Considerations and Approaches For Complex CI Cases

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- Thank you for joining us for today's webinar considerations and approaches for Complex CI cases. It is my pleasure to introduce our presenter, Dr. Joshua Sevier. You can read more about Dr. Sevier on today's course page. On the course page of our website. Thank you Dr. Sevier, and welcome.

- [Dr. Sevier] Yeah, thanks for having me. As she said, my name is Josh Sevier. I am the clinical program manager for the Cochlear Implant program at U Chicago Medicine, and today we're gonna be talking about some considerations and approaches for complex CI cases. These are my disclosures as well as my learning outcomes. Just to let everybody know, we're gonna be running a little tight on time today. I wanted to get as much information as I possibly could in this course and just to kinda get everybody as much out of it they can. As far as the information, it was originally marked as an advanced course and it still is that, but I wanted to make sure that everybody, no matter what your experience level, you're able to get something out of this.

So no matter where you come in, how many patients you see on a regular basis, hopefully you should be able to find something within this course to help you apply in your clinical practice. Because we might go over on time if we don't get to everybody's questions. My email address is gonna be at the very end of this so you can follow up and you're more than welcome to reach out and contact me at any point. But with that, let's get into this. So as we all know, when it comes to seeing cochlear implant patients, what our big focuses on is patient outcomes. There is a large amount of variability when it comes to cochlear implant patients.

Some people do extremely well, some people do very poorly. We need to make sure that we set that bar low. Honestly, when we go into this. So we have the proper expectation going in. We never guarantee anything more than sound awareness, but we can get patients up to where they're doing fantastic with their cochlear implants, talking on the phone and not having any issues, but everybody is different. So we need

to make sure, that we take that into consideration. So particularly focused on today, my practice specifically involves a lot of second opinion cases and referrals for complicated cases. I was teaching one day and I had a student ask me specifically if there was a standard approach that I had for Copeland implant cases.

And long story short, no, I do think that everybody should be treated as an individual case and individual person and have a plan of care marked out specifically for that. But when it comes to do I tend to use a generalized guide of going through yes, and it involves these three things, investigation through patient histories, utilizing objective measures and programming information that we find through our testing. One great thing about education through AuD programs, master's programs, wherever you are, is we do get a lot of foundational material that helps us with cochlear implants and what normal is supposed to look like. But as you'll quickly find out, the real world doesn't always go according to the textbook.

So that's why our team kind of uses this approach. And this is why every time that I've taught at universities, I teach this type of approach. I'm really big on visual learning, so you can hear lecture material all day long, but where I think people really get learning and getting that information that's applicable to what they're doing is seeing it with their own two eyes and making it personal. So because of that, each topic that we talk about today is going to involve a case study from a real patient. And you'll have to realize that every scenario is not gonna have a happy ending. So there are a lot of issues that we can fix. There's some issues that we can't.

One of the main reasons that I wanted to do this in particularly, is just to make sure that people are considering all the possibilities and make sure they've covered everything. We have patients that do poorly, as I mentioned, patients do well, you can give patients a rehab plan and some exercises to do at home and they could do every single one of them and still do poorly. And that could be a multitude of things. It could

just be anatomy, it could be a duration of deafness. And one thing that we don't really think about a whole lot is it could be programming errors. And the purpose of this was to kind of focus on what some of those programming errors could be and if there's anything we can do to fix 'em.

So as we go through these one by one, I'm gonna go into a little bit more detail on each one and just kind of give you the thought approach that we have when we go to see these second opinion and complex cases and try to resolve 'em as we go. So the first thing I mentioned is investigating issues through patient histories. And it may seem as a basic thing of, of course we ask questions when we go through who doesn't, but at the same time, I feel like we don't do a good job of diving into all the details that we may need. Sometimes one thing that we should always do is listen while we ask questions, make sure that we're listening to every single thing the patient says.

And the reason I say that specifically is that patients may describe issues to you and a way that you weren't taught, but that's the only way they know how to describe it. And we have to take that information from those patients and figuring out a way to make it applicable for them or make it make sense to us of an issue that we might be able to solve. So one thing that we always do is reading through medical records. And I know every practice will request medical records beforehand. Once we get a second opinion case at our practice, we actually sit through, me and my student will go through and read every single detail of every medical record they've ever had.

And that is not just post-implant or recent things that have happened. We go through the etiology from beginning to end and we have a powwow session afterwards to talk about any notes or highlights that stood out to us. And we use this because we wanna make a game plan for when this patient comes in. We wanna get their side of the story, make sure that we're listening to everything that they're trying to tell us, but we also wanna make sure that we take that information and don't kind of fumble through the

appointment, but we have a plan of action to efficiently take care of everything as we go. Including is that what testing measures are we going to use?

We are big believers, and I know every clinic does it a little bit differently. We do not change anything on cochlear implant programming until we've done testing because we use the evidence that we get from the testing to make sure that patients are doing well or we know what we're going into or what they're specifically hearing before we make any of those changes. So reading through those medical records are a crucial point. We've had issues with medical records in the past also from some smaller clinics will have pre-printed things on forms where they just go through and circle different things that they had done without really providing any explanation for it. So I'm really big about documentation.

If you ask any student I've ever had, I have a summary paragraph that we put at the bottom of every report, any programming changes that were made, specifically what were those changes that we made? But we also put why. And the reason that we put why is because if that patient moved tomorrow, I want whoever picks them up, take care of them afterwards to be able to look at that report, know everything that we did, why we did it, and they take off from the moment they see that patient to the end, we want to know the problem and the duration. We want to know if it's something that just started after their last visit that they'd never had before or is it something that's been going on for a really long time.

One crucial point that I would definitely hit on too is when I put up here information about the internal implant, some of the older implant models, when you think about a C1 from advanced Biox and N 22 from Cochlear, they don't have some of the capabilities that modern internal implants do and those patients still exist out there. So if you have somebody with some of those older models, some of them are unable to run impedance measures, they're unable to run ECAP measures. So having all that

information ahead of time is crucial. And that's another reason. In addition to the medical records, we also obtain a copy of the digital file from the programming software itself. When we get the records sent over, we wanna make sure that that we're not missing anything and we take every single issue into account before that patient even gets there.

We also ask them if things, if there's anything that makes it better or worse. Some people will say if they're in quiet situations, it's better. Everybody complains about background noise, so that's always gonna be something that comes up. But a specific instance where investigating these type of issues has come into play. A few years back I had a patient that had neurofibromatosis type two. She had done well with her implant, she was implanted before she came to us. She was doing extremely well their implant and she called one day to let us know that she was hearing screaming through her cochlear implant, a high pitch screaming. The first thing we did was ask her to take her processor off to see if she was still hearing it.

And she was, so due to the nature of the NF two that already gave us an idea if there anything better or worse, no, nothing makes it better or worse. We were kind of concerned about regrowth of a tumor on her auditory nerve. So we sent that information over to the implanting surgeon who ordered imaging and sure enough that implant had to be taken out because there was tumor regrowth there. So asking these questions will give you a huge idea, not only game plan, but what the patient's experiencing before they even get to you. And then moving on to objective measures. I am huge on objective measures in clinic. I teach them in class and the reason we do these is specifically what it says on the screen here.

We are able to obtain data from a physiological response from the person's body without any input from the patient. So we can have their body tell us what's going on, what they hear, what they don't hear, how well they can hear certain situations before

they're able to even tell you anything. So it helps out a lot when it comes to troubleshooting issues, programming's overall performance, we can take that data to help solve a lot of the issues from objective measures and we'll be talking about that through the different case studies as we move forward. We have met lots of providers from lots of clinics that when we start discussing some of these measures, they've never heard of them and they don't know what they are, don't know what they can do.

So that's one thing we should definitely try to incorporate. These objective measures. If you ever see a course on some of the ones we're gonna talk about today, please take it. The more information you have, the better your patients have the chance of doing. So there are a ton of objective measures, but the three specific ones that we're gonna be talking about today in regards to clinical programming with cochlear implants are the following three. As we get to each one of 'em, and I'm gonna go to in depth more for each one and how we can use that in clinic for the ones with acronyms, we'll explain what the acronym means when we get to it as well.

But impedance, whether or not we think that that being an objective measure and absolutely is, and we can find out a ton of information from impedances and they're just the measure of opposition of electrical current flow across the electrode lead and contact. eCAP measures is just when we send a electrical response to a population of nerves on the auditory nerve and recording the response that we get back from them and eSRTs as we're recording the response of the contraction from the stapedius muscle after we introduce an electrical pulse train through the cochlear implant. So in broad terms, if you've never used this before, maybe thinking what in the world am I gonna be able to do with this?

We'll go through it and we'll give you some real world examples of why we use them and why they make sense. Starting off, the first thing we're gonna talk about, as we said impedance is we've already gone over the definition of what that is. This should be

done specifically at the start of each programming session. This is so important. Two of the three manufacturers have it set now to where when you connect the processor and the coil to the patient's implant, they will automatically run them. One of them you still have to click manually measure, but it is at the top of their workflow. So it's just an indicator no matter what you do always do this first.

Even if you see the patient and you do testing on the patient, they do extremely well. You have no reason to make any changes whatsoever. At least still connect them and take what their impedances are. So you have that on file just to see if there's been any shift or change there. And we just put a small amount of current to each electrode and the different electrode is measured to find out what that is. Every single manufacturer does this. Just lets us know how well the electrodes are sitting in the tissue and it can tell us so much information such as we always do these in the operating room. They're typically lowest at the surgery. There are a couple measures we do this.

I know that a lot of clinics don't have the capability of sending an audiologist in for every single implant surgery there is. You can train some techs to do this as well. I've even been a place where the surgeon will run this, but they're typically lowest at surgery and it kind of gives us an idea if there's any issues with the electrode during the surgery and it's something we may have to address when the patient comes in for activation. Running this in the OR has actually even helped us catch a failure where the internal chip was not fully connected to the implant array and the impedances were continuously failed. And we found this during interop, so always ordering a backup, we were able to switch it out with no issue.

But had we not done that, we would never know. They're typically higher at activation day. They're very stimulation dependent. So if you don't stimulate them over time, they have a tendency to rise. Other issues that may come up that may vary your impedances device and activity. So like as I mentioned before, you've had activated,

they've never been stimulated before. If you don't use your device very often those impedance measures are going to rise. So the more that you use the implants, the lower they'll be. They do stabilize over time. But if the current levels are trying to overcome what the higher impedances are, it may lead to some difficulties with the patients middle ear dysfunction. This one's being discussed more and more.

We also check our tonometry anytime that we have a patient come in because if you do have some chronic ear infections with implants, it may have a tendency to make your impedances fluctuate. The most recent book we released about managing these type of cases, there is a contributing chapter specifically about middle ear involvement. When it comes to cochlear implant programming. I would highly recommend that it could tell us if they're open short or outta compliance electrodes. Oddly enough, we find this a lot and they've never been addressed. We've had patients come in for second opinions that have added compliance electrodes. The moment they come in, sometimes the software will find them, flag them and shut them off for you.

Not always, colds and viruses, very similar to the middle ear dysfunction. If you have some issues with the cold or virus, it could cause your impedances to fluctuate. We're seeing some initial wild things when it comes to covid in relation to implant progress. I'm sure we'll have much more research to come in the future on that. Hormone changes. For example, somebody going through pregnancy or somebody going through a puberty can cause a influx in your impedance measures. So specific example with this one, I had a second opinion come in. It was a teenage girl had a twin sister, both of them bilaterally implanted and the mom wanted a second opinion because her attending implant audiologist told her because she was going through puberty, it was most likely the cause of her impedance shift 'cause she had complained that things had gotten a little quieter and she thought that was a little outlandish.

So she wanted a second opinion that is 100% accurate. It is a real thing. Hormone fluctuation can change your impedances. Inflammatory conditions just such as general swelling or autoimmune conditions can shift what your impedance levels are. Fibrous tissue growth, and I'll say this in a couple different ways, fibrous layers that form in the cochlea after surgery. Also with the ossification as a result of something like bacterial meningitis, this is couldn't cause your impedances to be a lot higher or they're just not making good contact with the tissue and the fluid. Same goes with ground electrode issues. If you have a failed ground electrode, unless you have multiple ground electrodes in your process or your implant, this could be an issue.

If you only have the one ground electrode, this could affect the impedances of every single one of your electrode contacts. So keep that in mind because if that is an issue, it could change everything and that will also be a decline in performance as a result of that. Going into that, we're gonna talk about our first case study and that is a 42 year old female sudden traumatic single-sided deafness. She is a MetL user. When we first initially met her, she did not have an implant yet she was a previous Baja user. So when I say sudden traumatic single-sided deafness, this patient in particular, the reason and the way that she lost her hearing was her husband was an athletic trainer and he brought medical supplies home.

He often had a bag of the a little longer single sided cotton swabs or Q-tips, whatever you wanna call 'em. She was cleaning her ears after a shower. She had a towel on her head and she was standing pretty close to the door. The towel started to slip and she tried to catch the towel and she rammed that side into a door which punctured her tympanic membrane and went all the way through and ruptured her cochlea. Horrible pain. I can only imagine what that felt like. She tried using a Baja for a period of time, did not get benefit from it. Funny story of why she started using it. I'm not gonna go into it now, but she stopped using it and she had been on cochlear implant forums for

quite some time trying to figure out if they were ever gonna be approved for single-sided deafness.

Once that single-sided deafness was approved by the FDA, she made an appointment with our office. The next day she came in, her implant surgery went off without a hitch, no issues whatsoever. She was one of the last implant patients that we had right before Covid hit. So due to the shutdown, we weren't able to activate her until a lot later than we would've liked to just because of hospital protocols. But once she did come in, this was her first round of impedances. There are gonna be a few of these I'm gonna show you and now we'll go back and forth so you're able to see them. So first thing you probably noticed immediately in the MetL there are 12 electrodes, the most basal three electrodes have been turned off and that has a lot to do with the nature of our hearing loss in general.

As we were going through in programming, she noticed no sound perception whatsoever or loudness growth from those most basal three electrodes due to the trauma that area suffered that led to her hearing loss. Everything looks pretty good. This is two weeks after her initial activation, two weeks following that. So one month post activation, you may see, I'm gonna go back and forth here. Those impedances have risen significantly without explanation. She said that everything got really, really quiet. She wasn't sure as to why, we made a couple changes. She came back two weeks later, so we're six weeks post activation, everything looks great and then two months post they have risen again. So the fluctuation back and forth was kind of confusing.

We did ultimately figure out what was going on and I'm gonna go back to the very beginning of this one here. So if you look here at the bottom of this slide where it says ground path impedance, so that number says 0.70. After consulting with our MedL rep, she indicated that that number typically is lower than one. It can get up to 1.2, even

1.5, but they ultimately like to see it below one. So I want you to look at that specific number as I advanced to the next slide and has gone to 7.62 that lets us know that something is going on with that ground electrode. And then so the six week appointment as she came in, it had dropped back down to 0.79 and then risen back up afterwards to 3.78.

So just wanted to put this on your radar. The ultimate cause of this issue end up being an air bubble. After she was implanted, a small bubble of air had formed under the area of her ground electrode and because it pushed the ground electrode a little farther away from the tissue and the fluid, it caused all the rest of the impedances to rise. As a result from, this can happen. It's not super common, it's not anything to be super concerned about by any means. The implant manufacturer recommended, just taken a couple fingers and massaging the site and allowing that air bubble to move its way around and out and eventually gets reabsorbed in the tissue in the body.

This happened off and on for a few weeks, but after about six weeks she never had an issue from this ever again and she has done extremely well since that time with no issues. But the small little things you never think of can happen. So I wanted to put this one on everybody's radar as well. So impedances can tell us a lot of information, but we just have to know to look. Moving on to eCAPs here, electrically evoked compound action potentials and we've gone over what the definition of it is, so I'm not gonna repeat it, but basically we're using this level, every manufacturer has the capability of doing this in their software. It's something simple, quick to do in the clinic and it's great because it can also tell us the level of stimulation that is audible for a patient.

Audible, I want to emphasize that it tells us what is audible to the patient. We also do this to folks in the operating room in conjunction with impedances as well because we wanna try to get a baseline of what they're able to hear and if their nerve is responding well to their cochlear implant. There is no one-to-one relationship between an eCAP

and a behavioral threshold. So what I mean by that is your lower threshold levels in your programming maps or your upper comfort level, whether that be AAC and MCL based on the manufacturer, there is not a one to one relationship. It tells us what level can be audible. It could be on the lower side of things or the higher side of things, but it is audible.

It also gives us an an idea of what the integrity of the auditory nerve looks like. So if we get good responses all the way across the board when we test it in the operating room, we typically think that you know, they may end up doing pretty well with their implant. Some folks just don't have eCAP responses and that is completely fine. If somebody has a extremely long prolonged period of deafness, there is a chance that they may have some atrophy in that nerve and you may not get responses. If you don't get responses, it does not mean that they can't hear anything. Sometimes those people don't have the best of outcomes. Some of them do surprise you and do extremely well.

This is just a guide to let us know where they're at with their auditory nerve, their integrity and what we know may be audible for them. Use with caution as a guide with determining stimulation levels. It typically gives us a good idea of the shape of the overall map, but we can't use that as an essential thing to program just what level is audible to that patient. So how do we use this in programming? So as I mentioned before, we can use this by finding out what level is audible. We use this a lot when it comes to pediatrics because we can find out which levels they can hear at, but they can't tell us what's too loud, what's not loud enough.

So we use this and we can use behavioral responses to help raise or lower levels accordingly to find out where they need to be. And as they get older we can more fine tune those levels. We mentioned a few things where these things, this measure cannot be performed. One being some people just don't have the measure, but if you think back from the very beginning of the talk we we're talking about internal implants, there

are some models of implants that just don't have the capability of performing this function. So keep that in mind when you're seeing someone. We take a lot of different puzzle pieces when we're seeing a patient for a second opinion and if you have one of those older model implants that just mean one puzzle piece that you don't have to put together, we try to think about the entire picture.

So we find it to be audible, but is kind of gives us an idea of what they can hear. So moving on to our case study for eCAPs. This patient was a 72 year old female when we met her, a bilateral progressive hearing loss. She was bimodal and she had used her implant for six years When we first met her, seeking a second opinion, met her at a cochlear implant support group. I talked for two hours. If you've ever met me in person, I'm very rambly and I will talk for absolutely forever. So I can only imagine what it would be like to sit there for two hours and listen to me talk anyway. But afterwards she let me know that even though she sit beside me the entire time, she didn't understand anything that I said and asked me if I would write a lot of it down for her.

Gave her my card, gave her kind of a summary overall, got to work the next day and she had already made a call and set up an appointment to see us. So immediately, as I mentioned before, we put her in the booth and we're just trying to get a fill of what she could hear. And this is her initial sound filled audiogram that we got. So for the most part, thirties to forties for most of her frequencies. And then if you see the six and eight K there, they kind of dip off a hill there. So we also did a series of sentence testing to her as well. We did HINT sentences to start with, and I know that's not in the minimum speech test battery, but considering we knew that she wasn't gonna do well because she couldn't understand anything, the HINT sentences are a lot shorter and if you have somebody struggling in the initial process, they can be easier and can be using as a motivation and a morale booster to let somebody know to keep working on it and things are getting better.

But, and over time, as they get better with that, we'll transition 'em to the typical AC bios and CNCs but she got a 0% on that HINT sentence. So it really didn't give us a whole lot of information. And then after we got all the information that we need when it comes to testing, this is what her map looked like. So both of these are the exact same map. One on the left is the way it looked initially when she walked in. The only difference to the right one, if you see these little purple ticks in the middle of the map across the array here, this is what her eCAP thresholds were. So we let you know that they were audible.

Typically when you stabilize out, your eCAP threshold should fall somewhere between your T and your upper comfort levels. In this case C, they should fall somewhere in between this dynamic range here. It could be closer to the top, it could be closer to the bottom, but it should be somewhere in this region. There is a caveat to this as well. I'll go over it at the very end when we do a summary, but as you can see here, if it's supposed to fall between these two measures and they're coming in here, she has been very understimulated. So it would make sense that she can hear some things and know when people's speaking, but she can't hear or understand things when people speak because it's really not loud enough for her to understand.

So when we reprogrammed her completely went through, we remeasured all of her threshold levels and all of her C levels and we sent her out that way when we reactivated her, she cried a little bit. She said it was a little while, but she could actually understand some of what what we were saying and we were really motivated and excited for her for then two weeks later she came back and we did another list of HINT sentences and she went from zero to 64% in just a two week span. So this just kind of lets us know that this measure could tell us one that she was under fit. She thought things were a little loud in the beginning anyway, and we worked her way up in a progressive map type fashion because we knew if we put her all the way up to where she needed to be around out the gate, it was probably gonna be too much too fast and

she wasn't gonna take to it because she had gotten so used to using those same levels for so long.

She also indicated to us that this is the first time that this test had ever been performed on her. And also the first time that anybody had ever gotten her to repeat backwards in sentences in a sound booth, her typical appointment was just going in, hitting the button. When she heard the sounds they would tell her she's doing okay and there was nothing else they could do and she left. So we're very thorough when it comes to like this because we would want to see that patient's progress and we be able to track what they're hearing and what they're not and to see if there's anything that we can do to improve upon that. So eCAPs are extremely important if you're able to do them because it can give you information about whether or not this levels are set loud enough for that patient to hear.

So the caveat that I was mentioning earlier comes specifically with the cochlear software. So as you'll see at the bottom here, the pulse width for this right here is 25. When you run eCAPs through a cochlear Americas or wherever you may be, the cochlear brand software, the eCAPs will always post at a pol a pulse width of 25. If you change or extend the pulse width in that map to be 37 or 50, those levels are changed accordingly, but those eCAP thresholds will still stay on that map as if they were run with a pulse width of 25. So if you have a wider pulse width on your T and C levels, they will need to be a little bit lower.

So keep that in mind. The other manufacturers have the ability of adapting and changing as the levels move up. But just keep that in mind when you're programming and you're wanting to find them fall between the two, that 25 pulse width of those eCAPs run at when you do it on auto. One thing I also want to hit on here is over stimulation. Can you overstimulate somebody? Absolutely you can, when it happens. What could occur is something called facial stimulation. Facial stimulation is where

your current is a little bit higher than it should be and it's triggering your response from the facial nerve that runs really close to where the implant array is and it can cause involuntary contractions in a person's face.

It typically happens in the eyelid, the cheek muscles or the chin most of the time. And it will always occur in the rhythm of a person's voice that's speaking to them. So when they stop talking, the contractions will stop. It can be painful. Typically it's more just frustrating for patients because they have no control over their face, it's completely involuntary and if it's prolonged left in that manner, it can lead to facial paralysis if the levels are high enough for long enough. So keep that in mind. I recently was teaching at a university and somebody had told me, and I didn't realize how widespread this was, that nobody had ever actually seen what facial stimulation looked like.

So this video is about five or 10 seconds I'm gonna show you and you're actually gonna see what facial stimulation looks like in a person. So what I want you to do, you can see my cursor here, look at this patient's eyelid right here. So all you're gonna hear me say is, "Ah" and you will see involuntary contractions occur here as I make that sound with my voice, here we go. Ah Ah It can get a lot worse than this. I've had very intense contractions in people's cheek muscles before. If you feel like you're at a level like this, make sure that you run the other objective measures that we're gonna talk about as well. Lower those, you can even extend your pulse with a little bit so you don't have to use as much current to overcome this or ways to take care of that.

In addition, if you are working with a MedL patient, they also have the ability to change from biphasic to triphasic pulses. And because it's more targeted, it reduces, it can reduce the intensity and prevalence of facial stimulation. Okay, so now we're gonna talk about eSRTs electrically evokes topeial reflex thresholds. We discussed what that definition meant already. So previously when we were talking about eCAPs, remember there was no one-to-one behavioral relationship with anything in the programming

parameters. eSRT is a little bit different. It actually has a strong correlation between the upper comfort level, so your Cs, your Ms your MCLs, and when it comes through it kind of looks just like an acoustic reflux.

So when you get the measure, and we'll talk about how to measure it here in just a second, you wanna get it at a 0.02 millimole response, just like you open an acoustic reflex, if you initially start to do this and they're much bigger, like in this case it is 0.08, you will notice that those marks are much more intense and you need to back that stimulation down a little bit until you get to where that 0.02 area. This is a great tool for patients that can't communicate or have a hard time with loudness judgment, with loudness scaling, how loud or quiet things are. It's great with kids as well because they can't tell you the same or anybody that has any cognitive issues. So I would highly recommend on trying to do this with everybody if you could at some point just a kind of a verification of how loud things need to be for that patient.

When we measure these, the equipment you need, the majority of it you already have. If you're seeing an implant patient, you will introduce a pulse through the software itself like you're measuring a upper comfort level. You also need a tempnometer or remittance bridge that has a decay function on it as well. So they need to have normal tympanometry in order to perform this measure. And once you have that normal tympanometry you're gonna put it on a decay function and set the probe tone frequency to either 678 or a thousand. And Jay Wolf has a great paper about the rationale for using them and I believe I have it in as a reference at the end of this as well.

There are some instances where you can't do this on everybody, middle ear dysfunction. If you have fluid behind your eardrums or type B or C tympanometry you may not be able to have the normal tympanometry and needed in order to perform this function. So we'd like to do this on every kid that came through. Kids are notorious for

having ears that get kind of clogged up sometimes or tubes and it prevents us from doing that if somebody is excessively moving around. This measure is actually kind of sensitive to movement. So if you do that, you may not get an accurate response. And then just like with eCAPs, some people just don't have acoustic reflex thresholds and they may not have an eSRT that is also a possibility.

Also, prolonged periods of deafness, same thing, you may have a lack of response, they may just not have it and that's completely fine. But remember we're all using these as different puzzle pieces and that just might not be a puzzle piece that's available to us at that moment. There is gonna be a case study a little bit later on involving this as well, but it's, also tied into something else that I wanted to talk about so I didn't wanna ruin it right off the bat. And then that third thing that we talk about that we always use as an approach is programming information found through testing itself. Test results from the minimum speech test battery are great for tracking progress from candidacy to post activation.

So we use those same measures. Obviously there are multiple lists but if we go through and we see what they could do prior to having an implant through that cochlear implant process and how they're progressing, we should be able to find out what they're hearing and things that they're not hearing and what if we could use those same tools as figuring out how to better outcomes or possibly improving speech perception. Turns out in a lot of cases we can, one great thing about having the AzBio sentences or there's male and female voices to it, is it only occurring in certain voices? Is it only occurring in certain frequencies or sounds. So if they continuously miss words that have S or sh on it, we can track that as well as CNC words.

If they're consistently me missing the same phonemes over and over again, you can help detect patterns. And then once we have those patterns detected, if they're not hearing a specific sound, we could find out specifically what frequencies those sounds

come in at and raise those threshold levels to make those soft sounds a little bit easier for folks to hear. And I have an example of this as well that we'll talk about in one of the case studies here soon too. Alright, before we get into those case studies, I wanna talk about just a few quick other parameters that you may not think about. You heard me talk about pulse width a little bit earlier. You also have some people call it pulse duration.

These are the same thing. Pulse width is how wide the pulse is, but it is not actually measured in length. It's actually a measure of time from the start to the end of that pulse. So there are instances where you hit out of compliance, you can extend that pulse width a little bit, reduce that stimulation needed to get to that same amount of loudness. So keep that in mind. Majority of the manufacturers have a thing that is an auto pulse width adjustment. So as you increase those levels, it will automatically extend that pulse width for you to accommodate that measure so you don't go out of compliance. The other one has recently put in a little click in there that once you hit that out compliance electrode, it will extend the pulse width automatically full for you and just kind of generalize, lower all the levels down to accommodate for that.

Still go through a measure to make sure that those levels are loud enough for a patient. But we have ways of monitoring outta compliance with pulse width too. So make sure you look at that when you see these patients. Compression. I'm gonna talk about compression and dynamic range similar and in different ways. So if you think about compression, we talk about it in hearing aids too, what our compression ratios are. We don't want that to be too squished together because if the compression is too much, it's gonna make it to where it's kind of be hard to understand for patients as they're going through. So if we turn off tons of electrodes, you know those frequencies are gonna get reallocated to all the remaining electrodes so that compression is rising and it's okay to turn off a few electrodes but always have a reason why you do so.

And dynamic range also. So that difference between the T levels and your upper comfort level is your dynamic range. A couple of the manufacturers have a automatic set dynamic range, so no matter what you set those levels are, it may only be 40 decibels between the two, but they have an arbitrary unit system. But still, if you have a small dynamic range, it's going to compress everything down and people may not understand because it sounds more muffled. Typically we like to have at least a 40 to 60 unit difference between our threshold and our upper comfort levels. Anything smaller, it may be a little too compressed for people to understand at certain frequencies, it can get too large and you're gonna allow too much in, but at the same time I would rather have it be a little bit bigger rather than too small.

And thresholds and manipulations, we talked about that patient earlier with the eCAPs and her sample thresholds were a little low if you go through. And that is the case because most manufacturers measure their software off a percentage of whatever the upper comfort level is. Now you can actually raise manually raise those threshold levels and it can raise up the soft sounds needed for a patient to understand a little bit easier at those softer sounds. And we can do that specifically by frequency as well. That being said, we're gonna go into one of our case studies kind of putting it all together here. This patient that we're gonna discuss first is a 56 year old male. They were complaining with a Cochlear America's device in the left ear and they were complaining of background noise and voices sounding very quiet.

So when they did that, they went to their normal audiologist, they saw regularly and they immediately left and were having more difficulties. So they called us for a second opinion when they came in, they said that the background noise wasn't as bad, but they're constantly hearing a consistent humming like a machine-like humming sound, no matter if it was quiet or in background noise. And the voices still sounded kind of quiet to them and they really weren't sure why. So did some testing and then we connected and we took a look at this patient's mapping program. So as you can see

on here, we did run some of those eCAP thresholds and they're matching up but also a little bit lower too than we would like to see.

And then we have our dynamic range here and our threshold levels. And if you look at the very bottom here where this dynamic range is, we talked about having a unit difference of 40 to 60 for a good dynamic range. So we don't have excessive compression. Most of this patient's dynamic range is in the twenties, so lets us know that one. It explains why that things sound a little muffled. They're not able to understand things as well. But one thing I also wanna hit on was the patient's complaint of the machine-like humming. If you raise the threshold levels up too high, technology has gotten so well that patients can actually hear the internal processor noise of the implant working and processing sound.

And it sounds like a machine-like humming. Some patients describe it as a staticy sound. I even had a younger child describe it to me as it sounded like it was raining in his head. So that is something to account for in instances like this, we want to try to raise or lower those thresholds down a little bit if we can. And we also wanna figure out how loud things need to be in order them to have proper access to sound. So we did a combination of things. We've already run our eCAPs here. We also ran eSRTs, so this kind of ties back that case study from previous. Once we did that, we found out where those eSRT levels were indicating our upper comfort levels should be.

And you see that they are are mostly above that eCAP threshold mark now. And we have lowered the threshold levels in that patient's map as well. And if we go back down here and we now look at where that dynamic range is, it's sitting around 60, this patient end up doing extremely well. After this didn't have any issues. We were sending a report back to their previous audiologist and they asked if they could just stay with us. So they ended up transferring care to us. But this is a very good instance when it comes to thresholds relating to noise. Yes you can raise those threshold levels up to try

to reduce the amount of noise from the environment that are coming in, but if you do that, remember you may be able to raise them up too much to the point where it becomes distracting from processor sounds.

So you have to try to find that happy balance there. Are there other options for addressing this in different manufacturers. For example, in advanced bionics they have a parameter called input dynamic range. So if you have somebody that's complaining about that processor type noise, you can extend that input dynamic range and make it a little bit wider, which allows some a little bit more of that environmental sound in that distracts and prevents the patient from hearing some of that processor noise. And they can do very well, eCAPs let us know as I mentioned before, that this patient could be slightly underfit based off where they set in comparison to where their upper comfort levels should be.

And the eSRTs help us address that because we were able to reset the upper comfort levels to where they should appropriately be. And as I mentioned, this patient went on to do fantastic, I did a lot better in noise and so they were able to follow conversations extremely well after this. So always happy when we have the good outcomes when it comes to patients, as I mentioned before, you're gonna have good and bad when it comes to a little bit of everything. There are some instances you're gonna have cases that you just can't fix and the next one is going to be one of those. This next one we're gonna talk about was a three-year-old female.

She was taken to the ER with a high fever and was diagnosed with bacterial meningitis. Complications were identified much later and she stopped responding to her mother and her other family members when they were trying to get her attention altogether. She was taken back and found out that she had profound deafness. So if you think about complications with bacterial meningitis, one of the first things that may pop into your mind, and if it doesn't it should is the possible ossification that may develop the

bony growth that can come inside the cochlea following as a secondary response to bacterial meningitis. It doesn't happen in everyone, but it's something that should be discussed and I would recommend your clinic or hospital have a protocol to monitor this if you don't already have one because it could help identify these children or patients regardless of age a lot earlier.

So you can track the progress and if progress starts to decline, you can have some imaging done and you can see the development of this ossification if it does occur. So you can get ahead of it if, it gets to where too worse or too bad, rather, there are instances where you can't, the surgeons can't drill enough through to actually get the electrodes in all the way, which was very much the case in this child. She, this is just some impedances and attempts at running eCAPs. We did with that patient, of the 16 electrodes that she had in advanced bionix after hours of drilling. This patient in particular was only able to have less than half of the electrodes insert on both sides.

So had it when identified a little bit earlier, they could have, but at the same time we don't know the progression of how fast that ossification may occur, but that's why we have these monitoring protocols in place doing regular behavioral testing if we need to. If the patient's too young, we could also do ABRs and if there is a concern that something's happening in their hearing is progressing a lot faster imaging to take a look inside that cochlea to see if it's something we need to think about sooner rather than later at presenting cochlear implantation as an option. So as overall as where this patient is to this day, mostly everything is sound awareness because they were only able to get a very limited number of the electrodes within the cochlea.

The rest of 'em had to be deactivated. So you gotta think about the compression that we discussed earlier. All that information is compressed very tightly and the idea of trying to understand what just a limited amount of electrodes is slim to none. So she does communicate primarily with sign language now. Always consider ossification as a

byproduct of bacterial meningitis. I can't emphasize that enough. I've had one summer in particular in my career where we had five patients come down with bacterial meningitis all with heavy ossification within a month and a half of each other. So this is something you should definitely have on your radar just in case. So you can get ahead of it if it does occur, and that way you can have a, I said a plan in place to kind of get ahead of it if you can.

Didn't wanna bring down the mood, but this is definitely something you should think about. And our last case study that we're gonna discuss is a 74 year old female. She was implanted with a Cochlear America's device in the right ear, N22 internal implant. She could communicate really decently in one-on-one conversations, but she does struggle a bit in noise. Her aided audiogram was 25 to 30 DB in the 250 to 3000 hertz range, 40 to 55 from four to eight K. So a little bit lower. And we noticed immediately through her speech perception testing that both in AzBios and in CNC words, she was constantly missing S and SH sounds. So this everything we've talked about to this point already, you should have some ideas and flags popping up in your head.

Here there we go. Sorry. So this was her initial map. I hid some of the parameters here at the bottom and there's a reason for that. I did that on purpose. I'll show you the rest of 'em later. So one thing in particular we couldn't find was we couldn't run eCAPs on this patient and we couldn't perform impedances on this patient. And there are a couple of different aspects as to why that you can see immediately here. So if you work with Cochlear America's patients pretty regularly, you know that the common strategy they use in their processors is called ACE, speak. As a previous generation model, the very beginning of this talk, we talked about how certain internal implants just didn't have the capabilities of doing certain functions that they are nowadays.

So this is a perfect example. Then I told you in the previous slide that this patient was implanted with an N22 device, which did not have the capability of running impedances

or eCAP thresholds. And each manufacturer calls them something different. NRT, NRI, ART, they're all the same thing. So, and because of the nature of the speak strategy, you can only use so many electrode contacts and that's why it kind of looks the way that it does. But overall, not whole really concerned with this patient in particular. We just don't have some of the puzzle pieces. But the biggest thing that we have found already is she messes up on /s/ and /sh/ sounds and I told you a little earlier if we can find those, we can find out specifically where those frequencies come in at those certain sounds and we can raise some of those threshold levels to accommodate that.

So we can make those sounds a little bit easier for them to hear. So I know you're probably thinking, well how in the world do you know which frequencies for which electrodes and everything? There's a couple different ways. So I created a binder for every patient or every student that I have that comes through and it has this chart in it. And all the manufacturers have a chart very similar to this. You could probably request this from your rep if you do work with them. So it tells you which formats and which frequency specifically fall under a certain sound. So if we know that patient is missing /s/ and /sh/, we come down here to where /s/ and /sh/ are and we could find those specific frequencies and raise those T levels at those specific frequencies a little bit and go back over time and remeasure them to make sure that we're accommodating for that.

They also have it, this is just specifically consonants, but there's also vowels on the same sheet. I just kind of clipped it for this. Didn't wanna have any manufacturer information on it, but if you request these from your rep, they will have them for you. So we went through, found those sounds where they come in at, went through and adjusted. So told you there was a couple of different ways I put those parameters back. Once you have access to it, you can do this with all the manufacturers to find out kind of where their frequency bands are. If you look under the different electrodes to correspond with the information that you found and which frequencies go with which

sound, you could then come back and then find out where those frequencies are on which electrodes and raise those ones up that'll accommodate for that specific region that you're having those deficiencies in.

It's a great tool to have. So when I say that we target for patterns, we can frequently, specifically go through and and find the deficient areas and improve them. It doesn't work with everybody, some people just don't respond to it as well. But this is definitely something we incorporate to try to find and weed out some of those nitty gritty issues when it comes to specific sounds. So summarizing this case in particular know what capabilities that your internal implant plays and what it can do because it may give you or more puzzle pieces or less puzzle pieces to work with. As I mentioned before, frequency targeting is extremely effective in efficiency and speech perception. I use it every day and I always try to plug this in here.

Working in interdisciplinary teams is extremely helpful if you have the capability of if there is something that you miss. For example, our team has SLPs speech language pathologists that are specifically trained to work with deaf and hard of hearing individuals. If we do happen to miss stuff during our team meetings, we have a report of how their visits with they're typically seeing the same day. So they'll tell us, well, they did fantastic, but I noticed they're missing that S and H sound. So working with that can help you come up with a game plan together and address what the issues that the patients are having and it kind of helps everybody across the board develop a game plan individualized for how to best take care of that person and what the situation that they're currently in.

And we always monitor that through those patient outcomes. As I mentioned before. So out of everything, please take that. Outcomes are always the thing that we're looking for. There's different ways of getting there, putting this all together. Next time you're stuck with a tough case, just take a deep breath. As I mentioned before, when

you learn things in class, it's usually the most straightforward things, we do wanna get into the nitty gritty of what can go wrong or what does go wrong. Take a deep breath, just think about the different aspects that we talked about, that generalized plan, investigate those issues through all your patient records and histories. Use your objective measures. Please use objective measures more.

It will help solve a lot of issues that your patients are experiencing through clinic. And if you don't understand how to do 'em or interpret some of them, reach out to your reps or people locally that do work with them pretty regularly. It's a great thing to learn and take some of that information from their testing and it helps lead your programming decisions. As I've said a few times now, we typically don't make changes to anything unless we have evidence to support it. And this is where we get a lot of that evidence from those objective measures, what we find out through those histories and what the testing information tells us. And please never be afraid to ask for help.

I still learn new things every single day and we have a pretty extensive caseload and every place I've ever worked, we've had wild patients that we see when it comes to their programming. Never feel like you know it all. Always be willing to ask for help and always be willing to learn new things. If you can take all that together and put it together and implement it in your clinic, I think that you'll have a lot of these patients that are performing poorly and will improve them over time. These are my references here, and honestly, just wanna say thank you to everybody. This is our cochlear implant team here at U Chicago Pediatrics Adults. I love working with these people every single day.

Social workers, SLPs, everybody contributes such a huge way of everything that we do here. That is my email address there. If you have any questions, if we don't have a chance to get to 'em afterwards, I hope you took something from this. I hope it was valuable. If not, completely fine. I respect it, but I feel like if we use these measures

more and think about it in this way, a lot of the patients that are struggling, we can make a point in programming to improve their daily situation. Thank you.

- All right. Thank you to Dr. Josh Sevier for your time and expertise. And thanks to everyone who participated in today's course. We look forward to your feedback on the course evaluations and hope to see you in future courses on AudiologyOnline. This concludes today's course, and have a great rest of your day.