even with the best directional microphone, you will probably get a benefit of four or five decibels.

We claim that the modern carrying devices are so good at reducing the noise much better than the older ones with that small dB percentage. Just the compliance of middle ear can make a difference of more than six decibel. It's a huge variability between the fittings which we're encountering every single day in our clinics. Of course, the physical properties of acoustic couplings, what ear mold or down that you use will make a difference in the sound. Depending on this particular figure, whether the vent is one millimeter or three millimeter or no vent, there is a difference of almost 28 decibel at this frequency alone.

Anything below 1,500 hertz thing will get affected because of the acoustic coupling. But also how deep the insertion is of the acoustic coupling. How big the length of the ear canal part of the mold is or how deep the speaker, if you're fitting in a receiver in the canal type device, how deep that is that, that will govern how much of the high frequencies you are getting at the level of eardrum. Because a very high frequencies, as you know, higher the frequency, shorter the wavelength, they just get lost before they even reach the eardrum if the fitting is not deep enough.

Although some of the products will claim these days that they can go 10,000 hertz or above 10,000 hertz. Unless you're very close to the eardrum, you're not getting those frequencies. Unless you're measuring how much sound is an individual ear getting with the hearing device in by putting the probe microphone measurement systems mic in the ear, you have no idea how the sound is getting to the eardrum. There are all these variables that you have to encounter in each and every fitting. There is no averages that we're dealing with. We're dealing with individual people and individual environment. They're changing all the time. To reduce the variability, one of the greatest tools, a starting point for your fitting process or better hearing journey for your client is the real-ear measurements.

Here this paper talks about the intersubject variability. Whether you use the TDH headphones or you use the insert earphones. What they did is a really cool study with 51 people. They put TDH headphones and insert earphones and measured the actual sound pressure level at the eardrum. They put 90 decibel of the sound from the intensity dial of the audiometer in each of the ear, but none of the ear received 90 decibel at the level of eardrum. As you look at these values, the mean values were these, which are all different from 90 decibel for the TDHs and these were for the insert earphones.

None of the frequency produced 90 decibel in the ears that were tested within this study, which was quite a good number of people, 50 ears. The intersubject variability for the TDH headphones for a 90 dB stimulus range from 9 dB to 36 decibels. Can you imagine? You've done somebody's PTA and you found that threshold to be 50 decibel but in actual fact, the threshold could be anywhere between 50 and 86 at 8,000 hertz. That's a big range. Same is for the insert earphones. Lots of variability there.

More so for the seedling when you set the MPOs and the effect of loud noises, there can be a great amount of variability there as well. Unless you've taken the individual ears into account by measuring the sound pressure level at the level of eardrum with your relay system, you will never know how much that ear is getting on the basis of the graph on the screen which as one of my pediatric patients said, hugs and crosses so zeros and Xs on the screen.

Then if you just take manufacturer's fit, so if you try and program a hearing device, use the manufacturer's formula, and then you actually measure the level of sound a hearing device is producing at the level of eardrum via REM, there are large differences in there. People have measured different acoustics, they've measured different devices, and there are large differences from one device to another, from one ear to another when you just use the manufacturer's fitting formula.

I found this picture quite amusing when I saw it first on the social media a couple of weeks ago which says that if you use the manufacturer's fitting, and this guy is obviously trying to pretend as if the sound is between his fingers here, so he's missed it by a complete margin. That just sums it all what the REMs do. They give you that accuracy that you need in order to get your target at the point. If you play darts, then you know that you can hit the bullseye with the target but with REM, we always try to be within the green circle here. Within five decibel of the target when you've taken the measurements.

That will become clearer as we go along in the course and finish it on 28. The idea is that if you haven't measured the actual sound that the hearing device is producing in the ear, you are just blindly following the target, which may not be true for that particular patient. Imagine, I don't know, you go to your doctor, and they have to prescribe you some medicine, and they do that without measuring your weight and the actual dose that you will need whether it will work or not for you.

It's the same thing that you're doing if you're giving somebody a hearing device with some volume setting, some amplification across the range of tones without actually measuring what you're doing. You haven't measured the dose of hearing for that particular person, and you've just given them randomly a dose which you feel that because it worked for average people, it will work for them as well. But the data shows otherwise, it doesn't. It doesn't work really.

Another analogy that I was attempting to relate it to was that if you're trying to drive at 30 miles per hour and if you have so much variability and caught driving at 42 without understanding that you are looking at the averages, then you are in big trouble. You can get a ticket or you can get your license canceled if you're driving for more than 40 miles per hour at least in the UK, where the speed limit is 30. Excess speed kills, and

extra volume probably hurts the ear. You're not doing your job properly basically by not matching that target.

Here is a recent example I wanted to show you. I wanted to fit this line with the hearing devices and we'll go through it in more detail later, so if it doesn't make sense to you, don't worry about it too much. We are looking at this dashed line where basically with the real-ear measurement, the main concept for some of you who haven't ever seen a real-ear measurement being performed. This is the way that I describe it to my clients as well. That when we generate an audiogram, we can convert the audiogram into the audiometric target for that particular client for amplification, so that becomes our amplification target.

We have some calculations by which we know how much sound that ear needs on the basis of the audiogram. When we put that microphone in the ear from our special machine, namely the trumpet, and real-ear measurement system, then we know how much sound is there in the ear. We know how much should be there from the graph of hearing, and we know how much is there from our measurements so we can match the two. That's what REMs are about.

We have this target generated in the system on the basis of the graph of hearing. This is the response from that ear. If you look at your screen, this is the response on the first fit, where I usually use NAL-NL2 for the hardened lines. Here, this is the response from the left ear. Then after the target match, I've found a really good match. The idea is to match these two curves and match these two curves from the left ear. For the right ear, there's a good match up to this frequency, and for the left ear there's a pretty good match all round. Unless I did these real-ear measurements for this particular client, I will never be able to prescribe a proper amplification to them, and that is why we do REMS.

This is not just an individual case after case, as I showed you the data, will show the same discrepancy. Now, this was quite interesting and we'll talk about it later on, perhaps in the second session, where it helped me to prescribe frequency lowering as well on these frequencies where I just couldn't match the target at all. The right amount of frequency lowering was prescribed only because I knew what I need to do after doing the real-ear measurements. The evidence suggests that fitting to prescriptive target levels will lead to more comfortable listening.

When you actually fit to a prescriptive target level, rather than just randomly prescribe the fitting, it will be more comfortable. You will have significantly improved speech quality and intelligibility and then fitting that deviate from the target. You've set a target and unless you reach it, then you have a problem. That's the idea. We know that if you are fitting children, fitting closely to target has been shown to ensure consistent audibility and which is an important factor in long-term outcomes. There's speech and language, and the academics learning behaviors, etc.

Therefore, it is important to verify if the hearing device is achieving the target level of amplification in the individual ear. As we have discussed, unless you verify that that target has been achieved, you haven't done your job properly. I'm not saying that's the end of unknown and beyond. That's the basic starting point. You set out to achieve, in a hearing aid fitting, what are you trying to do? You're trying to prescribe level of amplification to somebody's ear. We know that if somebody has, let's say a flat 50-decibel hearing loss, five people have flat 50-decibel hearing loss, those five will have different level of amplification with their hearing device because of the differences in their ear.

Even if you keep the same hearing device, same coupling, everything same, hearing loss same, all five will have slightly different amplification at the level of eardrum because their ear canal sizes will be different there, middle ear compliance may be

different, etc. Unless you have verified it, you have no way of knowing whether it's different or not. The Probe Microphone Measurements are reliable, and accurate procedure for determining how well a hearing device is matching prescription target, and for adjusting the device in order to improve the match. That's all it does. It matches it and you can adjust the amplification to match the target. Additionally, you can verify the digital features, will again be discussed, so directionality, how well the directionality is, and there's a whole range. There's an interesting study from the UWO group where they measured the DNR of different products of five or six main manufacturers. They found that mild DNR application in the software for one product may be completely different than mild DNR application in the other. If mild provide 0-4 dB DNR, let's say, in the other way, it might provide 4-6 decibel DNR.

You don't know what's happening unless you verify. Those prescriptives doesn't seem to mean anything in terms of when you compare one manufacturer from other. Noise reduction, how much are you claiming? That is number 1 complaint of everybody coming to your clinic that they can't hear the noise. Unless you measured how well your device is actually catching for noise reduction, you will never know because whatever is claimed by the manufacturer is in very specific settings. It's like if you go to buy a car, they will always give you a mileage figure, which is really obscenely high than what you will get in the end, because the car manufacturers will assume ideal conditions, which never happened. You only get lesser mileage than claimed. Don't get me wrong, I'm not really condescending the technology companies here because they're amazing and because of them, we can do our job much better. All I'm saying to you is that you have to understand how the technology works in order to make it work for your client. Because at the end of the day, it's your job to make the technology work for your client. It's not technology job.

Some people think that it is. That's why we have all these PSAPs on this companies jumping into before the full array of hearing care, where you can buy OTC products,

etc. Because I think that is too easy. I think we are partly guilty of that by not following enough scientific methodology in order to make processes robust enough to create the value in the professional and professionalism. With all this hoo-ha, what do we get out of it? We know that you can mass target and we know that the real-world outcomes will actually improve when you match the target and validate your fittings as well. This is a big study on number of subjects that they recruit for these Marke Trak surveys. If you haven't been following them, you should and you must because it gives you such a great insight about the hearing industry. This is I think from number 8. Now we are on 10. The data for 10 was released last year, I believe. Which shows that if you do verification and validation, that results in lesser number of visits normally and actually better speech intelligibility scores when you do it. This is for some data from number 10. Number 10, where they've compared the hearing aid versus PSAPs. They asked the customers who had PSAPs only.

The person amplification devices and who had sharing devices? How their sound voice, hearing it did come out to be fairer than the PSAPs. But you see, these are big numbers. Sixty-one percent of them found them very easy to use. Product quality was really good, 55 percent found the appreance is really good. They are bound to work for a number of people. When people buy these cheap amplification devices, whether it's the Bose's new hearing devices in the De Novo category as FTA concept, which you can buy over the counter, program down with an app, and use it for mild hearing losses. Apple's working on their own Airpod Pros to reduce the noise and enhance the speech as they call it. That feature will be there in the iOS 15, so you can amplify the sound a little bit. This effectively is a hearing device which you and I can control without having specialist knowledge as a consumer. The Samsung's purportedly leaked Earacle device, which looks and works like a hearing device.

All these consumer electronic companies coming into the full array only because I guess at least some of it is because we have left a space where we made it sound like

it's the technology which is so great. That's why these new modern hearing devices work and not because of us, the audiologists in the middle who actually makes that technology great for the clients by customizing it. If you say that this hearing aid has this feature and that feature, and that's why it's great. Where are you in that? The hearing aid is great, but where's the audiologists? What's your role? If the technology is great, then why not just cater to the larger population within their home over the counter? Why do you need to be in there?

Again, similar graphs where you can see how when they compare these self-programmable devices or even non-programmable devices with the hearing devices. It's a line in the middle more or less these days. A lot of people are preferring what they can program themselves and then fit themselves rather than what they will get value out from the audiologists. That is why in the 21st century audiology, you will have to create that value for yourself and you will have to follow the science. It's not Voodoo, it's proven facts. I've shown you research, you can challenge any of the stuff that I'm showing you today, and Nicole will be showing you after May or on 28th. Hopefully, we will be able to answer it in a scientific way. We have the signs, all we need to do is apply it in our clinics so that we're not threatened by the stuff that's bound to come in next couple of years or so if more slightly longer, lot of people will be buying the OTC devices. But I guess that's a good thing because we know that about third of people who can benefit from the hearing devices, every one in three. I'm not using them. Those are the people. If they try OTC and if they find whether it works for them or not, they are bound to be about 50 percent people for hearing aid won't work and they will be coming to you. Then you can show them what difference do you make which they don't get by trying to program that technology themselves with this clever software. The future is bright, but as bright as you make it for you, by doing the right thing, by following the science. I quite like this latest systematic review that Kevin Munro and his colleagues have done it in Manchester in UK. They've looked at lots of studies and out of those studies, when they tried to conclude, they said that there is

moderate but statistically significant positive effects of REM compared to the manufacturer's initial fit when you look at the speech intelligibility. Speech understanding of the clients will get better if you do REM. There are number of studies they've utilized to be able to conclude that. There were other statistically significant positive effect of REM on self-reported listening abilities. The client like it as well and that's what the market track server will show. That they have more trust and more faith in their clinician when they follow the best practice guidance, including REM. REM is included in all the best-practice guidances around the world, no matter which country you look at, whether it's America, Australia, UK, New Zealand.

All the other European audiology organizations, every single practice guidance will speak very highly of doing REM within your clinical settings. I haven't come across one which doesn't. Collectively, we know that it's a good idea. I'm not sure I completely understand why we don't include it within our clinical regimen. That's my trumpet, by the way. If you haven't seen trumpet before, sitting proudly in my home office with my beloved plants. Second love of my life. Anyways, so benefit of REM; it's a great value addition. It's not be-all, end-all. It's not the only thing that adds the value, it's not the only thing that you do to improve the fitting, it's not the only thing that you will do at the start of hearing journey, but it is one of the most important things that you will start somebody's hearing journey. Because if you don't do REM, you don't know whether you prescribe the right case of amplification. That's the first reason why patients are coming to you and you don't know whether you have done that or not. You just hit the arrow in blind or threw a dart in dark and you're hoping that you will hit a bulls-eye. That's essentially what you're doing. If you're driving like that, then your license will be canceled.

They help you to correctly optimize the volume of the hearing device and its digital features. That's the only way you can do that. You can hope that the software will do it. But it doesn't do it for most people, if you haven't verified it. You can make the sound

more comfortable with it because you do REMs at high level, 80 decibel, 75 decibel, loud level. You measure the ceiling of the hearing device, the amperes as well. When you do REMs, more people are found to be keeping the hearing devices. They don't return them within the return period. Retention rate is much more for the clinics who do regular rounds. That big business case for them. You have less follow-up, so you save a lot of clinical time, which you can use in counseling and validation, again, building the quality of your service. All these combined together and a software which is measuring your hearing and then programming itself through a smartphone app that you can put it together side by juxtapose them and feel which one will you go for if you have to choose in terms of professional service or an automatic service.

But if you haven't included all that and if you look at the starting process, what process you follow, in order to prescribe a hearing device, I'm not sure you can find much more differentiation in the service provided by the professional and by the software application. If you want to challenge me on that, you can perhaps put something in the chat and we can have educated discussion about that. I always say this, good quality is good business. If you provide and follow a scientific practice, it will improve your clinical quality and it will improve your business quality as well. Because everybody who is coming to you understand whether they know a about audiology or not, they understand whether you're providing them a good quality service or not, or they will understand sooner or later anyways. This is a competitive world. You have lots of competitors who will be providing good quality service. You build a better hearing journey around every single contact point. Just give me one second, sorry. Children outside making the noise.

You build a better hearing journeys here. I usually do a video transcript in every single person who comes to my clinic. I do tympanogram, OEs, as well, acoustic reflexes, tone and speech audiometry, and then I talk about their hearing in much more detail. Every single person gets the picture of the eardrum. This is really interesting. I didn't

realize I was putting this one. This was probably the last patient I saw on Friday. As you can see, it's a right eardrum because the handle of malleus is pointing towards right. They have got this very curious retraction only in this area, posterior area of the eardrum. Where the eardrum on the anterior radial joint and the lateral process of incus, which actually resulted in normal tympanogram, but some conductive element within their hearing loss, which I could tackle with. But they were very interested in seeing this. It's a very small thing, interesting thing for me to take a picture. But they were interested in seeing this, and they were interesting in seeing this process that I did by measuring the audiogram, speech audiometry, and then doing the REMs for them.

Just an impression wise as well as clinically, I was satisfied that I had done as best as I could for that client. The client was happy that I spend the time in looking at every single aspect of their auditory system. That is what I'm trying to fix, I'm trying to fix the auditory system for them. So I need to have the whole information, how from beginning to end, the things we're working on. If there are no questions at this point, then I'll move on to prescription targets. Any questions?

Nicole DaRocha: Hey you, Jay.

Anna Scala: Yeah. In fact, I saw a very interesting point from Miss Annie Hogart. Nicole, Dr. Jindal, And ask them, ram matches pure tone. Is there any way it can be used for speech audiometry to which would seem to be more important?

Jay Jindal: Well, this is interesting. We don't match pure tones per se in the ram, we actually use a speech signal to match the target level of amplification. Now, I really need to concise what I could say about this because of the time. It's very interesting and I agree with the sentiment of that question in the sense that the speech is much more important, practical thing for us to hear. Why are we basing the amplification targets on the basis of pure-tones? I think that's the question Anna, wants to ask

basically. Now, the pure tone came much before and the digital hearing aids where we could match the target and that is the only reason. If the pure tones didn't come after the World War Two, for all these people who were coming back with the hearing loss and the Pension Department had together figure of their disability in order to prescribe them a certain amount of money based on their disability.

That's how the pure-tone audiometry was formed. Cohort and whose father of cardiology, considered as father for cardiology, worked on this project for us and Pension Department in America. Now because we had ballpark way of measuring how the hearing levels are, we developed all the prescription algorithm for the hearing at which came much later than pure tone audiometry on the basis of that. Obviously our knowledge about the old system has improved a great deal since then. We know that we don't go around in their real life listening to the tones. This is mainly to do with the speed, but there's no real way of translating the speech information into an average hearing ability. We can only do that on the basis of pure tone audiometry in one way or another.

You can do it for individual person, on an average, you wouldn't be able to do it. With prescription algorithms when dealing with the averages based on the hearing loss that we identify through the pure tone audiometry. But at the end, we use the speech-based system to understand how well this client will follow the speech. That's pretty robust because as I've shown some of the papers here, but some of the papers, we'll keep showing you until towards the end of the course. Which will show us that once you've done this process based on the PO2 at the amplification targets, delighted by the pure tone, and then leading to the speech intelligibility, well, we need to. I hope that answers that question in a non-broad way ?

Nicole DaRocha: I agree with you Jay I also want to say, Anna, I think I understand what you're saying because you want functional measurements, you want real-world

things. This is where it becomes interesting because you can actually do functional live speech testing in rain equipment. I'll speak about that a bit in my part of the presentation. Yes, I agree with Jay, we need we have an average across the board and that's why we use the pure tones and the prescription targets, which he is going to talk about now. Thanks Jay.

Jay Jindal: Yes, that's very nicely leads needs to reduce, the prescription target. When we talk about the non-linear prescription, that's what all the compression systems will prescribe. No matter whether you use the manufacturers prescription targets or the validated ones, mainly NAL and DSL targets. In my head, there's two categories. One that the manufacturers derived for their own products. Two, that, some teaching universities have derived for us. The main ones are NAL and DSL, which majority of people who use these validated targets will use. But there is a conflict prescription formula from Cambridge University as well, which is slightly lesser used, but still there are lots of paper bound.

Now, in all the prescription targets that are derived on the basis of compression systems, the hearing aids with compressions, and all of the hearing aids have compression these days. They have four basic concepts in derivation of those targets. Noise reduction, so you want to put low-frequency slightly down, high frequency slightly up on, the basis of the fact that most of the noise around us is a broadband noise with predominant components from the low frequencies. You want to improve the audibility or dynamic range of the compression and the dynamic range. We want to make as many sounds audible as possible, whether they're soft to loud, without affecting the comfort. You want to normalize the loudness.

I'll leave the rest of it here because we're going to discuss that in a little bit more detail in a slide that I'm going to show you later. You want to have automatic volume control or ADC or the compression. Soft sounds are more amplified and the loud sounds are

less amplified. Then you can have what some people call propriety fitting formulas which are derived by the manufacturers. Generally, the manufacturers do spend a lot of times on these fitting formulae and in particular in getting the technology to us in the way that it comes. As I've said earlier, I have a huge respect for all the research behind the process and everything else that goes on at the manufacturer's level because without the technology, we won't be able to do our job. That's one of the main things that help us to do our job effectively.

None of it that I'm saying, isn't a condescending way, I'm just talking profession to profession for you to make the decision, what you want to do within your clinical settings. But here are some things, how you can make some decisions on the basis of not only the science behind it, but the philosophy or the approach of your own clinical practice. Manufacturers fitting formula is developed mainly on two types of data. Preferred sound quality of the users and initial acceptance status. If you look at 1,000 fitting for one particular product, how many of them are returned and how many of them were changed, etc. If the patient reported after fascinating us to attorney, the fitting formula in the main, if number of patients reported was 210 in the fitting formula and domain will roll off the highest in the next version of the manufacturers software if the audiologist reported feedback.

If the audiologist says that many people who I see they complain, it's too tiny or it's too this, too that, then the main formula will get some adjustments made. If the audiologists or the patient reports that this brand of hearing device sounds better to me than that brand of hearing device, again, the main fitting formulas change for you. Lot of the adjustments in the fitting formula are done on the basis of feedback from the audiologists and the patients, which has its good and bad. I find in general, particularly with the manufacturer, I worked with most of them, but some of them more than the other. I've chose what I worked most often with, their hearing devices in general have

less a high frequency gain, than what NAL-NL2, will prescribe. I end up improving the high frequency gains a lot more through the verification process than anything else.

In my head, I don't have any scientific papers for it in my head, that's because the high frequencies cause the feedback. Manufacturers don't want their product to cause feedback, so I think the high frequencies are rolled off a little bit. If you don't do the verification, you'll never know what's happening in that ear. Anyway, this is a study where the researchers tested different hearing aids on manufacturer's formula for different inputs. If you look at the same colors, they were all different for the first fit. The one device gave different sound than the other device, but the same hearing loss. It doesn't make much scientific sense to prescribe a hearing device to somebody when we know that the volume of that device is much different than if we picked up some other hearing device whereas there are no difference between the person and the owner.

I go to get hearing aid for myself. I have a 50 decibel hearing loss depending on whether I get a ReSound device or Phonak device or article, I will get different volume. I haven't changed as a person. My ear hasn't changed, but the volume is different. Does it makes sense, does it? I would like it that way, I wanted more control. I want to know as an audiologist, how much sound I'm giving to somebody's ear? That's my job to prescribe the dose of hearing, and if I haven't done it properly, then I've got it wrong. In the next few slides, I'll quickly discuss NAL NL2. I'm hoping that most of you are using the NAL NL2 formula. If you're using DSL, I have a couple of slides that you can read in your own time, the differences between the NAL and DSL, but as I find in my own courses as well as my own network, this seems to be the main formula that we tend to use. That's why I've got a couple of slides on here to tell you what it's all about. NAL-NL2 works on the principle of giving the equal to normal loudness and maximizing speech intelligibility. It's very straightforward. When the prescription formula that we

use, there are two things that we want. One is the loudness has to be equal to normal for people with hearing loss.

If I have a conversation with somebody for three hours, my ears don't say that it's too loud. If I give a hearing device to somebody else who have a hearing loss, he should have the same comfort in terms of the loudness. They should sound loud enough and should be comfortable. Then obviously, we want to maximize the speech intelligibility in those broken cochleas. That's the important point to remember here. Again, I'm sure that you do too. I often say to my patients that it's not like glasses where you're dealing with the power of eye muscles, and you put the lenses in front and the power becomes 95-100 percent better for most people unless they have glaucoma.

It is that when you have a sensory neural hearing loss or any permanent hearing loss, some part of the ear is not working. If it's a damage in cochlea, some part of the cochlea is permanently dead, we can't revive that part, but what we can do is we can use the left to its maximum capacity. You never get a 100 percent benefit or even 95 percent benefit even with the best hearing devices in the world. I guess even the best devices in the world don't go up to 16,000 hertz, which is a range of adult hearing . They only go to about 8,000 hertz. Actually 10,000 hertz arguably.

We want to use the rest of it to maximize the speech intelligibility, not make it normal, but to maximize them. How we look at the loudness in the device. It's based on this model adopted for Moore and Glasberg. We know that any sound, even at threshold has some finite loudness. As the level of sound increases from the thresholds for the first few decibel, a loudness increases equally to somebody with normal hearing and hearing loss. Let's say my threshold is 10 and I have a patient who's threshold is 15. At 15 DBHL, I should have quite the same loudness as my client has at 55 decibel. Five DBSL, same loudness.

But we know that with sensory neural hearing loss, as the intensity increases or the sensation level increases, sound above your threshold increases, we can encounter the loudness recruitment. Suddenly, it becomes too loud for the person with hearing loss. It may remain within the normal loudness levels for person with normal hearing. There are obviously differences between the monaural and binaural loudness. If I have sound in both ears, that increases because of the summation at the level of brain than if I have sound only on one side. All this is taken into account when we prescribe certain amount of amplification to somebody.

How much hearing loss they have? What level for those 80 decibels are you talking about? The loud level of speech being amplified? Medium level or soft level of speech is amplified, because we know that loudness perception will be different. For loud speech, medium speech, and soft speech with somebody with sensory loss. Again, another thing that we want to tackle is the speech intelligibility. Just give me two minutes of your attention and it will become really easy to understand. It's really simple concept, but lots of wordings here. Let's look at this graph. One-third octave SPL is the common dividing technique that we use when we talk about the speech signals.

That's why we are measuring one type of octave SPL on this axis, and we have frequencies on that axis. We have a threshold of hearing. Of course, the frequency, we have a threshold. This is the speech spectrum. That's the upper range, 95th percentile, and fifth percentile, and average speech spectrum, which is mostly about 30 decibel apart from each other. Anything above this threshold here is audible. This bit is audible. The bit from the right-hand side is not audible. This speech spectrum is not audible, only this bit is audible. If you introduce a noise with anything below the noise, we can't hear. We can only hear what's above the noise.

Fifty decibel of noise is present. We can hear the speech which is at 55, so we can hear, this shaded area here. That's what this graph is about. Anything above the

threshold is audible, anything below the noise is not audible. The shaded region is audible within this spectrum. Now it turns out this is important point, this is the point of this line. We can quantify the proportion of this information coming in in decibel at each one-third octave frequency. Each one-third we can quantify it. How many number of decimals are coming in? We know that very low and very high frequencies do not contribute as much to the speech intelligibility as the mid-frequencies do.

The mid-frequencies are more important. In other words, than below and high. We can multiply the audibility that we've got times the importance of each frequency, that gives us a contribution to the intelligibility of each frequency. Essentially, what it means is that if somebody has a hearing loss of, let say, 50 decibel at 1,000 Hertz, they do not get 50 decibel gain. That will just be too loud for them. They get a percentage multiple of that 50 decibel in order to achieve an optimum gain. In this figure here, that calculation comes to about 30 percent. So 0.3 into 50 will be the gain, which will be about 1.5. Then there's another twist in that that if the speech is too loud, intelligibility goes down.

There's a rule of effect even for normal listeners due to the upward spread of masking. At the very loud intensity, you know how the loudness system works in cochlea, the more the basilar membrane vibrates, the more the loudness that we perceives. If it vibrates too hard, then not only the tonotopic point of that frequency, but other points on the basilar membrane starts vibrating as well therefore the spread of masking which affects the speech intelligibility. When the amplification goes above a certain range, you get lesser amplification than one. For every one decibel increase in hearing loss above a certain range, you will get less amplification. That's a very convoluted concept. If you are hearing it for the first time, you might have found it slightly difficult within these two very busy slides. But the idea is that mainly, you're looking at two things within the prescription target based on number of researches that these experts have done. How to equalize the loudness, or how to make the loudness equal to how anybody with

normal hearing will perceive. That depends on how much hearing loss they have, recruitment, etc whether that's present. Also, whether they're hearing from one ear, both ear, binaural fitting, that will make a difference. Your gain in the hearing device will be accordingly. That's why you have to select the right parameters.

How to maximize the speech intelligibility. That depends on how much hearing loss somebody has, whether it's a flat configuration or sloping hearing loss, where we know that if we try to increase the volume after a certain range, that will actually cause more distortion at the level of cochlea, and therefore, in the understanding. There's a lot of thought that has gone into developing this prescription algorithm. You can just take probably a screenshot of this slide, and you can read it in your own time. What are the main differences between NAL and DSL? But to be honest, the latest version of NAL and latest version of DSL are much closer to each other than they've ever been.

There are studies after studies which keep telling us that whether you use NAL or DSL, the ultimate outcomes are not that different lo and behold. As long as you use taught out scientific validated prescription method, preferably one of them, then your outcomes are pretty much the same. Once you've chosen your target that this is the amplification you want to provide, then you have to make sure that this is what is getting to somebody's ear, by doing the real ear measurements. I'm just going to quickly go through the measurement screen. I think I'm doing okay for the time. When you look at the measurement screen, this is taken from trumpet. You will see, this line here which is your uncomfortable loudness line derived by the software. You will see a target of amplification. How much amplification you want to get across the range by this dotted line. This solid line is actually what the device is doing in the ear.

You could place the probe microphone, the mic, the tube, the wire, which is this one. You place that in the ear, and that tells you how much is there in the ear. You know how much should be there, which is shown by this dotted line. You know how much is

there, which is shown by this solid line, so you can match the two. This system had a very handy feature where you can show distance from the target here. This will become slightly darker, so you know that you are far away from the target. As you go closer to the target, within five dB, that dark area will disappear. You know that you are right on the target. This is the audiogram here.

Now, one thing that I'd like to ask you is, you look at this audiogram, so get ready to type something in the chat, so I know that you're listening to me, and you're attentive. Look at this, at 1,000 hertz, this system is saying that I have a 30 dB response. Whereas here, 1,000 hertz is 10 dB. Can somebody tell me why there is that difference? Is it wrong? Has the software for the REM has wrongly pulled out the information from the PTA audiogram? Can anybody tell me why that is? You can type it in the chat. George gets 100 percent of the points and so does Sue and Shy . Here, we've converted everything into dB SPL. Remember that dB is a relative unit. Depending on what suffix you put in front of dB, the number will change.

This one is in dB HL, and we've just magically converted them into dB SPL by using the predicted RECD values here. Which by some account gives you about plus-minus three decibel accuracy in finding the audiogram. Plus and minus three dB of error in finding the SPL audiogram. I quite like the fact that this system, when you use it to show single-site, can give you both the REAR and REIG. They really insertion gain and ages response. The ages response is the one that you're looking at. But it's quite handy particularly for people who've been brought up to do REIG like I was, because how the analog hearing devices were, and how we used to use the functional gain, etc. With the modern technique, we mainly try to use the REAR to measure the overall output that's coming at the level of eardrum without using a slightly hypothetical quantity, which is REIG.

Insertion gain doesn't exist. You derive it one way or another. But this is what exists at the level of the eardrum that you see on the screen, REAR. This will become clearer, when we do practical. When you use a speech stimulus such as ISTS, International Speech Testing System Stimulus, REAR, speech output, it becomes speech mapping definition. This is an interesting one that I did in my own ear. Here I put the Airpod Pro and I put the microphone tube, try to measure how much noise cancellation does Airpod Pro provides. With noise cancellation off, I had more output for a pink noise as steady-state noise. Then with the noise cancellation on, it really does work, which I can feel, but now I can quantify this one. You can use it for many, many different purposes.

I've had patients coming in in my clinic wearing musical instruments. I'm using these noise flex, do their work in my ear? I'll ask them, what do you use them for, to play a guitar? Why don't you bring the guitar in my clinic and I'll put the probe microphone tube in your ear with your plug and see what result we get. I can show it to them on the screen and they get fascinated, because they can visualize what's happening within the ear rather than a hearsay, which will be when I say to them. The starting point is that they have some trust in my abilities as a professional, but that actually confirms that trust when I can show it to them. That's me, unless there are any questions. Somebody is asking, what system is this? That's the trumpet system from INVENTIS. I'm hoping you are asking about this and Anna knows everything about it. She helped develop it.

Anna Scala: Lany, sorry for how I pronounced your name, really. I can provide the technical sheet and answer all your question about the INVENTIS trumpet, which is our real ear measurement system. It is an audiometry as well. I am taking note of your email address, and so even tomorrow, I will send to you all documentation about the chat. Thank you very much.

Jay Jindal: I will add a plug here for you. I'm honestly not saying it because I'm sitting here and doing an INVENTIS webinar. I think it's a brilliant system, and I use it a lot for audiometry as well for all my APD testing. I think your speech software, I find it really, really effective how I do the speech testing. I put all my tests within the speech box. I can easily select the test and listen to what I'm giving to the clients as well. The other thing that I like about it is that you can do free fill much more effectively with the system, not only the REM system. I quite like the audiometry from Maestro software in general, so I use cello and INVENTIS trumpet a lot within my own practice.

Anna Scala: Thank you, Jay. Thank you very much. Nicole, this is your turn.

Nicole da Rocha: Great. Well, thank you. Thanks so much, Jay. Thanks Anna, thanks for managing the chat. Welcome to this introduction to real ear workshop. I think we've been going for how in a bit so everyone please stretch, get up your seats wherever you are, stretch those muscles out, and let's get into this next section. But I've tried to put some quizzes in here to keep you guys interactive and keep going. To introduce myself, my name is Nicole da Rocha. I'm a speech language pathologist as well as an audiologist. I have worked for manufacturers of probe mic equipment, which is how I came to know a lot about probe mic measures because I have been on the other side. I'm a clinical audiologist as well as having worked on the manufacturer side, so I know it from both leagues. Now, whenever I start talking about rims and the importance of rims, I like to use analogies. The analogy I use a lot, especially when counseling patients, is the analogy of treating hearing loss is a lot like making a cake. How it is, is that you're going to choose the brand of manufacturer. You'll choose Oticon, Sivantos, Phonak, whichever brand of manufacturer of hearing aid is going to give you your ingredients.

Now you fantastic clinical audiologists out there you are responsible for making sure that the ingredients that you get turn into the most tasty batter for your users and

families. You're going to measure out just the right amount of moles of milk and just the right amount of grams of butter. It's a lot easier to do this if you have a recipe that's tried and tasted. Exactly what Jay is just gone through talking about the prescription methods that we use. Now, DSL, boy or boy, loads of research have gone into those to get the recipe just right for you users. Certainly you are also going to do this by measuring the thresholds accurately, by doing all of the VRA and getting those thresholds just right and putting that into the system. Now you're going to sit with this tasty batter, but the only way you're going to get a good butter is by actually following a recipe and using your prescription targets. You can guess and that's exactly what Jay was showing you earlier. You can guess by giving just a splash of milk and maybe just two teaspoons of butter, but it's never going to give you the right amount of rise out of the cake as if that we know that prescription methods do give us.

Of course, as a speech therapist and in my current role that the treatment doesn't end there, we know that it takes time to acclimatize to the hearing aids, and this is with the oven part of the journey comes in. Also just as important is validation to make sure that they are having an oral rehabilitation program, and that you're tasting the cake. That's your validation measures like your cozy, the Glasgow hearing handicap inventory. All of those questions that have been developed to taste the cake to make sure that it is actually tasting good for your users. That's where I always start off with and let's now go into how to do those measures? How to get that right amount of moles of milk and right amount of grams of butter? This is what we're going to cover in my session. This Session 1 is more about the theory. The theory behind what these different measures are? In Session 2 what I'm going to do is show you videos, practical examples, and do a little bit of case studies for each of these measures.

We're going to start off by doing a deep dive into what is an unaided response or gain response? What is an occluded response? The difference between when you do an open fitting versus a closed fitting. Then we're going to break for a little quiz, and then

in Section 2, we're going to look at doing an aided response. What is the difference between insertion gain and during an aided response? Doing maximum power output measures, and then I'll end up by talking very briefly about live and advanced features that you can do within the trumpet system, but pretty much within most verification equipment. Then we'll end off with the second quiz. I've put a picture here of alphabet soup because very often in audiology we love to abbreviate, and especially in real ear measures, they so many Rs and Gs and Us and Is, it can look like alphabet soup sometimes.

Let's have a recap exactly of the terms. We'll start off by just talking about what is the difference between a response and gain? You'll see when you look at these terms, they either end in the letter R or they end in the letter G. If they end in the letter R, that's generally what we use to describe a response value. It means it is an absolute measure. You are taking the output measure at a specific place in that patient's ear canal and you measuring the output of the listening device, whether it's an AirPod or a hearing aid. If the term ends in a G, it means that that value has been calculated. An example of this would be insertion gain, which we'll talk about later on.

But insertion gain is derived by taking the aided response minus the unaided response. Taking away the natural amplification that our concha and our ear canal give, will give you a gain measurements. This is where the confusion comes in. What's gain? What's responses? Generally, we are going to talk about both. We're going to talk about gain when we do occluded and when we do unaided measurements. We're going to talk about responses when we talk about aided, when we switch the hearing aid on and measuring those output labels. Let's get deeper in because it'll make more sense as we go along. But if you can keep at the back of your minds that if it ends in an R, it's an absolute measure and if it ends in a G, it's a calculated difference measure.

Let's start off by talking about an unaided response. What are we measuring when we do this? When you do an unaided response, what you're going to do is you're going to put the probe tube in your patient's ear canal, and what you want to measure is the natural resonance of that individual person's ear canal and concha. You'll see that it has a specific shape generally, and we know that our ear canal gives us an advantage, it gives us an amplified advantage. That's why that is shaped-bent, and the advantage generally seen at about 2.7 kilohertz. At around 2.7 kilohertz, we see a peak in the resonance. That resonant peak can be anywhere between 12 dB to 22 dB.

The concha effects, that concha resonance is between the four and six kilohertz measure. You'll see these peaks when you do an unaided response. Really what you're measuring is that advantage that the structure of our pinna and the structure of our ear canal give us. What does that look like in real life? This is exactly what it looks like in real life. Please remember, we're going to do practicals in the next session. This is more just about the theory. So what you're seeing here is we've placed a probe tube in the person's ear canal, and that purple line that you're seeing is the measure of the advantage of that resonance, that ear canal and concha are giving.

This is what I mean by the resonant peaks. You'll see from zero, you see this peak at about 2.7, and then the next peak you see at 4K is the effect of the concha bowl, that resonant quality beam. The probe tube and aided response's main purpose is really to tell you that you're in the right place. Now, in Session 2, we're going to talk in more detail about getting your probe tube placed just right. But when you do real ear measures, generally, you want to be five millimeters away from the tympanic membrane. Doing the unaided response is going to tell you that you are deep enough to do this measures. How you will know is if you are too shallow at six kilohertz, you're going to see this dip, which you see here. That black line that you seeing is an average.

The software has taken a cohort of patients, and based on the prescription target that you've selected now or DSL, it's given an average of that person's age range. What the resonant qualities are on average for that person, adult or female, and within a particular age range. You see this actual measured response is not too far from the average, but it was a little bit shallow because you seeing that dip at six kilohertz. If it dips below the zero line, you really are too shallow. It will make a difference when you start looking at targets and matching your targets at six kilohertz, which is quite important in terms of a frequency for the clarification of speech in background noise.

Here's just a summary. You see that this is a gain response. It's a gain, so you see REUG there at the top. It's easiest to do your unaided measures in gain view because it's easiest to see it against absolute zero line. You can see what are the absolute dB peaks outside of that zero line. Also, it's easiest to see in gain view if your probe tube is too shallow because as soon as that six kilohertz dips below the zero mark, you know that you're not close enough to the tympanic membrane. The main purpose, as I said, of your unaided response is, of course, probe tube placement. Now, when we start talking about measures, aided responses, whether you choose to do insertion gain versus aided response, the unaided response makes a difference. If you use insertion gain calculations, this absolute effect does definitely have an influence because remember, gain is a calculated response.

Anna Scala: If you use insertion gain, it's quite important that you do this measured unaided response. If you do aided responses, that absolute measure does not matter too much because you are taking into effect that ear canal resonance at that output, at that specific time. It also helps to do unaided gain responses to know if the probe tube has become occluded. Sometimes this often happens, especially with our users of hearing aids with molds because you get that rumin of surumin. You know what I mean, after that first pain, you get that rumin. When you put your probe tube in, oftentimes it can become blocked with wax. If the probe tube is blocked, what you're

going to see is just a flat line. This is a really useful measure to do to make sure that the probe tube is not blocked, to make sure that the probe tube is placed appropriately, and also very interesting to see the person's natural peak resonant qualities of the ear canal and contact.

Here, I've just taken some screenshots of various different unaided measured unaided responses, and you will see that people's ear canals and conscious are so unique. I don't know if you know this, but our concha it is more unique than fingerprints. Actually, our ears are the most unique feature on our bodies because no two conchas are the same, no two pinnas are the same, so I thought that was a very interesting fact. Now the question comes in, should you measure with an average, or should you measure this unaided response on all of your patients? It depends on who you ask, but it also depends on several factors. Certainly, you want to measure that response because you want to take into account the unique characteristic of your patient's ear canal. Definitely, if you're going to do insertion gain measures, you want that unique characteristics of the ear canals to be taken into account.

However, if the patient has pathologies such as mastoidectomy or otosclerosis or something in the ear canal that is causing drastic resonant differences, you're going to end up with a really strange-looking insertion gain response and aided response. It depends on the pathologies. If they are vast pathologies in the outer ear canal, then sometimes using the measured response, the average one is better. Because remember we need a gold standard and if that person's ear is falling completely out of the norm, it's going to be difficult to use a prescriptive target that is based on normal average ears. The answer is, it depends on how wildly different that unaided response of that user is. If there are pathologies present, consider using unmeasured response, and not measuring it and taking the average responses because it's going to give you a better base for making adjustments rather than taking this wildly different looking ear canal into account.

Here are some examples of how wild different pathologies can make your unaided response. Here is a sample of a mastoid cavity. What you see in A, the black line, is a general normal unaided response with those peaks and those resonant peak qualities. In the rate is what you're seeing what a mastoid cavity can do to that unaided response. You can imagine how different your targets are going to be calculated, particularly for insertion gain, and that person might find it very hollow, very echoey, too loud. That's why consider using an average response here. Again, with hypermobile tympanic membrane, if you're seeing dysfunction of the ossicular chain, it can certainly cause the peak to resonate at a different place. Here in the red you can see peaks much earlier than expected before 1k. Again, that will cause a hollow effect, sound very odd for the patient, especially if you're going to use your prescriptive targets and otosclerosis.

Otosclerosis also peaks at a different resonant quality than a normal average ear canal. These are just examples to show you how outer ear pathologies can affect that resonant quality and what to consider, whether you're going to measure it, whether you're going to use an average. That's everything about the unaided response. Now let's talk about occluded responses. [OVERLAPPING] Yes, Nicole.

Nicole DaRocha: Sorry. I have a question from our audience regarding real ear unaided response and gain. Brenda ask you, is there a reason why we use pink noise for real ear unaided response and opaque ISTS for aided measurement?

Anna Scala: Yes, definitely. What you want when you're doing your unaided and when you're doing your occluded responses is a quick white noise type of stimulus because you just want to quickly record the resonant qualities because we're not really looking at targets to match speech. You don't want to use your ISTS signal here, really, because it's going take too long because the ISTS has spectral peaks within it. You

want to have a white noise that's going to give us the quickest resonant qualities of the ear canal, and it's also faster to do because when you do the ISTS signal, it's a long-term average speech spectrum. You've got to measure it for at least 10 seconds and more to get the average out of those spectral peaks or speech versus using a white noise or a pink noise stimulus that's just going to give you that total resonant quality. That's why you only need to do it for five seconds versus your aided responses that you need to measure for a longer amount of time. Hopefully, that answers the question.

Nicole DaRocha: Yes, brilliantly. [OVERLAPPING]

Jay Jindal: In second line, is interest of visualization, Brenda. You want equal spectrum across the frequency range. That's why you use a steady noise rather than a sound which is peaky, so the speech will always be peaky. We'll have peaks and troughs, whereas a steady broadband noise will be more equal. Therefore, whenever you're trying to measure the effect of noise on something, you will use a steady noise rather than a loud speech. That's why with my AirPod prose, I will use a broadband signal like pink noise or white noise rather than the speech noise because that would be too peaky and I will struggle to see how it's affecting the noise cancellation or off. In the same way here, there will be too many peaks and troughs to be able to identify a uniform structure. It's for visualization mainly. That's a good question, though.

Nicole DaRocha: Yeah, fantastic question. Thank you. Any other questions Anna?

Anna Scala: Yes. There is another question, but it's up to you. If you want to answer it later because the question is, what is the difference between a real ear unaided gain and the RECD?

Nicole DaRocha: This is a good question. We are actually not covering RECD in this session. I'm going to cover RECD measures and text box measures in session 2. I can answer very shortly. Your RECD, you need a text box for. Here we are describing things that you don't need a text box for. You need a text box to do an RECD because you're going to use a coupler. That's going to mimic the ear canal in that coupler. We use RECD generally in children because they can't sit still long enough for us to do all of our measures. That's why we do an RECD. We are always going to take the ear response even in children. We're going to take an unaided ear response and we're going to put that ear response into a coupler, which is an artificial ear canal that holds that information so that we can run our occluded responses in our aided responses as we go forward. That's the difference between an RECD and unaided response.

Anna Scala: Brilliant. Thank you very much. That's all for now, so see you later.

Nicole DaRocha: Let's talk occluded response. Now you've got the resonant qualities of the ear canal. The occluded response, in short, is what effect do we, as audiologists do by putting a hearing aid or an earpod into that person's ear? What effect does the sound delivery system of the hearing aid have on those resonant peak qualities? Whether it's a thin tube with an open dome or closed dome or a mold or a custom, what detrimental effect do we have by putting something in the ear? Your occluded response is always going to be with the hearing device muted. If that it's not on, we want to see what effect does that have on those peak qualities.

Here, again, you're going to do it exactly the same way in terms of parameters that you measured your unaided response. You're going to use pink noise, 65 dB, five seconds to get that resonant quality. Again, it's easiest to do this response in gain view because what you're looking at is the absolute gain effect of that sound delivery system on those peaks. Now, what is the primary clinical purpose of doing the occluded response? It's to know for sure whether your fit is open or whether it's a closed fit. This

will become very, very important when we start talking about doing the absolute output measures.

Here what you're seeing is a couple of examples. The first graph, the one on top that you're seeing, is a patient that I fitted with a closed mold and it had a very, very small vent. It was a one-millimeter vent. What you're seeing is the unaided response in the black line. The black line, those natural peak resonant qualities, and then we occluded the year with the mold hearing aid off and what effect did the mold have on those natural resonant qualities. That's what you're seeing on the pink line. You see it differently occluded the ear and I'm quite confident that it occluded the ear after one kilohertz. As soon as it hit 1.2, definitely occluding the ear. But it mimicked more or less the low-frequency unaided response. Now, the pictures that you're seeing just below that are the unaided response on an open fit. An open dome with a thin tube, and you see the average measure in the green lines. You're seeing that unaided response and then you put the open fit in and we did the measure again, that's matching very much.

I can say with confidence that actually that sound delivery system is not really having an effect on that person's resonant qualities of their ear canal. Now, what I will say at this point is that you would expect that molds would occlude, and that open fits and open domes would be open. But in practice, when you start measuring these, you'll find that that's not always the case. Certainly, I have done some fittings with open domes, that because of the ear canal and the shape of the ear canal, collapsed ear canal, that actually the open fit is a closed fit. Same closed domes, double domes really occluding the ear, or actually, the ear canal is large enough that it's not occluding the ear, and similarly with molds.

I've seen some molds where you would expect the mold to occlude the ear completely, but actually, it doesn't. The only way really that you know, if your fit is open or if it's closed is by actually doing this measure. That's the primary reason for doing the

occluded response. It's also great for counseling because you can then counsel your user on how close the fit is, if it's appropriate for the hearing loss, and what the sound delivery system is doing in the ear canal. Here are some clinical applications where it's quite useful to do the occluded response. Here you're seeing example on the left-hand side of the screen. Where if I hadn't have done the unaided and the occluded response, you would have seen that I would have tried to bring down 1.5k to match my daughter target, but you'd click and nothing would happen because you see that the natural peak resonant qualities of that person's year from now are actually above the target that was set. What you're going to end up doing is just bringing down and being frustrated that you can't match target but you won't know that that natural resonance is there unless you've measured it. Then here on the right-hand side of the screen, another example, I don't know if you've ever seen this in practice is that little annoying dip that happens at 1k. Why is that there? If you see the red line is the occluded response, the green line is the aided response. You see that they cross over and that's why the dip is that natural peak resonant qualities even in the occluded response day which is why you're seeing that annoying dip at 1k. That's why it's quite useful to do these measures so that you know what's happening when you do your actual measured responses, when it's open.

The occluded response as well, remember I said it's quite useful for counseling. Here wonderful study that looks at exactly that at the occlusion of your fit is going to directly correlate to the advantage in signal to noise in the directionality of the hearing aids. I know it certainly in practice, I've had some of my users that have bought the most advanced hearing aids with the most fantastic features and that automatically make directionality available, but then they want an open fit and the hearing loss is not one that is actually subject to open fit, so this is a direct correlation. The more closed the fit is, the bigger the SNR advantage, the bigger effect that they will feel from the directional microphones. The more open the fit, the less SNR advantage that they'll have from the directionality of the microphones. You could measure this in the ear by

whichever way you choose to measure your SNR. QuickSIN is generally the most used way to look at SNR base of a loss, but it's a great tool for counseling as well.

At this point I always like to talk about occlusion effect, because sometimes people confuse the occluded response for the occlusion effect. We don't actually talk a lot about occlusion effect because majority of our fittings these days are thin tubed, open dome type of fits or rigs. But occlusion effect certainly when hearing aids first came out we often talked about occlusion effect, that barrel sound because a lot of our fittings were molds and so occlusion effect, what it is? Is the sound that our internal throat and mandible make on the ear canal itself. It causes those slight cartilaginous displacements in the ear canal. The symptom is that the patient is going to perceive their own voice because those little displacements are going to resonate in their ear canal, particularly with the mold and it's going to cause that barrel hollered fit. That is what the occlusion effect is. It's not actually the occluded response. The occluded response is the effect of the mold on the ear canal, but the occlusion effect is the effect of the person talking inside the ear canal and how that resonates with the sound delivery system. Here I've just put a screenshot of a quick fix for if you do have patients that complain of that barrel effect with molds, a quick fix out of it is to just make a little trough so that they isn't that resonant quality in the ear canals, in the mold where the vent is you make this little trough and there is just two examples of how you can do it. That usually resolves any occlusion effect that you find in a person's ear canal.

Last section then we're going to do the quiz is the importance of knowing the difference between open and close. I've talked a lot about now during your unaided responses, during your occluded responses, and why it's so important to measure it, to know if it's open and close, but why? The why is because any real ear measured systems, when you start doing your measured outputs, you either are going to do a modified pressure method with co-current equalization, or you're going to do a modified pressure method with stored equalization. What does this mean? It means

that when the person is sitting in front of the speaker, the speaker is going to put out soft, medium, and loud sounds based on your eyes to ear signal. Just as what Jay was talking about earlier, you're going to use your eyes to ear signal. It's going to put that out and that person is going to, of course, maybe shift a little bit. If that person slouches back or leans forward, what we want to measure is that absolute decibel out at the ear. The system automatically will adjust for the person's head movements. This is what we call concurrent equalization. That's really, really handy because even if the person starts slouching backwards, if you're measuring a 65 dB signal, the speaker will match the person with their aids. If they start slouching backwards, the system itself will increase to a 70 dB output so that what reaches the ear is 65. If the person starts leaning forward, a 65 dB output will drop automatically on the system to 55, 56, so that what reaches the ear is equal to what we want to measure. This is just me trying to describe to you that the movement of the person is taken into account from the system. That's great and it's wonderful that our systems do that.

But it does cause a problem when it comes to open fits. Because if your fit is open, then what's going to happen as you go up in the gain of the hearing aid, there is going to be some sound leakage that happens. The hearing aid is going to have some sound leakage but your REM system doesn't know that that leakage is coming from your hearing aid fitting. You REM system thinks may be that the person is leaning more forward, so it's going to drop the absolute decibel output. You're measuring 65 and as you're going up in the game level, that sound leakage is coming out. The person is actually not moving, but the sound output from the speaker is dropping without you knowing. What happens is it causes you to over amplify. You won't know that unless you have measured your occluded annual unaided responses to know that it's an open fitting, and that there's going to be sound leakage and telling the system, "Hey, this is an open fitting, please do not automatically change."

Here is when you use stored equalization. If your fit is open and there is a transport sound leakage out of that hearing aid system, you need to tell the software that this is an open fitting and to use stored equalization. Many systems will have different places for where you're going to select that it's an open fit, but since we are inventors and we're talking about the trumpet, here is exactly the way. When on your fitting screen, it's your sidebar panel on the right. It's going to say, open fit and if it is an open fit, you need to toggle it on. What this does is that it will then not automatically change if the person is moving. Then that absolute decibel output is the same, so that you can be confident that even if there is sound leakage which there will be within open fit, it's not going to drop the decibel speaker output. What's very important is if you are going to toggle that open fit fit on, the patient actually needs to stay quiet still, because concurrent equalization is not going to take into account for the patient moving back and forward, they actually need to stay quite still. In practice I always say it quite sternly but kindly, that, you going to do the measures it's very, very important that you don't talk and that you stay quiet and still because I want to measure as accurately as possible. That's the stored versus open.

Here I just wanted to show you a clinical example. I can certainly say that I'm guilty of doing this in practice. What you're seeing here, this is on a very fixed system. Apologies for that, but I'll just briefly explain what it looks like. The green crosses are the target. You can see, I fit it to target beautifully, but I used co-current equalization and it was an open fit. I'm fitting target beautifully but the patient is complaining to me that it sounds very tinny, sounds very, very loud. I swapped over to stored equalization without changing any of the gain measures in the hearing aid. I just ran it again, and you see the pink line is actually what I was measuring. The system was dropping the decibel output level because it was an open fitting. I wasn't actually measuring 65 when I ran that 65 again in the pink, you can see actually I'm about 20 decibels above the target for 3k. Certainly you will find this in practice if you don't routinely put on that open fit, the patients will complain. It sounds very tinny, it sounds very sharp. This is

just your fore warning that it could be actually that this is an open fitting and you have over amplified unknowingly. Frequently asked questions; is it okay to use stored equalization when the ear is closed? Yes, certainly you can do that, but just remember that it won't take into account patient movement. The patient cannot move the head. Often frequently asked question; is there any other time other than open fittings, where should use stored equalization? Yes, actually.

We'll talk about it in Session 2 when we talk about verifying CROS hearing aids, where you actually want to measure the effect of the heat in absolute. Now we're going to just do a little bit of fun. Let's break for a quiz. What I'm going to do is I want you guys to open a new tab in your browser; whichever way browse your using. If you have a mobile phone, that would be great as well. What you're going to do is type into your mobile browser, www.kahoot.it. When you type it into the browser, you'll see it's going to ask you for a game PIN. This is the PIN that I want you to enter into the system. I'll give everyone a moment to put that game PIN into the system. [MUSIC] There we go. We've got our first users coming in. Gus Mueller. I hope Gus Mueller is not on. Fantastic. I'll give you guys another 20 seconds. Wonderful. Let's have some fun. I'm going to start the quiz. What you're going to do is you're going to see a question pop up. You have 20 seconds to answer the question.

There are five questions, and you will win bragging rights amongst your colleagues and a vast number of imaginary points. You've got 20 seconds, fastest time, as well as most accurate, get's the most points. Let's starts. First question; occlusion effect is a cause of? One second left. That's fantastic. Majority of you guys scoring that one correct. Thirteen of you got that one right, well done. Yes occlusion effect, reverberation in the ear canal from the internal throats and your vocal folds and the mandible. Who's on top? Sandra V, you are on top of the school board with George slowly climbing up behind you, so watch out. Ready for the next question. True or false this time. Ear canal curves generally peak at 4-6 K, true or false? Ten seconds, 8, 7, 6,

5, 4, 3, 2,1. False. The concha is the one that resonates between four and six and your first peak at around 2.7, 3 kilohertz is the ear canal. Very good. But half of you guys getting that one right. Let's see. Who is on top. Rami coming for the win. Sandra, you still hold the position, but Rami is just behind you. Next question. Primary application of the unaided response, what is it? One second. Fantastic stuff. Majority of you guys getting that one right. Probe tube placement, to know way you on the canal and that resonant qualities. Very well done. Let's have a look.

Sandra, you are still holding that position but YST, right behind you. Let's have a look. See, true or false. Question 4; real ear occluded response can directly affect SNR. Five seconds. Great stuff. Majority of you guys getting that answer right. Yes. Certainly it can affect the SNR because of course it's going to affect how well those directional microphones are going to give that advantage. Fantastic stuff. Let's have a look at this leader board. Gus Mueller coming up in the ranks. Sandra, you are amazing. You've held that leader board position. Last question. If stored equalization is used? Stored. Three seconds two ,one. That's it. Majority you guys getting that question right. Stored equalization means that you've put on and it's an open fit stored when we use open fittings and patient cannot move the heats because it's not going to take into account that patient movement. Amazing stuff. Let's have a look at the leader board. Who is third? Rami congratulations to you. Gus Mueller coming in second, what? First? Sandra what happened? YST, I don't know who you are, but you have bragging rights amongst all us colleagues for sure. Fantastic stuff. Let's back to the presentation. Hopefully that was a quick little break.

We don't have much more to go. Keeping the attention and thank you guys for participating in that way. Now the second section where, I want to talk to you about doing the aided measurements. You've done your occluded, you've done your unaided. Remember, we'll do practical examples of this in Session 2. You've selected the perimeters and we're going to talk about perimeter selection, in session 2, further.

But now you're going to theoretically do you aided responses. What the aided responses are going to measure is the output. The output of the sound delivery device that we've put into that person's ear. Now you're going to unmute the hearing aid and you're going to measure that effect. Here I've just taken a screenshot of what the aided response screen looks like on Trumpet. But most manufacturers systems are set up very similarly. You'll see there right on the top, you've got your unaided, your occluded and then what's highlighted is the aided response. Now because we are in response user, you'll see on the side panel you're fitting details, its response. Remember it's an absolute output measure. Generally in SPL, you want to view it in SPL.

When it's in response, you're taking into account the thresholds. The hearing thresholds are you viewing it there at the bottom, but remember they're upside down because you are in SPL. It's been calculated that way. Then the dotted line, are your different ISTS signals. When we do our aided responses, we always want to use the speech standards. They are different speech standards, LTASS, you'll hear that phrase. The LTASS stands for long-term average speech spectrum. There are quite a few of them out. But the gold standard is that international speech testing signal. Think I used to know it off by heart. Hello, [inaudible] You'll be familiar with that in worst equipment. If you've done Verifit like I was brought up on Verifit, you will be very familiar with carrot passage, which is also an ISTS type of signal, but that's unique to the Verifit. Your ISTS signal, and you're going to do your output measures for soft, for medium, and for loud. Generally that's 55, 65, and 75.

What we're doing is we're looking to see for this international speech tasting signal or our outputs of our hearing aid matching. Have we provided the appropriate amount of gain in absolute levels at that person's ear canal taken into account the resonant qualities of that ear canal? Here's where because you are doing an aided response and it's in absolute measure in that person's ear canal, it's really great to put on some overlays. Your targets will be based on whatever parameters and fitting details that you

entered into the system and certainly the thresholds that you entered into the system. The line that you're seeing on top there with the Us are your uncomfortable loudness levels or loudness discomfort levels, LDLs, UCLs. Majority of the systems, and this one in Trumpet certainly, they will measure it on average. Based on the parameters that you've put in, they will show you uncomfortable loudness levels that is an average for that person's age and hearing loss. I would recommend that you do measure your uncomfortable loudness levels. It will become very useful when we start talking about doing maximum power output at MPO measure, there it becomes very useful.

But yeah, so you've got your uncomfortable loudness levels, you've got your threshold and what you're seeing in between those two lines. The top red line, and your thresholds, your dynamic range, and that ISTS signal, the dotted line. For soft, is the dark green; for medium, 65 is the yellow; and loud, which in this case is 80, is this dotted light green line and that's falling within the patient's dynamic range. What we want to do is match that solid line to that dotted line. Here is where you're going to go on top mode. You're going to have this software, your REM software on the screen, and you're going to open up the manufacturer software via Noah, you're going to open up Genie or Starkey or Sivantos or Phonak or Target, whichever hearing aid manufacturer you're using, and you are going to adjust. Generally, it's absolute gain levels across the frequencies to try and match that dotted line.

Of course, each software is unique, but Trumpet software, you can hide the different signals. If you're doing your softs, you can hide the 65 and the 80 so that it's not too messy so that you can look at exactly what you're measuring. It can be very useful to add overlays, especially in response because you're seeing it in real time in that person's ear canal. You can put a speech banana overlay as well as speech letters, and I find that's very useful, particularly for counseling. This is the protocol. You're going to run your ISTS signal for a minimum duration of 10 seconds. Why? Is because it's a long-term average speech spectrum, and like I said earlier, speech has got peaks. The

longer you run it, the more accurate it is, so that's why we say for a minimum of 10 seconds and you're going to do your 65, so your medium speech, most important one, your soft 55 and then your loud 75. You're going to try and match the target, whether it's DSL or whether it's NAL as accurately as possible.

You want to be within five decibels plus or minus of that dotted line to say that this is a good fit to target. This is where the SII score becomes very useful because that tells you in percentage how much of the signal have you made audible. Each software slightly different and I think we'll deep dive into this a little bit more in Session 2 in terms of SII, and it's going to give you an absolute percentage of how audible you've made soft, medium, and loud. A very frequently asked question I used to get when I sold this equipment is, why are the prescription targets below the thresholds? Particularly, if you are going to do aided responses versus insertion gain, which we'll talk about in a moment because aided responses show you in real time in absolute levels against the thresholds what the targets are based on.

You see here, and I'm sorry, it's a bit blurry because I've just taken a screenshot of it, but they are the NAL targets for medium, soft, and loud. You'll see especially at 4K, all of those targets are below the patient's hearing thresholds and the same for DSL. This is DSL 5 adult, and you see medium, soft, loud below that 4K target. I get asked this quite often, and there are several factors that come to play. The first thing is to remember that solid line is not showing the percentile. What you're seeing here on the lower half of the screen, this is just from Verifit software, is that solid line that's going through the green crosses is your ISTS signal. But if you haven't selected percentile, you are not seeing the spectral peaks in speech. Very often you think that you haven't hit the target, but if you switch on percentile, the shaded area that you're seeing, that's the percentile. Those are taking to account spectral peaks and very often you have hit the target.

NAL and DSL have quite accurately placed the target so that the peak of that speech spectral, particularly in the highs, because it peaks quite widely in the highs, does hit the target. Make sure that you've switched on percentile in the overlays so that you can see that peak. Also, remember that these targets, and particularly NAL, NAL was developed on a 174 ears. That's the screenshot that you're seeing on top of the slide on the right-hand side, and you'll see that there is variability within that target. It is close to target, but there is still quite a lot of variability within our prescriptive targets. As long as you've hit exactly what Jay has said, there's the bullseye, if you imagine it like darts and you've got your red bullseye, you don't have to get it dead at the center for it to hit the target. That's why we give you that flexibility of plus minus five dB because you'll still get a bullseye, even if you're to the left or even if you're to the right of that circle.

Very often, I've heard people say, don't worry about that target thing for the highs, just pump up the volume in the high frequencies. But please be very careful, because remember that you have a budget in terms of gain. If you use all of your budget in the high frequencies, you are going to affect the budget in the rest of the mids and the lows. Also, that patients, especially now, have taken into account comfort versus audibility, and this is the game that we're always playing as audiologists, giving that audibility but still providing comfort. NAL has spent lots of time developing that target, taking comfort as well into account. What I can say is trust that target because if you are going to put audibility over it, remember that what will most often happen is that the patient is going to turn down over all volume. When you give a VC control to patients that's not specific to high frequencies, it's going to compromise the entire frequency spectrum by them going down because they find it to tinny.

The overall message is trust the targets because the research has been done in there and put your percentile on because you will have seen most cases it does actually hit that target. Just to finish off here, talking about insertion gain versus aided response.

Now, insertion gain in the UK and in Australia, was particularly popular to do in terms of a view when you're doing your aided measures. Why the change to aided response? Well, there are several reasons. But insertion gain, what it is, is it answers the question generally, does this hearing aid provide the appropriate frequency specific gain for speech? So it's telling us about gain. The response is better for asking the question, does this hearing aid place amplified speech at an appropriate output within that person's resonant qualities? Gain, remember is always calculated. Calculate the target.

Insertion gain is your aided response minus the natural amplification qualities, resonant qualities, that the ear canal and the concha give. It's that gain minus those electro peaks that the unaided response gives between 12-22 dB. A quick example, real ear aided response, you could say at 3K is at 92 decibels. That absolute output is at 92. The view in insertion gain, it would minus that natural peak resonance at 3K which might be up to 22 decibels. Actually the insertion gain would be 70 decibel output. You are only giving absolutely 70 decibels gain for that view. That's a bit complicated to understand, but hopefully it makes sense. Here is the screenshot of, in the Trumpet system, the two different views. On the left-hand side you're seeing the real yet aided response, so the absolute measure with the thresholds in view, uncomfortable loudness levels and you could put on speech banana overlay versus the insertion gain response which is just a gain measure; soft, medium, and loud in gain from zero. You're looking at what output absolutely does that hearing aid give. The reason why insertion gain was done for a very long time is as audiologists, it's just easier to talk about gain without thinking about the resonant qualities of the ear canal and the concha. You want to know a total amount of gain from the hearing aid without taking into account all of those extra unique features of a person's natural ear. But it's not ideal when you want to look at, is it appropriate against the thresholds, against the speech banana? Because it's not going to give you that view unless you're in response view. Here are the various different reasons why we move from insertion gain to real ear aided response. But the most important reason is that it's a very useful visualization of your

target between the threshold, the uncomfortable loudness level of the dynamic range, and the speech outputs.

Lastly, main components is the MPO. We're going to look at the MPO. You've done your unaided responses, you've done your occluded responses, and you've done your unaided occluded, unaided reponses and now the MPO. The MPO is the maximum power output of an actual hearing. This is where it becomes important for you to have measured some uncomfortable loudness levels or loudness discomfort levels. The MPO is real ear 85, real ear 90. I'm seeing a message- I'm just going to turn off my webcam because I'm hoping that you guys can still hear me. The MPO is also known as the real ear 85, real ear 90, and formally it was known as the real-ear saturation response. What this is is a sweep tone. You're not going to use ISTS to measure MPO. It's fixed as a sweep tone and it's going to tell you the ceiling of where that hearing aid is. You always want the ceiling be underneath your loudness discomfort levels or your uncomfortable loudness levels; about 3-5 decibels below those uncomfortable levels.

What's the main purpose of measuring the MPO? It's for comfort; to make sure it's not too high, that the patient is discomfort and also to make sure the manufacturer has given you enough headroom of hearing aid. Because very often the manufacturers of the hearing aids will make the MPO lower than what the actual output of the hearing aid is because they want it to be more comfortable for the patient but it's going to compromise the dynamic range and what you have for your patients. It's always good to measure the MPO and interchange not gain, but compression in the MPO to lift that headroom or drop it. But generally most of the time you're going to have to lift it. Here's just a clear example of the problem, it happened most frequently is seeing that Real Ear Measure into a dynamic range that you have for your target. You'd see how an entire frequency is cutting across that patient's threshold, so there is no way that we're going to be able to match targets for 6K because the MPO, the ceiling, has been cut.

Here is just the proof in the pudding by what I say that manufacturers lie about the different MPO outputs and how they deviate.

Here is the deviance from different manufacturers to what is the actual recommended MPO from NL2. Some of them deviate up to 25 decibels. They've cut 25 dB of headroom out of your dynamic range. This becomes particularly important when we start looking at turning on features like frequency lowering because it might not be necessary to switch on that feature if we have a little bit more headroom to make SH audible. Last couple of slides and then you've got the quiz. This is the question that Anna brought up about doing a functional measure. I'll have to talk to you about what is required as gold-standard to fit hearing aids and nothing is going to replace the REM. I'm going to switch my webcam back on tentatively but hopefully the Wi-Fi signal is keeping. The live and advanced features; now each manufacturer name is slightly differently. In auto matrix equipment they call it freestyle but generally it's called live with bonds.

This is where you can deviate from using the prescription algorithms like DSL and NAL and do functional measures that make more real-world examples for your patient. I really love these live and advanced features. Here in advanced is where there are different presets available. Most manufacturers put in simulations of cafes, of children, of bubble, of male speech, of female speech, so there's different sound scenes in the software itself and you can play that at different decibel levels. Play it of course at a level that is appropriate for what you want to functionally assist. If it is for example a cafe, don't play it at 50 decibels because that's not really what a cafe is.

Cafes are generally above 75 plus, so you're going to put it at 75 plus and you're going to see what the output of the hearing aid with all of the noise reduction features on is doing to that sound scene simulation. That's in the advanced screen. But if you go to live speech, that's where it becomes very interesting. You can create very unique

programs for your users. Just as Jay was saying earlier, so important that we try create as person seem to dissolution as possible. I've had lots of fun with using live speech. As soon as you go to live it's going to take into account whatever is around the speaker software and it's going to measure that from the microphone of the hearing aid. I've been very creative and created music programs for example where I've asked the patient to bring in the guitar, bring in the flute, whatever musical instrument they're into and as they play, I can shape and check the music program is within the dynamic range, is covering all the frequencies.

There's no target per se. You just need to know what the audiology knowledge that you are because you are the experts across which frequencies do you want to put that music and is it hitting patient's uncomfortable levels? Is it within that dynamic range? Is it hitting what you want? I've created unique and person specified music programs. I've also found it really useful to create spouse or significant other programs, because I often get that complaint of I can hear everyone but I can't hear my husband or I can't hear my wife, and they mumble. You can create a live speech sample using that significant other. Just remember that it needs to be an OWLS test. You need them to speak for a minimum of 10 seconds, but I would say go longer because when a person is speaking they take a breath and they pause.

Get them to read some newspaper clipping or magazine clipping and average out that speech as they're talking and see that it's hitting the speech banana and all the frequencies of covered. That's me and we've come to time. Before playing this quiz, actually let me open it up to questions so that we can cover your questions. If anyone wants to remain over time then we can play the quiz. I'm going to ask Anna and Jay just to open up your mics and cameras and let's have a look at each question.

Anna Scala: Thank you very much Nicole. We got a lot of questions but Jay already answered. But two questions left. Shai asked, should we use store equalization in the MPO measurement in an open fitting hearing aid? Stored equalization.

Nicole DaRocha: Yes. But actually the MPO, because what you want to do is measure that absolute output. It's very fast, it's a tone sweep. It's not as necessary as it is with the Owl Test that it's a long measurement because it's a sweep tone. It's just doing the absolute of pi pi pi and it's quite loud. It's much quicker than doing the Owl Test, and when you do you impure measurement. Generally you're going to do that at the end of your fitting after doing your aid. It's already selected if you've done your aided measurements with stored equalization. If you've already measured the open fitting, just going to do that sweep of MPO. What I will say that I've just thought of now is that if you have a patient that has Hyperacusis or Tinnitus and is easily triggered, be very careful about doing MPO measures. In the ear, you need to measure that at 85. That's quite loud. If you do have patients that have those conditions, it is best to do this measure in the test box. In the test box, you're going to do an impure measure at 90 dB. You're going to do that tone sweep at 90 dB. [OVERLAPPING].

Anna Scala: Brilliant. Thank you very much, Nicole. Another question Always Brahma Shi. How can we be sure that our earing aid isn't saturated for an input of 85 or 90 dB, or probably still in the W RBC range?

Nicole Da Rocha: If I understand it, do you mean that you want to be sure that you measuring the absolute outputs without the noise features turned on. So just asking for clarification because when we do an MPO, you switch off noise reduction because you want to see your absolute output measure. But in this case, in real ear, you actually want to see the MPO with those features turned on. It depends on what you're looking for. If you are looking for the absolute outputs of the hearing aid in terms of manufacturer, and you want to see what is actually the total output that I can get out of

those hearing aids. You want to match it against your technical spec sheet. That's when you put it in the test box. You switch off all of the different features, noise reduction features of the hearing aid and you're going to do on a hearing aid output measurement, which we'll talk about in session 2 of exactly how to do that. But in a real person, you do want to see what headroom you have, because in real life, those features are going to be switched on. So you want to mimic as real as possible the MPO in that person's hearing aid with all of the features that that person is going to walk out the door with.

Jay Jindal: I think if you dissociate the WDRC from the ceiling that we're trying to achieve in the fitting. Then probably it will make more sense because you think about WDRC as the automatic volume control and you think about MPO as the ceiling of the amplification. It's not about soft, medium loud inputs, how the volume is changing dynamically without the patient having to do anything, which is what WDRC will do, it's about custom maximum limit and beyond which, no matter how loud the sound is, it's not going to amplify. [OVERLAPPING] Remember usually you would not want to go above 80 or 85 decibel in the real ear because if you convert it, particularly for the narrow ear canal, if you can lower the SPL levels it can reach 135-140, which obviously can cause acoustic trauma in couple of seconds and that will be played for. Most equipment do have a limit set to it, the RAM equipment, I suppose inventors is around 120.

It won't take it beyond that level anyway, then the measurements will stop. But you do have to be careful for people, particularly with a narrow ear canal, smaller ear canal, if you're doing it in the real ear or just measure it in the capula.

Nicole Da Rocha: Thank Jay. 100%.

Anna Scala: The last question Nicole. What range in the speech intelligibility index can be considered as a good response. Since through personal observation I have observed that it doesn't change after one point in many patients.

Nicole Da Rocha: Good question. That's actually very interesting and I think we'll cover this a little bit deeper in session two, is these are the guys that develop the speech intelligibility response epidem, have actually put out new levels. At of the process in February of this year they've given against age actually percentage levels what's considered good. Generally, as a rule of thumb for now, adults fittings. If you are getting an ASI percentage score, the goal would be to get 70 percent. You don't want a 100 percent because remember it's just a measure of audibility. You could give a 100 percent but the patient won't probably wear the hearing aids. They'll will keep putting them down and keep them in the drawer because they'll find a too overwhelming. So a measure of between 65 and 70, is a good for an adult user, for an ASI score for soft, medium and loud.

Jay Jindal: Don't get started on this and she can talk about it for hours.

Nicole Da Rocha: I love the scope. In pediatrics, please is very different you need to plot it against age limiters. In pediatrics, please use the PDM score sheet, but well, I'll show you the PDM score sheet for pediatrics of way you can plot and if they are falling within an age appropriate of enormities.

Anna Scala: That's all with the questions so Nicole, if you want to go on with the quiz, it's the quiz time again.

Nicole Da Rocha: Now please, I know I've gone over time, so those of you that can stay and want to participate, you're welcome to stay, of those of you that have to leave totally understandable. Please you're welcome to go. But let's just have a little bit of

fun here at the end. What I'll do is just share my screen with you again and if you can enter into www.kahoot.it this pin and we'll play the speaking game. [MUSIC] There we go. That must be Jay. I'm sure it's Jay pulling my leg here. The great Susan Scolie participating with us.

Jay Jindal: I'm not playing.

Nicole Da Rocha: Oh, you're not playing.

Jay Jindal: No.

Nicole Da Rocha: Someone is playing games with me here. Give a couple more seconds. Lets get going. Question number one, get ready. Remember you have 20 seconds. REIG insertion gain is a calculation of? Six seconds. Fantastic stuff. Majority of you guys getting this answer correct. Let's have a look at this leaderboard. Rexy is on top of the leaderboard, but Rami is not far behind. Let's have a look. Question 2. True or false. MPO is also known as real ear saturation response. People confident with this. Loads of answers coming in at once. 5, 4, 3, 2. Great. Yes, majority of you guys getting this right, yes. It used to be known as the saturation response but because of changes and also a nomenclature and it was a bit confusing saturation because it's really just the ceiling MPO or that real ear 85 or real ear 90 is how it's described now. Let's have a look at this leaderboard. YST, will you hold the top position for the second time in a row?

Let's have a look question 3. The target NAL or DSL should be matched to what tolerance level? Great stuff. Yes, good. Majority of you are getting this right. Within plus minus five dB of that dotted lines. You want to get that solid line within five dB of that dotted line. Fantastic stuff. Beautiful, Rami getting the scoreboard. Top position. YST, what's happening? Let's go to question 4. Live voice, can it be used as a verification

target? True or false? Better check questions as one. Two seconds. Great. False is correct, I'm sorry for this trick question but it's the word target. Yes, of course you can use live voice in verification, but not as a target. Targets, you can only use prescription formulas like NAL and DSL. Those are targets. Live voice is not going to give you a target. There is no target. You're just going to look at it appropriately in SPL. Has it been placed at an appropriate level against the speech but not in the speech letters. There is no dotted line or target per se. Let's have a look at this leaderboard.

YST has taken that lead at top position again. Priya is close behind. Let's have a look the last one. True or false? Measuring loudness discomfort [MUSIC] levels or uncomfortable loudness level is recommended. Fantastic. You guys confident with this question? Yes. 100 percent True. I would say, you don't have to do it for all the frequencies even if you can just do a high and low and if you've got time to measure a mid-frequency just so that you know, for that person, what is the uncomfortable loudness level? Like I say, manufacturer software will estimate it based on average. But as we know, each person is so unique, so it's great to know what is their uncomfortable levels so that our MPO can be that ceiling can always be below it.

Let's have a look at the podium. Third place, Karthik, I hope I said that right? I don't know. Your third place, Priya, second place. Top position, who is it? Who has the bragging right? YST, second time in a row. Fantastic stuff. You own all of the bragging rights and have all of the imaginary points, fantastic stuff. Guys, I'm going to leave you there. But just so you know, to end off with, is that, just because you are now part of the probe mic club is I encourage you to go to www.eartunes.com audiology probe song. You type that into your browser, you'll find this website developed by Gus Mueller. They've got some hilarious songs for audiology. I love the song called PROBE, based on Madonna's Vogue that talks about doing probe mic measures. Hopefully, you guys enjoy that. I'll stop screen sharing. Any further questions Anna that you see?

Anna Scala: I'm here. No more question, Nicole. Just a lot of congratulation. [OVERLAPPING]

Nicole DaRocha: Thank you.

Anna Scala: Amazing game, amazing lecture. This has been a super educative and fan. Thank you. Best webinar ever

Nicole DaRocha: Well, thank you guys and I'm sorry again, we've got overtime, so sorry for taking your [OVERLAPPING] evening, all day.

Jay Jindal: We love you too.

Nicole DaRocha: We love you too. We love probe measures. Thank you Anna for organizing and to invite us. [OVERLAPPING]

Anna Scala: My pleasure. Thank you very much Nicole and also Jindal for your presentation and outstanding learning opportunity. Absolutely. Just to underline, because I got a question about the speech intelligibility index in the trump, yesterday. The calculation of the speech intelligibility index and the visualization of the person high cords area in aged mode will be present in the next release of Maestro software, which will be launched in one month more or less. See you next June 28th for the 2nd session of your REM workshop, which will cover the setting and verification of various fitting parameters via real ear measurement. Register yourself for this 2nd training and know why, what, how, and when of real ear measurement. Thank you very much, Nicole, Dr. Jindal and see you in two weeks.

Jay Jindal: Bye Anna. Thanks Anna, you've been great and so everyone attended. Cheers. Bye.

Nicole DaRocha: Bye everyone.

Anna Scala: Bye everybody. Thank you.