Optimizing Accuracy in Fitting Pediatric Hearing Aids Using Real Ear Measures

Presenter: Alida Naudé, PhD

- [Host] Good morning, and welcome to today's course, Optimizing Accuracy in Fitting Pediatric Hearing Aids Using Real Ear Measures. Today's learning outcomes are as follows. After this course, participants will be able to describe the fundamental principles of real ear measures and their application in pediatric hearing aid fittings. After this course, participants will be able to identify the unique challenges involved in conducting REM with pediatric patients, including considerations for ear canal size and patient cooperation. After this course, participants will be able to describe how to integrate REM findings with holistic care strategies for children with hearing loss, enhancing overall treatment effectiveness and patient outcomes. And now I'm gonna turn it over to our presenter.

- Welcome, everyone. I'd like to express my gratitude to the audience for joining us in such great numbers for this second event of 2024, organized by Academia. The Inventis project aim at scientific dissemination in the audiological and vestibular field. And I'm particularly delighted today to welcome a new professional aboard. Please join me in extending a warm welcome to Alida Naude as she joins Academia. Alida is a seasoned audiologist with over two decades of experience, holding a master, a PhD, and a postdoctoral qualifications. Her expertise extends across private practice, academia, and corporate sectors. She's a prolific author with over 30 published articles. Additionally, Alida serves as the director of Amtronix Diagnostics in South Africa. Alida, thank you so much for being here with us and for accepting my invitation.

Seminar title is Optimizing Accuracy in Fitting Pediatric Hearing Aid Using Real Ear Measures. Dr. Naude will explore the pivotal practice of optimizing hearing aid fittings for children through the application of real ear measure. As usual, I invite all of you to write your questions in the space on the screen, and you will se a survey at the end of the webinar which I kindly ask you to fill out to provide the feedback on the topics you would like us to cover in Academia. Alida, over to you. Wishing everyone a great webinar.

- Thank you so much, Anna, for the warm welcome and kind introduction. And thank you to Inventis Academia as well for inviting me and hosting this webinar. It's a real privilege for me today to speak to you as the delegate, and I want to welcome you to today's presentation, the webinar on enhancing pediatric audiology practices. It's really a topic that is so close to my heart, and I know if you're attending today, it also means that pediatric fitting is close to your heart. And it is so important that when we go through this process of also continued professional education and that, that we really just reflect again on if we're doing best practice and what we can do to actually be better hearing care professionals for children, because as we'll see today, it affects every aspect of their life.

So I hope that you will enjoy this webinar. You're welcome to put questions in the question box, and we'll get to them at the end. So without further ado, let's jump right in. So just quickly, just to give you an idea of where we're going, we just can have a quick overview of pediatric hearing loss and the significance of specifically accurate hearing aid fitting. And we will talk about that a lot. We're gonna look at what are real ear measurements or measures, which we will refer to as REMs, including its role in adult versus pediatric audiology, more looking at the difference between the two. And then we will look specifically at the importance of REM in pediatric fittings, including just a brief overview of the equipment and setup for pediatric REM and a little bit more, which we will go into.

And then we will look at overcoming some of the challenges in pediatric REM. If you are a hearing care professional and you already see the pediatric population, you will know that from assessment right through to fitting, you have to be creative, you have to be innovative, and you have to be child-led, so we will see some ideas around that. And then we will look quickly at analyzing REM results, mainly looking at what are the things that we should consider because the software obviously does most of the

analyzing for you, but it's more the interpretation that we would look at. And then we'll just end off with some key thoughts, some reflection, and then some takeaways from what we've been speaking about today.

Okay, so we're going to look just at not heavy stats, just a few stats and basic facts, just to refresh our memory of how common it actually is, because even if you have one in however many, if that one is yours, that is your world, so that is important. Then we're gonna look at the impact on development and communication, just a brief overview, and then just to refresh our memory and just to talk again about early detection and early management. And with all of this, we're focusing on intervention, but accurate and appropriate, which we'll be talking about. But let's start off with talking about pediatrics, and we're talking about hearing loss. So let's just start with the definition.

So pediatric hearing loss refers to a partial or total inability to hear sound in one or both ears among children. We know that it can be present at birth, so congenital, and that's why we're doing newborn hearing screening. But these are sometimes the ones that we miss when it's an acquired hearing loss, and it can be due to illness, bacterial or viral, usually, injury or trauma, or exposure to loud sounds. Now, if you look at some of the older literature, and just, while Anna was reading or introducing me, I was thinking two decades of experience. I actually think my reputation makes me sound very old. But if you look at some of the older articles, you will see there's a lot about toys and the maximum output of toys for children and actually how that can cause hearing loss.

And I'm sure you know there are those toys that you'll buy them for somebody else's children but not for your own because they're gonna drive you crazy, those that work with batteries. And that situation has changed because now kids are exposed to loud sound based mostly on tablets and phones, and they've got inserts or pods in the ears, insert earphones into the ears, and they've got control just to make things louder. And

that is actually, there's some new evidence showing that hearing loss is caused by that. So it's also good to just know that and to know that hearing loss is occurring earlier and earlier. For example, not gonna talk about that population, but the high school population and because of the gaming and all of that's also a huge risk area.

So we know that the impact of hearing loss on a child can vary, and it depends on so many things. But the main things will be severity of the hearing loss, the type of hearing loss, and the age at which it occurs, the age at which it's identified, and then obviously the age at which intervention starts and if appropriate intervention actually happens. And that's what we can talk about here as well. So early detection and appropriate intervention are crucial for minimizing the impact on a child's development. And the reason why, I'm probably gonna say it so many times, so at the end of this, if I say, "What do you remember?" you're probably gonna remember the word appropriate, but why is appropriate intervention so important?

I just wanna talk you through two examples. So a couple of years ago, we had a speech therapist that contacted us that said she's got a 2-year-old that she's doing therapy with, speech-language development therapy, and the child is just not progressing. And the parents are actually at the point where they're considering switching over to sign language, just because the speech and language is not getting there. And the audiologist that did the fitting and all of that closed her practice, she actually immigrated, and they needed just some advice because she felt like there were times that the child did respond, but it just wasn't consistent enough. Anyway, so we assessed the child, and luckily, parents had all the reports, we had all the the thresholds, we had all that information.

And then what we did is we did a real ear measure, which we are going to talk about today. And what the results showed us was that the hearing aid was actually, it wasn't a high-level technology hearing aid, and the algorithm that audiologists chose to

program the hearing aid to is not the one that we usually use for children. So the output of the hearing aid was a bit softer. So on first fit, on the hearing aid software, it looked like quite a good fit. But apart from the formula that you might have chosen a different formula, the child had quite a sharp turn in the ear canal. And you know, when you do otoscopy, you had to really pull the ear to look beyond the turn, which changed the natural resonance of the ear canal as well.

So where the ear canal naturally amplified sound was not in line with what the hearing aid software would predict as an average. So the hearing aid was under-amplifying. So child was identified early, intervention happened, parents did everything, did speech therapy, and the child didn't progress because you cannot learn what you cannot hear in that context of speech-language therapy. So just showing that it is so important for us to practice best practice and to do real ear measurements so that we can actually see what is happening in the ear and that we don't rely on approximations and averages, because with children especially, they can't give us feedback and we'll go through that a couple of times today, they can't give feedback, they cannot tell us that it's too loud or too soft, and every day counts in terms of their speech-language development.

Another example was we had a 2-year-old girl from a creche, and she had an acquired hearing loss, she had a infection. So they got the hearing aids for the child, and then the parents moved from Cape Town to Pretoria. And the creche phoned us and said, you know, the child keeps on pulling the hearing aids out. And they thought maybe that the ear molds were hurting her, and maybe that's why she was pulling it out. And again, the parents made an appointment, brought her in, and we did the real ear measurements. And it actually showed, number one, that the maximum power output of the hearing aid was above the comfort level of the child. So the sound was so loud that it was just overwhelming.

And then all the sounds, soft, moderate, and loud sounds were over target. So the hearing aid, in that case, was over-amplifying, and it just wasn't comfortable for the child. So as soon as we adjusted that, she had no problem wearing hearing aids 'cause she enjoyed the sound. But if sound causes pain in your ear, you're gonna pull it out, but the child had no words or vocabulary to express to us that that was the problem. And this is just where I also want to say that in our country, there's a African proverb, and you might have heard it, but it says that it takes a village to raise a child. Just meaning, you know, we all need to stand together in the development of children, and that's where team, multidisciplinary team, and the whole team, including the parents, play such an important role, 'cause here we had a speech therapist that picked up something's not right, because the parents often believe, you know, things are okay, and here we have the creche teacher referring.

So we need people out there that's monitoring and that can give us feedback because we don't have these children with us the whole day, so we actually need people that are in contact with these kids every day to give us feedback so that we can make continuous adjustments and make sure that they're getting the best sound. Let's move on, so the incidence, we know it varies worldwide, but it's estimated that one to three babies, well, one to three per thousand babies, according to the US stats. And like I said, it can increase with age, depending on infection, trauma, and exposure to loud sound. We know that there are three types of hearing loss, can be sensorineural, conductive, or it can be a combination of both, so it can be mixed.

And then there are so many causes. So just to name a few, genetic factors, complications during pregnancy, childbirth, certain infectious diseases, chronic ear infections, exposure to loud sounds, and ototoxic medication. Okay, so let's just quickly talk about the impact on development and communication. So hearing is critical, you all know this, in the development of speech and language skills. So children with hearing loss may experience delay in speech and language acquisition

and affect their ability to communicate. So we wanna give them the best chance possible. So by using real ear measurements, and we'll go through the definition and everything now if you're not comfortable with the terminology, but this is how we can give them the best chance to develop language and speech.

We know that hearing loss can also impact cognitive development, and that leads to other problems, learning problems, memory, attention. So we want to do early, I'm gonna say it again, appropriate intervention so that we can help mitigate these challenges. Okay, so difficulty in hearing we know can also affect a child's ability to interact with friends, adults, family. And it can lead to social isolation or decrease in self-esteem and difficulties informing relationships. And we know that the biggest impact on social and emotional wellbeing as an adult actually is from development as a child. And then we've actually alluded to this already, but all of this have an impact on academic achievement, and here, again, is where we need to give them the best chance possible but where kids also need special accommodations or educational setting or additional devices like FM systems, we need to work with a teacher to provide that information.

Okay, so many countries have implemented universal newborn earing screening to detect hearing loss early, and this is fantastic. But with identifying hearing loss early, we have a huge responsibility to also do appropriate intervention. And that is crucial for, we've already said, child's language, social and cognitive development. Okay, so obviously it depends on the type and severity of hearing loss exactly what our interventions going to be. And we are going to focus on hearing aid because we're gonna look at real ear measurements, but sometimes they need implants, sometimes sign language in addition or full sign language, special education services. And then to remember that the support is to the child and the family, and the goal initially is developing communication skills.

Okay, so let's look at the significant of accurate hearing aid fitting. So how important is it, and what is the long-term implication? Okay, so in the realm of pediatric audiology, precision isn't just a goal. It's everything, it's a necessity. We've got a little human being that cannot give us feedback, that they do not have a reference. Adults, we also want precision, but sometimes adults will guide us off precision more into comfort because of their specific environment. But they already have language, and they already, you know, they've got that information, so they might choose, for themselves, other priorities, but for a child we need to give them all the speech information that we possibly can. And this, to me, is so beautiful, is that every child's hearing loss and ear and ear mold is as unique as their fingerprint.

And I sort of feel like that should just sink in. So that tells us that we require a tailored approach to hearing aid fitting. So doing just a first fit on a hearing aid software is not good enough. I'll say something about that now again. So accurate fitting with real ear measures ensures that hearing aids not only amplifies sound, so it's not just about volume, but do so in a way that's tailored to the specific contours of a child's hearing loss, including the unique ear mold characteristics. And you know, this is just, if you think of, for example, if you're going to buy clothes, sometimes you go to one shop and maybe you wear a small, but at another shop, for the same thing, you might choose a medium.

And if you go to a tailor and have something made specifically for you, it would also be very different from what you're just buying in a shop. So this is about tailoring it so that we can give them the absolute best, because if you wear something that is not absolutely tailored to your body, it's not going to impact every aspect of your life. But if you're wearing a hearing aid as a child with a hearing loss and it's not adequate for learning speech and language because it's not a good fit, it is going to impact on every part of your life. So this customization, and we're gonna talk about doing it, is critical

for speech development, academic achievement, and social integration, which we know are the core pillars of a child's growth.

Okay, so I think by now, you understand the importance of just doing something that is tailored and specific, and this is where it gets us to real ear measures. So we are not using averages, we are not guessing, we are actually working with that specific child's ear. So we're gonna look at the definition and the purpose. So we're gonna talk about the definition now, but I just wanna start off by saying that real ear measures are also known as or referred to as real ear verification or hearing aid verification. Now, there are two things. The one thing is some people will say that they are doing verification, but what they're actually doing is validation, okay? And we'll look at the difference now.

I think that's important. And then some hearing aid manufacturers will tell you that you can do verification via the software. If there's not a probe microphone going into the ear, telling you what's going on at the eardrum, it is not verification. There's no hearing aid that is doing a real ear measure verification. Okay, so let's just quickly have a look. So I love this, because isn't this what we all want? When we're working with a child, and working with adults, I'm not saying not with adults, my focus today is just the pediatric population, but it's quality assurance. I think in everything that we do, we are outcomes-driven, and therefore, we need quality assurance. So we want to ensure that the hearing aid meets the requirement and expectations.

Parents are gonna pay a lot of money, gonna put something in the ear, go through the whole process, and the hearing loss was identified early, we want to be able to deliver. So verification asks the question, does the hearing aid meet the specified requirements according to a target? So all of these will have targets, just like you have on your first fit, there's a target, but that's a estimated target. Verification means that we are doing a real ear measure, so it is actually a target based on that ear canal, that impedance of

the middle ear, that ear mold, and that hearing aid. Compared to validation is, does the hearing aid meet the user's needs and requirements?

Okay, so let's just continue with that. So validation means I'm doing a functional assessment. For example, I test you with free field sound in the booth without your hearing aids, and then I'm testing you in the booth with your hearing aids. I take the hearing aids out, I let Mommy speak to the child, maybe child's not responding, they don't have the hearing aids on, and I see how the child is responding to the mother's voice, those type of things in the classroom. So it's very functional. How is it working in that child's environment? And it changes depending on the age of the child, okay? It often requires acclimatization. So we know in the booth, we can't just expect the child to suddenly respond to sound.

It's not interesting enough. So we've got different techniques as hearing healthcare professionals to get a response and to know when there's a response. Very often, it is binaural. So we can't really get ear-specific information. Even if we've got free field and we've got speakers on the one side and on the other side and we only place sound through the one or through the other one, this sound still goes to both. So it's giving us not really ear-specific information. Very subjective, okay, and you get better and better with the more experience you have. You need cooperation, and clear response is needed, so sometimes you're not sure. But verification is hearing aid assessment, we're looking at the hearing aid, okay?

There's no delay. We are getting a response immediately. It can provide us monaural data, so ear-specific information. It is objective, you cannot go with your gut. There's a target, and there's a response from the ear. You need minimal cooperation, okay, especially when you're using RECD, which is, which we are, sorry, which we are going to have a look at as well. So let's just finish with real ear measure, with REMS definition, and then we'll go over to the RECD, which is the real-ear-to-coupler

difference, but we will go into that now. So REM is an objective measure, we already said verification is objective measure, that assess how well a hearing aid amplifies sound within the ear canal.

So we're answering the question, what is the hearing aid doing inside the ear, which we don't really know if we don't measure it. And we don't know from a first fit what is happening because we do not know what that child's individual ear canal resonance is, what the individual characteristics of the ear canal and the ear mold is. So it's a thin probe microphone that we place a few millimeters from the eardrum and then a sound stimulus is delivered to the ear via loudspeaker, and then we get a response. So the purpose, so REM ensures that hearing aids are programmed to meet each child's unique hearing aid needs. And this is at the heart of personalized audiology, and anybody who works with hearing healthcare, I know in different countries, there are different professionals that specialize in pediatric fitting.

Again, it's not about volume. So it's not, how loud can we go, okay? It's about speech intelligibility, and it's about how the sound travels and resonates within the unique contours of an individual ear canal, looking at the ear canal length and the middle ear impedance, which will be different for each and every single child. So by inserting a tiny mic into the ear alongside the hearing aid, we can measure how sound is amplified and modified by the hearing aid in situ. And this real-world data is invaluable, makes such a big difference and allows us to fine-tune hearing aids so they complement the natural acoustics of the ear, ensuring clarity, comfort, and natural sound for children.

Because if we don't know the ear canal resonance, we can only guess what we are doing when we're working with averages. And I don't think anybody, it's not like when you ask somebody, how tall are you, most of us know how tall we are. If somebody had to ask you, do you know what your natural ear canal resonance is, most of us don't know unless you've done real ear measurement on yourself. Okay, the purpose

of today is not to teach you how to do it, because when you have the equipment, you'll have a step-by-step guide, and you'll get training from your supplier, and it's really easy. So I want to more focus on the importance and the difference that it can make, but I want for you to, if you haven't seen it before, if you haven't done it before, that you just have an idea of what we are talking about.

So the first thing you do, again, I've said this now a few times, we talked about the ear canal resonance. So we wanna know, where is the natural ear canal resonance? So which frequencies are naturally most amplified in your ear? Now, for adults, it's usually, on average, around about 2,500 hertz, but varies between 2 and 3,000 hertz. For children, it's usually a bit higher 'cause of the size of the ear canal that's smaller. So usually, it's 3,000 hertz or a little bit above that. Okay, so you will first just put the probe into the ear, no hearing aid, no ear mold, just a little probe. And then you will send a sound via the loudspeaker, and you will get the natural response of the ear canal.

Some software will provide you with a target curve, others won't, but you will see, then, the natural resonance. So that is the first one that you would do. Then you would place the hearing aid in the ear. So now we're doing an occluded fit. So the hearing aid is switched off, it's not an aided response, it's an occluded response, so we're closing the ear up. And now we can see how the characteristics of the ear mold changes what is happening inside the ear, because then the software will take that into consideration. So to get to a target, it's going to take the natural ear canal resonance, it's gonna take the effect of the ear mold. And then we're gonna switch the hearing aid on, and we are going to get a response.

And here you can see you're gonna do a response for soft sounds, average or your medium sounds, and then your loud sounds. So you will see that you will have a dotted line on software. On most softwares, the target is the dotted line, and then you get a

response from the ear, there's your real ear response there. And what is so beautiful about this is not just the value that you're getting, we look at the interpretation now, but you can see where to make adjustments to make it better. And that is really the value and how you're going to optimize the fitting. So isn't the manufacturer's first fit good enough? Now, I think I've already answered that, but I just want to show you this.

If you haven't yet read this article, I strongly recommend that you do. It's a really good read by Valente and colleagues. It's a 2018 article. And what they did is they actually looked at comparing a first fit with a programmed verification response. And I don't really wanna look at the programed response. What I wanna do is I wanna show you here, and actually, this is just one of the graphs. So they asked, does the first fit of the manufacturer lead to a good target match? And I wanna show you here, this was for adults. Now, remember, with children, there's greater variability. So for adults, if there's so much variability, imagine what it looks like for children. But I want to show you here.

So here's the zero line. Zero line means that that is where the real ear measure target is. So considering all the factors, natural ear canal resonance, ear mold, hearing aid, age, all of that, okay, is on zero. The first fit, on average, so here's the median, so if we count all of them and get an average, at 500 hertz, at over-amplified, okay, so now we're getting the noise. Then from 1,000 hertz onwards, look there, just drops, drops, drops, under-amplification. Now, you will see a look here from, if we just look at 8,000 hertz from a little bit under-amplified to very, very under-amplified, okay, and this is just the average, so here we can just see.

So that is why sometimes people say to you, you know what, I've done a verification, and it was spot on, so I'm not gonna do it. There are people with a more average ear canal or a ear canal that represents a 2cc coupler better, and they are going to have a better response. So it's not that you're gonna find this in every single person, that it's gonna be a horrible fit. But with children, and obviously adults can tell you also how it

sounds, although it's very subjective. But in children, they can't give you feedback, and the variability is so great that we cannot depend on a average, okay? So yeah, I just quickly wanna show you that it looked at speech understanding with first fit versus verification, and the white one shows the first fit.

So just looking at words correct in percentage, so the higher up, the better. Now, you'll see here this was for soft sounds, this was for average sounds, and this was for loud sounds. Now, obviously, for loud sounds, I mean, if it's very loud, you would hear the sound, you would hear the word, you would hear it a little bit softer. So that's why there's not so great variability in the loud sounds. But for the soft sounds, look here, the difference when we do real ear measurements versus if we don't and the difference that that will make in a child's life. Okay, I'm gonna look at adult versus pediatric audiology. Just look at what's the difference between adults and pediatrics and some of the challenges.

Okay, so the core principle remains the same. The only thing is, like I've already said, we need to be a little bit more creative and a little bit more adaptable and a little bit more patient. So the key difference is in the size of the ear canal, so you have to be very careful with that tiny little ear when you put the probe into the ear. The behavioral aspect, usually adults will be cooperative, most of them. They will comply, they will allow you to run the full procedure. Children not so much. Okay, so our protocol will change. We're gonna look at some tips and tricks of how to do it, how to make it a bit easier in children.

And then we're gonna look at RECD, real-ear-to-coupler difference. And this is actually part of the tips and tricks to make it easier to do real ear verification with children. Okay, so let's look at RECD. What is it? So this measure considers the unique ear canal and ear mold characteristics in comparison to a coupler that simulates an average ear canal. I can explain it to you now. It is a quick measurement and can be

used in simulated real-ear verification measures. The coupler measurements allow the REM fitting to be performed inside a 2cc coupler instead of the patient's real ear. Okay, so what we are doing is we are saying we're measuring, so we're not going to do soft sound, or the natural ear canal resonance, then the occluded, then the soft sounds, average sounds, loud sounds, maximum power output.

That all takes time, and a child needs to sit still because the probe is moving. So what we are doing is we're saying, can we just look at the characteristics of the canal? So we measure that, then we measure the characteristics of the coupler. We deduct the two, and now we can actually buy the software. Luckily, we don't have to make the sums. Via the software, we can use the coupler because the software now knows what to do different with a coupler than from the real ear. And we can do all those measurements in a coupler while the child is playing. So you only have to do a measurement once, and it's only going to be one measure.

So it's quick, quick, quick. Actually, once you've got the probe in, we're talking about a minute or two, okay? So that is really one of the, there's things for me, in terms of tips and tricks, that really makes pediatric fitting so easy. So you're going to first, and this you can do before the parents come. So before the appointment, you can measure the characteristic of the coupler, okay? And depending on if it is a custom-type hearing aid, usually, we will be using a BTE with children. Now we're doing it inside the ear, and we can do it just with the transducer and then with the probe mark, or we can do it via the hearing aid mold, okay?

And that gives us something that looks like this, which means that is the difference between the coupler and the real ear. And now the soft software can use that to do all the calculations for us. So you will probably also have heard because we sometimes look for shortcuts, and shortcuts are not always bad, okay? But I think it's important for us to know that most equipment have averages built in for RECD, otherwise, you can

also find them in the literature and use them. So from one month through to five years, there's average RECD values. But like I've already showed you, the variability's so high that there's literature saying it's actually better doing a first fit than to use an average RECD, okay?

And it's so quick. The other thing to make it a bit easier is the literature showed us that between-ear RECD are highly correlated. So if you can get a child to sit still for two minutes for one ear, you've actually almost won the comrades, because you can use the same value on the other side, until the time where the child allows you to do it on the other ear as well, so we can do it in steps. And I like this recommendation that they say we are going to do either verification, either as real ear measurement verification with REMs, or we're just going to get the average of the ear, the information of the ear and then use RECD every three months, because the child's growing, the ear canal is changing, the characteristics of the ear canal is changing, so the amplification is going to change, and our targets need to change.

And then every six months up to the age of three and then annually after that, unless there's a child where we are concerned about progressive hearing loss, and that's where the team comes in again, and people can give us information on how the child is doing. So just in summary, so we're going to have, with RECD, we're gonna have the transducer connected to a standard coupler, and we're going to introduce a signal via the transducer, and it is going to give us a sound pressure level as a functional frequency of the coupler. It's gonna do the same with inside the ear, when we put it inside the ear, and that's gonna give us the difference. What I do want to mention here is just always the question of, how deep do I put the probe into the ear?

Now, they usually say 10 to 15 millimeter from the ear canal opening, but five millimeter in a child's ear can be quite a lot. So I like to use some software, some equipment will give you a probe guide to show you. Others will just allow you to do live placement. So

as you put it in, you're gonna actually see this curve occur and that you're gonna see the natural ear canal resonance peak, and then you know that you are in deep enough. Then once we've got the difference between the two, we're gonna use the coupler as a simulated ear. We're gonna run soft, average, loud sounds, we're gonna run maximum power output, and we are going to see the targets.

And then we're gonna try and best match them to optimize audibility of speech. And this is not part of it, I'm just putting it out there because it's also valuable for adults. But we can use the hearing instrument test box that we use for RECD to verify advanced features of hearing aids. For example, frequency lowering, is it working, automatic noise reduction, feedback suppression, and directional microphones. And then some, depending on your software, will allow additional features to test. But we know that the hearing aid's functioning optimally, and that, we want for adults as well. So the importance of REM in pediatric fitting, the benefit, and examples. I'm not going to go through the examples now because I'm going to first do the interpretation with you 'cause then the examples are gonna make more sense, but I'm just gonna show you that it fits in, yeah.

Okay, so benefits, I think you already know. So REMs precision allow for custom-tailored hearing aid settings directly translating to clearer sound perception for a child, which is so important. And by aligning the device output with a child's specific hearing loss profile, so let's say their fingerprint, their hearing print. REM or RECD, okay, it's the same thing, it just depends on how we're using the equipment, ensures optimal speech development and hearing. So it not only enhances auditory experience but also fosters greater engagement and confidence, because if you can hear the best that you can hear, you're going to function better in social and educational settings. Okay, so here's the two examples. I'm going to get back to them, I promise.

Okay, so here is an example of the equipment. So you will have some piece of equipment where there will be something that goes around the neck, okay? And you will have a probe, or you will have a space there where you can attach a probe that you can put into the ear. So these loops here, you put around the ear to stabilize it, and then this is your speaker. So that's for REM. If you're doing RECD or advanced feature testing, you need the hearing aid test box. This is what the couplers look like, depending on the type of hearing aid. And you see here, here is the coupler for when you're using a BT, okay. Let's talk about some of the challenges.

Okay, so we might have to have shorter, more engaging test sequences. You can't sit and play a paragraph and expect a child to sit and listen, because for your slightly older children, you might not use RECD, you might go through the actual verification process with REMs, but you're going to just break it up. And you might have to gradually get them used to the equipment, and that's okay, as long as we've got a plan to move forward. We need to use engaging distractions. And to be honest, I never book a pediatric fitting on a Friday afternoon, three o'clock when everybody's tired and ready for the weekend. I do it early morning when they are fresh, when I am fresh and we are all good to go and creative.

So visual or auditory stimuli is amazing. Now, this also just depends on your child's hearing loss, okay, if you can use auditory stimuli. So we use bubbles, you blow bubbles, they can touch the bubbles, they love popping the bubbles, so you distract them with that, and then they don't really notice necessarily that you're putting something in the ear. Something that we find work very well is coloring in, especially the girls. We've got a princess coloring book, and once they start coloring in, you can almost do whatever you like. A tablet or a phone with a movie always does the trick. It's not our first go-to, but if you struggle, that is definitely the go-to, and ask the parents what they like to watch.

Most parents will actually bring a tablet or a phone with them in any way with the stories on that the children watch. And then we've got a huge, I think it comes up to here, about, for me, a huge, big, stuffed toy elephant. And he's so soft and fluffy and cute, and he's the first thing they notice when they come into the practice. And I mean, we in South Africa, our kids are very familiar with elephants. And they will sit on his lap or they will sit in between his legs and just lie on him and relax. He's such a safe character for them. And then very often, they allow us also to just go ahead and do what we need to do.

So whatever works, I always say whatever works. Team up. I do not do pediatric fittings by myself. I find that, you know, you can always, and not just can, you should involve the parents always, but parents sometimes are emotional, they're sometimes nervous, so you need somebody that can help you either with the distracting or with the actual fitting. And the ideal, I'm lucky, I've got an audiologist that does it with me, but you can use the team. There's a speech therapist that can come with, or the occupational therapist, or anybody in the team that is willing to come. But I find that it is very frustrating doing it by yourself, especially with a difficult child or difficult situation.

And to try and distract and do the testing is very hard. And if you're only relying on the parents and it doesn't go well, the parents feel so disappointed. They feel like they've let you down and the child down, and we don't want for them to be dealing with that. So get a team together. With babies, use sleep. So when they're sleeping, you can quickly do it, especially if you're gonna do RECD 'cause it's such a quick measurement, okay, 'cause we only want basically the natural ear canal resonance and because it's gonna give us the characteristics of the ear canal. If you can, and you also do the assessment at where we're doing objective measures, like ABR, ASSR, et cetera, have the equipment there so that while the child's still sleeping, you can also just get that information.

And for slightly older kids, I've done REMs on kiddies from about four. Not all of them allow you, but some of them will, especially if you make a game out of it. So like they're a secret agent and they're gonna get a special message in the ear, but it doesn't work so well with girls. But clear instructions, you want to be clear, you want for them to know exactly what's gonna happen, exactly what you're expecting of them, and it is possible. Okay, so let's go into analyzing. Now, when we analyze a verification result, either via REMS or RECD, we need to understand what speech mapping is. And I'm sure most of you have heard the term speech mapping.

Okay, so it is actually very simple. So speech mapping is an objective assessment. It measures how sound, speech, is amplified by the hearing aid and delivered in the ear canal. It uses a probe mic placed in the ear canal alongside the hearing aid. That sounds exactly like REMs, right? The only thing is with REMs, you can also use pure tone, well, you can use pure tones, you can use wobble sounds. The older software didn't use speech as a stimulus, but now we're using real speech as a stimulus, and you can also use live voice to actually track what is happening in a specific environment, like, say, for instance, when Mommy's speaking or when you are listening to music or story or to make sure that there's no over-amplification.

But then we get a visualization, sorry, of speech which gives us targets, which we've already looked at. You get a target. Remember the dotted line? Target, based on speech stimulus, and we get the SII, which is the speech intelligibility index. And that is a metric used to quantify how much speech is accessible to a listener. Okay, so this is usually a value of zero to one, but most software will express it as a percentage. So if it is 0.9, it would be 90%, okay? Now, speech intelligibility index is quite an important thing, and I always explain it like this, just to make it more real if I have to explain it to either a patient or to parents, is that if you think of, you know those tests you get, visual

tests on social media where every second word is missing, and then you read it, and you can read it 100%, even though you only get every second word?

So you're actually only getting 50% of the message, but your brain just puts the whole thing together, and you can actually read it. Now, this is almost the same in terms of understanding the concept, okay? It's not theoretical. So if you could talk to me and only say every second word, I would probably understand. If you've ever been on a phone call with somebody and there's a bad signal and you miss a little bit or you miss a word here and there, but you still know what they're saying, so this is basically it. So we need at least 50% to be able, for the brain to fill in the missing word. So below 50% is really bad, And for children, it's even worse, because remember, as adults, we can fill in the missing word because we've got context, we've got language, we've got our brain processing all of these things all the time.

Kids don't have a reference. So for adults, we want about 50%, it's what I work according to. But for children to learn speech and language, they need more than 0.75 or 75%. Okay, so the closer you get to 100%, obviously, the better. It's very rarely that you get to 100%, but you can get above 75%, okay. And just remember that this is not, so it's speech intelligibility, it is not understanding. So if you talk to me in a language that I do not understand, the hearing aid will pick up that the speech intelligibility is maybe high, maybe I've got 80% intelligibility, but my understanding is zero because I don't know the language. So we must just remember that we still don't know what the brain is doing or how the brain is processing that sound, but at least we're providing the information to offer the brain the opportunity to actually interpret the sound.

Okay, so when we are looking at analyzing, we actually ask ourselves a couple of questions. And the first is, what does the fit look like? So if we look here, we've got soft sounds, we've got our average sounds, and then the purple, we've got our loud sounds. Okay, just by looking at it, if we look here at the average sound, we see here

goes the dotted line, that's our target, and the real ear response goes, the low frequency, below the target, it goes above the target, below the target, for quite a bit below the target, a little bit over the target, and then here, in the high frequencies, below target. And I go, hmm, yeah, I would like for a child to be a little bit closer.

But then I go down, and I look here, and I see my speech intelligibility index is 46%. That is not good enough for a child. So I am definitely going to make changes. So I'm going to do that with the soft, the average, and the loud sounds. Okay, I definitely want to look at my MPO, so maximum power output. So there's the target, I don't want anything going above this line. So I look at this, and I go, that is good for me, as long as it doesn't go over. And then the question is, can we improve audibility? And yeah, the speech intelligibility index will guide us of soft sounds 'cause we want to boost the soft sounds, okay, well, especially because they go missing in the noise, and we live in a noisy world, while keeping average speech comfortable.

So with the whole time while we're making adjustments, we're gonna keep that in mind. Okay, so we are basically at the end, so just to go through those examples that I had in the beginning, here I wanna show you the real value of real ear measure. So here you've got speech intelligibility index percentage, you've got right your left ear, aided response, unaided response. Now, look here. This was just without doing any adjustments, just on a first fit. The unaided response was 0.38 or 38%, and the aided response was 37%. So we're actually worse off with the hearing aid in than without the hearing aid. And that gives us such valuable information because now we can go and we can make the change.

We can see up as we went, soft sounds, medium sounds, or average sounds, loud sounds, and then loud sounds again, and we're getting closer and closer to the 75%. And this really guides us. So we've got a goal, we've got a way of outcome measure, and we can objectively really say that we're doing what is in the best interest of this

child. Okay, here again, you can see this is the one we looked at previously, but before any changes was made, just for the first fit, we've got with loud sounds, 52%, average sounds, 46%, and soft sounds, 28%. That is completely inadequate for a child, even for an adult. And this guides us towards the next step. So in conclusion, I think we need to think about how we measure outcome when we are working with a special population as part of quality assurance in a population that cannot communicate their needs to us and do not have a reference for comparison.

We need to consider if we are practicing evidence-based practice in line with our medical board guidelines because the guidelines in most countries are saying you cannot do pediatric fittings without verification. It's actually unethical. And if we are doing it in line with person or child, centered hearing care, which REMS and RECD allows us. So REMS precision allows us to tailor hearing aids to the unique acoustics of a child's ear, ensuring they receive the most natural and effective auditory experience possible. We are the tailors. We make it fit exactly for you, and I think that's very special. This approach not only enhances speech clarity and understanding, but also supports overall development growth in communication, education, and social interaction.

Then just remember we can simulate REMs using RECD, so if you're thinking of a 1-year-old that's not gonna sit still through the whole process, we can make it easy with RECD. It's an easier way to perform REM and also test features of the hearing aid to make sure that hearing aid's always working perfectly well. Although average RECD values exist, remember there's great variability, and that compromises the fitting. And then I always like a guideline like this, but verification every three months, during year one, during year two, every six months up until they turn three, and then we're gonna do it annually unless something happens, there's an ear infection or the hearing changes or anything like that.

There's just a few references if you're interested. And then thank you very much for attending this webinar, and thank you for your interest in pediatric fitting. And for those of you who are already fitting the special population and changing lives, thank you for the difference that you're making in our profession. So if you have any questions, you are welcome. I'm gonna stop sharing my screen. There we go. I'm just gonna open. Ah, here's a very important question. Yes, can't just answer it, I need to read it to all of you. Okay, so the question is, does middle ear pathology affect real ear measures or measurements? If so, how does it affect, and what can be done to tackle this?

Okay, so the first part of your question's very easy, and then it becomes more difficult. Okay, so yes, the moment, sorry, there's just a lot of questions coming in. The moment the impedance of the middle ear changes, and we know that it changes with middle ear pathology, our REM is going to change, our natural ear canal resonance is going to change. So that is going to affect our result, it's going to affect our targets. So the only way to really tackle it, and if it is in small children, it's gonna be a lot harder, is then you're going to have to use a bit of clinical experience to guide you there. But with a older child, you are going to have to do verification more often.

So not every three months or every six months or annually, but you're going to have to actually do it when you see them because it's going to be changing all the time. Okay, okay, how do EML design and fitting affect REM outcomes in pediatrics? Okay, this has got to do a lot with the occlusion. So how much occlusion is happening in the ear when we're putting the mold in because that is going to affect the target and your normal first fit cannot take that into consideration, but with real ear measures, it will actually tell you how much occlusion there is because remember, for example, if you put your fingers in your ear, you can hear yourself through bone conduction.

You sound like you've got a cold, but it sounds like the sound is amplified, it sounds like it's louder. So that is going to happen when you put a mold in the ear. The child's

gonna hear themselves a lot louder, but they're not going to hear the environment so well. So we need to bridge that to make the child sound more natural and making the outside world sounding loud enough. Okay. Yeah, if a child has a tube, we call it grommets, tube in the ear, applying RECD, is it advised? No, it's not. If you look at the literature, it says that it is not advised because it can put the child at risk. You're looking at such a small ear canal, and also your impedance is completely different.

So it is not advised what, yeah, you know, then you have to do the best you can. I would probably, if I'm just thinking, you know, usually, children don't have grommets for a very long time or extended time. So adults sometimes have bigger grommets in that stay in for a longer time if they're struggling with infections or eustachian tube problems. I would wait before I do REMs. Yeah, okay, so is there any preferred distance to insert the probe inside the ear canal for child and adult separately? Yes, so they say about five millimeters from the eardrum to stop. Now, that depends on how long the eardrum is, how long the ear canal is, sorry. So for children, they say 10 to 13 millimeters from the opening of the ear canal, and then for adults, they're separate values for male and female, and those values you will get with your equipment because there will be normative data.

The other thing that you can do that is quite a nice tip, is you can take the, it doesn't matter if it's a ear mold or, like, a custom ear mold or a custom hearing aid or open fit, but you can take the hearing aid, and then you can, so let me just see if I can sort of show you. If this is the hearing aid, okay, or the tip of the ear mold or the tip of the open fit, you will actually take your probe, and you will place it about three millimeters, sorry, getting confused with my left and right, three millimeters above, okay, that's more than three millimeters, three millimeters above where what you're putting into the ear would actually stop, and then that is quite a good distance to put it in.

I still prefer to use the live guide because it's a lot more accurate. The moment you get that flat line with that nice peak resonance, you know that you are in the correct position. And otherwise, we're still working with averages, and we do not know how long each and every child or adult's ear canal is. So I really recommend that you use that live feature. Okay, this is a very nice question. Thank you very much for this question, 'cause ethics is something that I'm quite interested in. What are the ethical considerations for conducting REM in children, particularly in infants? Okay, so there's two sides of it, and I think we could probably have a whole discussion just on the ethics.

But I see there's some other questions as well. So I'm just gonna try and answer it quite quickly for you. If you wanna discuss it further, you're welcome to send me an email. But on the one hand, there's the thing of if you're not doing REMs, it means that you are unethical and you shouldn't be doing pediatric fittings. I'm sorry if that offends anybody, but that is what the guidelines tell us, and that is the truth. We've seen that a first fit is not good enough, okay, so there's the unethical part of that. In terms of the ethics of conducting REM, there are a couple of things. The one thing is you need consent, okay? So you need to explain to parents the risk, okay?

So they need to understand what happens if your hand slips and that tube goes against the eardrum. They need to understand the risk if you don't do it, and they have to consent and say that is fine. If you do it as a forced thing, so if you have parents holding a child that they can't move, and they're screaming, and you're putting it in and forcing the child, that is unethical. If you have not done the correct training, if you're not sure what you're doing or you don't understand the procedure, that is unethical. But in terms of if you're doing the right steps, you've been trained, you are fitting hearing aids, you want the best for that child, you want an individual response, your ethical way to go is to do REMs.

I hope that answers your question. Let me just check here. There's still a couple of questions coming in. Okay, this is also a good question. Are RECDs measured with foam tip and ear mold the same? Okay, yeah, so no. The coupling type affects the RECD values, okay? So what we actually want to do is we want to use the same transducer when we do testing of, the evaluation or assessment of the hearing. So when we're doing the ABR or ASSR or the audio, so say we're using an insert, then we want to, when we're testing in the coupler using insert and then when we're doing the response in the ear, we want to use an insert.

But in saying that, if you don't, so if you, for instance, use the insert for everything, but when you're doing the response in the ear, you attach the transducer to the tubing of the ear mold, then most of the new equipment allows you in the software to specify what you used, and it'll do a conversion for you, okay. How does venting condition of a fitting influence REM measure, and how is it verified? Okay, so venting, so it's the same as with your open fit. So the bigger the vent, the more open the fit, and that will affect how much, especially low frequency is being amplified. So that will be determined via the real-ear occluded response.

You will see how open or close the fit is, and the software will take that into consideration, okay. Okay, I've seen a lot of emphasis of otoscopy before performing REMs. Do you recommend? Yes, so performing an otoscopy is essential for various reasons. One is you just wanna check, again, just the integrity of the eardrum and to make sure you don't see any infection. But the main thing here is, remember, we're using a probe microphone, it's a tube, and it's hollow, okay? So if there's a nice piece of chunky wax there and you push the tube through the wax, you're gonna just block the tube, and you're gonna get a flat response. So I would definitely use otoscopy to then also check for any wax, any debris, anything there that might impact on my probe fit and then also just to check, again, the contour of the ear canal.

So some air canals have, like, a slight upward, some have a slight turn, some are quite straight. And the straight ones you think are the easiest, but they tend to slip out, so you need to make sure that you stabilize the probe, so very important. How does loudspeaker location affect REM results? Very important, okay, and remember, you're also doing a calibration when you are doing it. Usually, placement is about a half a meter to a meter from the speaker, and you will do a calibration. And then usually the angle of the speaker is either zero degrees, so it's right in front, or it's at a 45-degree angle. Let's have a look, last question. You spoke about verification and validation.

Would you not do validation if you're doing verification? Okay, so it's got two different purposes. You will see some of, I think it's the British Academy changed some of their guidelines in terms of validation. Verification, I think, is more important for children than validation from the point that if you're only gonna do one, then I would rather do verification because the guideline says that we have to do it, and we can see why, because, otherwise, we don't have a good fit. But if you want to practice best practice, then you will do both, but I won't do it on the same day. So I'm gonna do verification, and then when they come back, I will probably do a validation as well.

And I'm gonna speak to the teacher, and I'm gonna say, "So I want some functional information as well." I can give a checklist to the teacher, I can have a child in the booth. I can see how they're responding to Mommy. I definitely want to also have, I don't want to be so clinical and just say, "No, this is a good fit." But you know, then they come in a noisy environment and, you know, it distracts them. So you still have to be led by the family, led by the rest of the team and work together to get the best for this child. So I would do both. Thank you for those questions. I think that's it, Anna.

Thank you.

- I believe there are no further questions. So thank you so much, Alida, for your fantastic contribution. Very inspiring, I would say. And I really hope to have you as a speaker in other educational sessions that Academia will organize. Thank you so much. So did you discover the secret to perfect hearing aid fitting for children during our session? I believe so. We have come to the end. Thank you again, Alida, and thanks to the audience. And as always, I strongly invite all of you to keep an eye on Inventis social media pages to discover what's coming up next. Thank you once again. Bye-bye.

- Thank you. Bye-bye.