Challenging Mapping Cases
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Hello, my name is Allison Biever and I am a Cochlear Implant Audiologist at the Rocky Mountain Ear Center. And I started working with cochlear implants in 1992 and I wanted to share my case study with you from a unique perspective. Unique in the fact that I work in a private practice with two neurotologists, Dr. David Kelsall and Dr. Erik Lupo. And I wanted, before I begin my case study, to put in a plug for telehealth and remote programming. When I was asked to share the case study that I would have presented at ACIA, I really wanted to rewrite everything and present a case on telehealth instead. I really wanted to share my experience so far with remote monitoring and also remote programming. Since before the COVID crisis, our clinic activated a number of 80 and 90-year-old recipients who obviously have been unable to come back to our clinic for reprogramming. In some cases, we’ve been able to remotely monitor those patients.

So we’ve set up a telehealth session through doxy.me and we’ve been able to talk to our recipients about how they’re doing, what sounds are difficult, what they’re not hearing well. And we’ve been able to make recommendations, especially for our cochlear recipients that have the Nucleus Smart App. We’ve been able to make recommendations on what adjustments they can make from that app, whether that’s increasing their master volume or turning down their treble. So remote monitoring has been very, very successful for our patients. But in addition to that, we’ve had a fair amount of experience with remote programming. So we’ve been shipping our tablet to our patients and actually taking over control of the tablet. They have a programming pod and the appropriate cables in their home and they’re interfacing with the tablet and we’re taking over the tablet and actually providing remote programming for these patients, which has been extremely helpful. In a number of other cases, what we’ve been able to do is glean information from the telehealth appointment. We’ve been able to then acknowledge that we have to make greater changes than what the patient can make. And now I’m talking a little bit about remote monitoring rather than remote programming. But we’ve been able to say, "Okay, increase your master volume on the app, "decrease your treble." And they may say we’ve already decreased it, it’s negative
six. I'm having a very, very difficult time handling they way the sounds, I am almost tempted to take it off. I'm getting too much high frequency. So what we've been able to do for some of our patients is program our clinic loner with their most previous map and then take that map and make additional changes to it, decrease the treble pretty significantly. Upload that map into the cloud and then request the cochlear, ship them a replacement processor. And that's been another successful way that we've been managing care for our patients. So in both the remote monitoring and the remote programming, where we're actually running the impedances, running auto-NRT, assessing and changing T and C levels. In both of those scenarios, we're able to provide really good care to our patients without having to see them in person. And that's been exceptionally challenging during this COVID crisis.

So switching gears, I'm gonna share the case study I had prepared to present at ACIA. So my case history is a 90-year-old male, is pretty spry. His hearing loss was identified between 35 to 40 years from when he saw me at the evaluation and he reports that his hearing loss has progressively gotten worse. When we evaluated him at the CI candidacy appointment, it was determined that the patient had a moderate to profound sensory neural hearing loss in his right ear and a severe to profound sensory neural hearing loss in his left ear. The etiology of his loss is otosclerosis. And he reports having had a stape surgery on the left side about 40 years ago. The stape surgery was not successful, but he was able to continue wearing two hearing aids and he was aided really only about 18 to 20 years ago. He reports being a consistent user of Oticon behind the ear hearing aids. And we did real ear measures and confirmed that the aids were fit appropriately for his loss. A little bit of additional background. This gentleman's younger sister who's in her 80s, has a cochlear implant. The patient, the 90-year-old gentleman has chronic lymphocytic leukemia. He denies a history of noise exposure. There's no tinnitus or dizziness. And he's had subsequent CTs and MRIs and they've revealed normal cochleas bilaterally. This is the patient's pre-operative audiogram. So again, you can see he has moderate to profound hearing loss in the right ear and severe to profound hearing loss in the left ear. His word recognition
scores using monitored live voice center headphones, he scores 36% with his right ear and 28% with his left ear. I don’t have his aided scores here, but his functional gain is really good. In the low frequencies, he’s at around 30 to 35 dB, but in the high frequencies aided, he’s between 55 and 65 dB depending on the ear in the high frequencies. His aided sentenced scores, we of course started with easy bios, but he couldn’t really repeat back any of them. He reported that the sentences were just going too quickly and he couldn’t understand what they were saying. So we switched to HINTs, keep in mind he’s 90 years old. And his HINT scores for his right ear, he scored 38% and this is in quiet and 30% in the left ear. We did test the patient in noise and he wasn’t able to repeat back any of the sentences in noise. His aided CNC word scores in quiet for his right ear, he did about the same as when we used monitored live voice. Perhaps because it was a male voice, he actually got one extra word right, 40% in the right ear and 20% in the left ear, a little poor in that ear.

So he was implanted on the left side and he was implanted with a cochlear CI532 device. There was a full insertion. In the operating room, we routinely run nine electrodes. We run auto-NRT on nine electrodes and eight of the nine, we were able to obtain thresholds. We could not obtain a threshold on electrode one. At activation, which was two weeks after surgery, the patient reported having a really difficult time adapting to the sound quality and specifically high frequencies. Everything sounded like screeching and chirping. He was only able to understand some close set speech perception materials. He could determine whether it was a one, two, or three-syllable word that was given to him, but really struggling with making sense of what he was hearing. The only thing that was a little bit out of the ordinary at his activation, he would have been activated with a 25 microsecond pulse width because it was a lateral wall electrode array. But because his impedances were high, even 20 minutes after activating the device, after we remeasured the impedances, they were still pretty high, his electrodes would have been out of voltage compliance and, therefore, we had to use a 37 microsecond pulse width for this particular patient. So the challenge. The patient returns at two weeks post activation and he’s reporting that he can’t
understand speech at all with his implant. That speech is just unintelligible, but if he's not wearing the hearing aid in his right ear along with the CI on the left side, he's just not understanding. So auto-NRT thresholds are remeasured and they are obtained again, eight of the nine electrodes were still not seeing a response on electrode one. It's noted, and this is pretty typical for most of our patients that the auto-NRT thresholds are lower than the ones that were obtained in the OR, but I'm recognizing that the C levels I have set for this map are well below the auto-NRT thresholds. So his C levels are increased pretty significantly at this two-week visit. We also remeasure his T levels and they also increased significantly compared to the maps that were created at his initial activation. We recommend that the patient isolate the left ear as much as possible and try taking the right hearing aid out as much as possible, relying just on the processor and continue with intensive rehab. And it was pretty much self guided. We gave him different things he could work on. We gave him exercises from the old cochlear rehab manual. We talked about speech tracking, we showed him telephone with confidence, we talked about audio books.

So we gave him ideas of things he could do over the next two weeks to try to improve his comprehension. And one of the things I want you to know is that currently all of our adults who are now activated, work pretty intensely with our auditory verbal therapist. But at the time this patient was seen, we weren't making that recommendation for our patients largely because of reimbursement issues. So at one month the patient returns and he's reporting still that speech is unintelligible. Unless people are talking very, very slowly to him, he's just not able to understand what people are saying when he's not wearing his hearing aid. And he has been trying to isolate, but he can't isolate by listening with just the implant, but he can't understand speech unless he knows what they're talking about. Certainly audio books are too difficult for him. He's reporting he's only doing very basic rehab exercises like speech tracking. So we administer the HINT AS. Yes, in fact he's doing poor than he was preoperatively or pretty close to that. So he's not really doing well. He scores 20% when listening from the implant alone. We administer the MOCA and see that he's essentially showing normal cognitive function.
We attempt the ESRTs at the one month visit, but we’re not able to maintain a seal for very long. And keep in mind he has a history of otosclerosis so there is some concern that that may be making it difficult to obtain an ESRT when we are able to get a seal for long enough to administer the ESRTs. So at this appointment, it’s determined that we try turning off electrodes one through three because we’re not getting auto-NRT in electrode one or two and three is very elevated. So we make a decision to turn off those three basal electrodes and the patient immediately reports that the sound quality sounds better when we turn them off. Also the C levels are increased in the apical end, so four, five, six, seven, and eight, but the apical end electrodes 22 through about 16, but they remain the same in the basal and electrodes 24 through about seven or eight. And his T levels at this point are essentially unchanged compared to where they were two weeks ago. This is what his map looks like at that one month visit. The patient returns at three months and he’s still reporting that he’s not understanding very well and he’s getting frustrated. At this point, we switch him to a 500 Hertz map with 12 Maxima. And we do it by using the predict levels software and the custom sound software.

So we just take the map he’s walked in the door with, essentially measure thresholds on one electrode, predict the levels. We’re keeping him at a 37 microsecond pulse width and essentially do the same thing with the C level, create a map and talk to him. And he immediately reports that the sound quality is better, but also he’s understanding us. I can understand what you’re saying. We then reassess his thresholds a little bit more thoroughly and we notice that there is a big change in thresholds across the board. But the comfort levels are largely unchanged compared to the map he walked in the door with. And excuse me, we take them to the booth and we see a pretty dramatic improvement in his recorded HINT score in quiet. He scored 65% on recorded HINTS with the implant alone and 56% on CNC words. And this is what his mouth looks like when he’s leaning. And so I think what I wanted to share with everyone is, at what point should we have changed the rate? Is this something we should have done sooner? What are other clinics doing? Is this perhaps something we
should have considered at activation? How many clinics are giving people at activation, multiple maps to see what rate might sound better? Keep in mind that really all we did to improve his performance was lower the rate and give him a 12 maxima map. So there’s two things happening here. We are lowering the per channel rate to 500 but the total stimulation rate is also lower. So he has a 12 maximum map. His total stimulation rate with this particular map is gonna be 6,000 pulses per second compared to the one he walked in the door with, which was 7,200 pulses per second. So it’s a little unclear whether it’s the lower stimulation rate per channel that’s helping him or the increase in the maxima. And I didn’t separate those out at this appointment and might’ve been helpful to also give him a map that was a 500 Hertz map with an eight maxima offering to see if that made a difference. ’Cause at this point I’m a little unclear whether it was switching him from 900 to 500 or whether it was increasing the maxima from eight to 12. I’m a little unclear which thing made speech so much clear. So thank you for your attention with this case.

- My name is Sarah Coulthurst And I am a Clinical Pediatric Cochlear Implant Audiologist at UCSF Benioff Children’s Hospital Oakland. And when I initially talked to the coordinators of ACIA 2020, they were looking for some difficult mapping cases but really didn’t want to focus on the child or the person with the cochlear implant as far as the behavior aspect and things like that. They really wanted to focus on the maps. And I really think that the mapping parameters around a difficult group that we often see are the ANSD kids or auditory neuropathy spectrum disorder kids, or often that is accompanied also with having hypoplastic nerves. So mine is really a case where we had a transfer child with auditory neuropathy and hypoplastic nerves. And it’s kind of a cautionary tale. So it’s one where we all kind of missed the boat a little bit on serving this family the best and this child as far as language acquisition. So I’m gonna talk about Erik, a very, very sweet little boy who transferred and he has one cochlear implant. He received a left Med-EL Concert electrode at approximately one and a half year of age. He was utilizing a RONDO and OPUS 2 processor. His parents were really adamant that they did not want to sign. They really wanted to have their child obtain
listening and spoken language. Further aspect or complication was that this child also was exposed to Spanish in the home, but in his school setting, he was exposed to English. When I first met them, they were just being exposed to ASL, and the child was having it presented to him and talked to him in school, not very many hours a day and it had not been extensive and the parents really again, were opposed. His right ear had been difficult to test in the past and he really no longer wore his hearing aid on that side even though he really liked it in the beginning. So history. Full term birth, no complications. Referral on his newborn infant hearing screen. He was eventually diagnosed with ANSD at six months of age. Fit with hearing aids around nine months of age. MRI then revealed hypoplastic nerves. Cochlear implant was placed in the left ear because according to the family and actually a review of the chart, it was noted that this was the more viable nerve. The communication mode. Always a hot topic, I think, for everyone involved and we always try to tread lightly, but remembering that the child’s language acquisition is of utmost importance in this circumstance. The parents interpretation, and I say interpretation because this is what they heard. I do not know what was told to them. The interpretation of the initial counseling in the first couple of years was that they should not sign under any circumstances with their son if they wanted him to develop listening and spoken language. He attended an oral program, being myself by calling it an oral program, until about three and a half years of age.

So two years with his cochlear implant team was in an oral program. At this point, his school had been for about a year really marking concerns with language or lack of language development or auditory skills and they were pushing him to go into the TC program that was local. He had moved to the preschool program for TC and at this point the family wanted a second opinion. They really, really had all of their hopes fixated on getting a sequential implant in the right ear with the continued hope of acquiring spoken language. So Erik shows up four years of age. He's two and a half years out with his cochlear implant. We really began by doing a lot of counseling and getting to know each other. Informal behavioral observations, looking at auditory
awareness and communicative intent. That was my main focus for the first few, through the first hour. Erik did not respond to any auditory stimuli. He didn't respond to Lings at all. Didn’t respond to noise makers. There was an inconsistent response to a loud drum. We attempted a task, then I wanted to see if really he was language-ready. It's always so hard with these kids, so they have a layer of a language disorder on top, right? So I attempted a quick, very language involves a task of looking at with the IQBS that Med-EL has, which I love. Looking at five familiar objects, there’s one on each side, which he easily carried out in a closed set once I taught him the sign for each object. So we sat, taught him the sign for each object. And then when I could just ask him, "Where’s the cat, where’s the dog?" He would then go ahead and show it to me. Super eager to learn and communicate. We did an equipment check. We did tymps and we did a brief review of the maps. We evaluated the impedance measurements. Everything was within normal limits. His equipment was working just fine. We carried out listening checks and of course just in case, programmed our brand new processor to see if maybe I had missed something in just another general check. Everything was within normal limits. Spent the bulk of the visit discussing language acquisition, sequential cochlear implant candidacy, expectations, and projected outcomes. We discussed issues with our insurance here, CCS, California Children’s Services. They will not authorize the sequential ear if language hasn't been obtained with the first year.

Again, he had normal tymps. We attended the first audiogram, brought him in the booth honestly this is the best trick in the train, I love this. We started off conditioning with vibrotactile via bone. So implant on the left ear bone behind the right ear, started off vibrotactile only, teaching him the play task. Then paired it with the auditory sound coming from the speaker, still very reliably doing the task. Then we went ahead and dropped the vibrotactile only with the auditory and there were no responses. So clearly wasn’t hearing with his mouth. This was the map that he came in with. It has FSP, go ahead and ... A faster stim rate map. Not lot of a 1,000, thresholds are locked to 15. Now this is not just double, but triple dipping, trying to give the greatest emphasis on those soft and medium sounds, which you understand. But with a child who’s not
making any gains and who's very pre-lingually implanted, it's kind of something to think about and take pause before doing it. No dialoguing sadly because he had an OPUS 2 and a RONDO. ESRT was attempted, but we could not obtain anything. One, because we ran out of time, but also because he just would not sit. First map we created and you will see there is an ESRT not right there, but that is actually from a map obtained later on. So our first map that we created, we started with small changes. We have limited information, so you're not gonna just willy-nilly make all these changes. We did take it down to FS4, slowed down the rate. We disabled e12 because he really had no auditorium percept on that. We were able to condition them once we went louder. Lowered threshold lock to a more of a default, if you had 5%. Kept map, at the time it wasn't default, kept in maplaw at a 1,000 and we wanted to not make too many changes, but we wanted to also start to really open up that envelope. We slightly increased the charge units, we sent them off, we talked a lot about language acquisition and signing.

So this is his third map and we really wanted to make sure that at this point, time was taking the way. We kind of assessed the situation, really focused a lot on the counseling and talking to school. And now we really had to get auditory stimuli to this little guy. And again, not necessarily for language purposes, but to maximize his use of the implant. Staying with FS4, duration is higher as the terms levels were taken up again, as he could provide some loudness feedback. And we did obtain an ESRT. We tried every single channel and obtained one ESRT and about 36 charge in it for electrode nine. Thresholds were moved back down to zero default at the time. Slightly increased the M levels, but clearly still below audibility. So gave them progressive maps to work towards. So for the fourth map, now we're a few months out. Staying with FS4, duration is higher as child's levels were taken up again and he could provide more and more feedback with each mapping. We're now up to about 40 to 48 charge units. Threshold is again at zero. We're heading back towards the simpler defaults. And we obtained our first audio. It doesn't look like a big deal, but I will tell you, as long time coming, and we were very excited. He had very good reliability and we were very
happy with getting this first aided audio. So ongoing team communication of course is incredibly important as we all know and you all do. Our focus continues to be on language acquisition. Parent counseling. Fluctuation in hearing in the right "hearing aid" ear, now I say hearing aid in quotes because he hadn’t worn it in a while and had been super hard to get an audiogram on that ear. The first two times I saw him, there was no response whatsoever. As well as his current levels had fluctuation in the left ear. Again, not unheard of with ANSD. Communication with the educational setting as well as the family, as they continued to want this whole services AVT and we hadn’t observed them signing even though the child wasn’t assigned class.

So the next time we saw him. Staying with the PS4. Again, the duration is higher as charged levels were taken up and he can provide more feedback. Rate is basically the same. Again, went up about 10 more charged units. Now we’re developing some strong super segmental auditory skills that we’re observing with him. He’s using three consistent word approximations. It was, no, mama, and dada and they were very consistent. Family had accepted and was now modeling ASL throughout the appointment. I was so happy. First speech appointment was on this date as well. We hadn’t been with speech for a little while because she was on maternity leave. But we had input from the schools. So this was the first speech appointment when she was back. Again, just kind of looking at those very traditional emerging auditory skills and when you’re looking at that auditory pyramid. And then the next time he came, we were able to have Med-EL attend or clinical speech specialist as well as their Spanish speaking consumer specialist who is amazing, and really connected with the family. It was so helpful in every way. I highly recommend you reach out to all the companies and all of their support systems. So we were able to repeat the SLP session and at this point the family continued to recommend AVT or outside services. But that was okay. He’s making gains, we’ll recommend that as long as they didn’t drop a sentence. The thought was also with the map, that with the changes we made that day, they were pretty significant. But the thought was, let’s go back to that brilliant thought process when we have no input from them and let’s slow the rate, reduce the maplaw, and
change the strategy. We changed it to HDCIS. And without that variable rate, have that steady rate across all the channels, right? Automatically that changed the lower limit of the frequency band, from now it was 100 Hertz to 50. Lowered all the M levels to the flat map. And the duration is back down a bit with the lower M levels or charge levels. T stayed at zero. We made a lot of changes. I tried to keep one thing consistent. Let’s also talk about Ts. We know what the, obviously Med-EL and Advanced Bionics, we want them to be non auditory. We could, when we’re looking at children who have matched with these, especially with hypoplastic nerves, when they have high current levels, we could think about measuring, making sure that obviously we know where that’s going to be. Have it within that percentage rate, the dynamic range needs to be consistent for the company’s recommendations. So you could go up, measure that T using player VRA and then go back down to make sure it's not audible. After having three months with this new map, we started in the booth and came in between about 35 and 40. So creeping up. Kept all the parameters, discussed observations, gave progressive maps, recommended to move towards FS4 to inch back in the fine structure, play around with ESRT. Pulse width, we could change it to 700 instead of 500. That might make the duration longer to capture more neural activity. But when you do that, you risk losing some specificity. This was our audiogram that day and we got our first reliable right ear audiogram.

So we recommended a new hearing aid. They saw a neurotology that day. We obtained a CT to evaluate the placement of the electrode. That was on early on and it was within normal limits. But today they really looked at the MRI and reviewed and thought that the opposite ear, the right ear was actually the more viable nerve. Review projected outcomes with the parents about a sequential CI and provided medical clearance for the right aid. Next appointment came in. He was seen for the SONNET fitting and new hearing aid for the right ear. And so now data logging was in our future for both sides. Family had been going to AVT two times a week in addition to the TC program and all of them were learning sign, which is great. With their consistent signing with him, I think that we can’t be scared that if we sign with them, they’re not
gonna talk necessarily. And I think that really aided him in his auditory gains as well. I know that was a bold statement. As gains are being made auditorially, we moved to FS4. With this charging it’s being so high, the point is to get fine structure. It fell out because the charge units are so high. We also then, now that we've changed the strategy again because we're having those gains made, went from 250 to a 1,000 Hertz for that frequency cut off. Took Ts back up to 10%. Now we can measure and balance the Ms and focus on an aided and speech session. We continue to see a fluctuation in that right ear, but look at that audiogram, that is just amazing. And he loves both his implant and his hearing aid. So first time we get to use data logging is when he comes back just recently in February. It was really a four month window of time, shows 6.9 hours a day for the SONNET, but he also was running a RONDO intermittently.

So take it with a grain of salt. Turned off the e2 today, electrode two as no auditory percept was observed up to 70 charge units, making it irrelevant to have that FSP because now it affects its fine structure, right? Balance the Ms again. In the audio on that day again, beautiful right ear. With his implant, he detected all the Ling sounds. He imitated ah, sh, and s. Imitated the others as well, but they were more inconsistent. You can definitely identify suprasegmentals now and he continues to use about 30 consistent word approximations. His science skills improved greatly. And the auditory skills also have been slow but steady. In each visit, we carried out ART, no responses ever. ESRT consistently carried out with that one response seen again and again on electrode nine, taken with a grain of salt as well. Continued focus on auditory training and conditioning. Loudness scaling was emerging as more where time was observed and language obtained. Speech evaluations or routine sessions. Counseling regarding outcomes. Those were done each time. So we all know that with these kids, our goal is to match auditory input, right, for so many reasons. But with anatomical and physiological differences that Erik has as well as the fluctuations that are secondary to an auditory neuropathy, we're gonna miss absolutely each time. And we wanna move ahead with a sequential CI with appropriate expectation. It's clear that the neurotologist deemed the other ear as the more viable ear and the residual hearing that
we’ve seen on that ear as well kind of means that probably was the better ear. Lessons learned and thoughts for the future. It’s really easy to look at this four years out and make recommendations and certainly no one did anything wrong. But I think that we all need to kind of put our thinking caps on and serve him in a better way. Definitely in the future, we can try to open up those burst parameters for ESRT, focus on one basil and one apical and trying to round it out, right? Feedback from speech. Lower end levels, double the pulse with manually and then move maplaw back to a 1,000 if progress continues. With anesthesia and hypoplastic nerves, we have a lot of auditory neuropathy kids. And definitely always with them and always with the hypoplastic nerves as well as long as they have NIEC a simultaneous implantation if the family’s expectations are appropriate and services are appropriate. We always need a second set of eyes, every one of us. Reaching out to colleagues and clinical specialists is a must and I trained many of them in with him. The TC approach, until we understand access to auditory stimuli and emerging spoken language, also it would be something that we would recommend. So that was a little bit of a cautionary tale and a thinking and kind of just all eyes on a kid that we continue to implant that maybe we didn’t implant 15 years ago, right, 10 years ago. But I want to thank the entire team here at UCSF Benioff Children’s Hospital Oakland, and of course our wonderful families. The tireless effort made by ACIA, AudiologyOnline, SpeechPathology, and the scientific chairs for ACIA in 2020. I cannot wait to see everyone in the same room again and I know you all feel exactly the same way. Take care and be safe everyone. Thank you for your time.

- [Artur] Hello, my name is Artur Lorens. I am professor at the Institute of Physiology and Pathology of hearing in Korea Town in Warszawa, Poland. First of all, I’d like to thank the organizers of CI2020 and American Cochlear Implant Alliance and American AudiologyOnline for the opportunity to share our research experience in the area of fitting of EAS cases. So the title of this presentation is the challenge of fitting case of partial deafness, how to optimize fitting after delayed hearing loss in the implanted ear. So let me start with a brief introduction about what is partial deafness. The concept
was introduced in 2002 and professors Skartzynski implanted first case with a normal low frequency hearing and steeply sloppy cardiogram. So that was the first implantation in this type of patients which allow not to combine electric and acoustic hearing. So we publish a series of papers about the outcomes of fitting they do at speech processors. So the device that have electric and acoustic part in one housing. So one is actually the fitting of this type of device. What is the different than a normal fitting, let's say the traditional fitting of speech processors? So first of all, this is the needs to fitting the hearing aid parts or prospective fitting strategy to determine the gain and maximum power output of the hearing aid is performed and then the cut-off frequency for acoustic amplification should be set and the frequency range over with electrical stimulation will be allocated, has to be defined. And this is actually the most important for this case presentation because we, well, actually explained how we change this frequency range because of a progressive hearing loss. So actually, what situation can arise when selecting the lower limits of the electric frequency range, so-called the crossover frequency? So it can be below, at, or above the frequency up to which acoustic hearing is maintained.

So we have a situation. Below, it's called the stimulus overlap at, this is called actually minimum overlap or "meet condition." And above, so no overlap with a gap between electric and acoustic stimulation. So this is the visualization of the condition of a stimulus overlap in which, in this condition, frequency in a particular band like a 70 to 750 Hertz are presented both acoustically and electrically. And next we have a "meet condition," and the "meet condition" is achieved when the cross-over frequency for electric stimulation is actually matched by the upper edge of the acoustic amplification. This is this matching point and that needs to actually define this frequency where the audiogram crosses typically 50, 65, or 80 dB. We usually use the 65 dB to calculate this frequency. And next, the third condition is the non-overlap condition with a gap between electric and acoustic hearing usually results from an attempt to minimize the mismatch between the position of the most apical electrode and the frequencies assigned. Okay, so let me introduce a similar case, a 20 years old woman at the
moment of implantation. She was implanted with Med-EL device, medical high implant system since then her hearing loss diagnosed at the age of 12 use. And she actually, we didn't find any progression of hearing loss from the 10 years before implantation. So what to do in terms of a fitting of a speech processor? So first of all, to determine the cross-over frequency to actually maintain the "meet condition." And this was according to the manufacturer procedure. So we did that. And these cross-over frequency was defined here at the 65 dB point. So it was 1,100 Hertz. And the next follow up was without any modification of this cross-over frequency. But three years post op, we discover, we actually found different threshold when we maintain the audiometric evaluation. And here is the audiogram after a few years and there is a shift in the threshold in the implanted ear but also in the controlled other years. So definitely there is a progression in pathology not related to cochlear plantations. So at that point, we decided to make a clinical decision.

So what will you do next? We considered to actually fit that different type of speech processor because before it was not meant to amplify, there's no frequency hearing. At this moment, we decide to actually use the duet system or wherever a hearing aid box to amplify low frequencies. And we haven't changed the cross-over frequency. But after five years post operative follow up, there was another change in threshold and at that point, we decide to actually change the fitting, the gain of the hearing aid, but also when we decided to change the cross-over frequency. So how to calculate this cross-over frequency? Of course, we are using the 65 dB point. And at that P U Hertz, this frequency was actually defined as at 800 Hertz. So we had to change from 1,100 to 800, because if we stay with 1,100, there was going to be actually a gap between acoustic and electric. And we want to avoid this gap. We want to have a "meet condition." So the decision was to change from 1,100 to 800. But we encountered some problems. There was a complete lack of acceptance of this change by the patient because she reported to high pitch of sound. She even had a severe difficulty with controlling her own voice, and she reported a huge listening effort and even a speaking effort when we change the cross-over frequency. Because we actually deliver
a mismatch between the frequency in the speech processor. And she actually used to to use to find a solution we decide to use the brain plasticity. So we discover that tolerable frequency shift is around 50 Hertz. So desired frequency shift, 300 Hertz, we divided by 50. So we end up with six steps and six steps for one year. We actually have two miles for accommodation for each steps. And in this way, we were successful to shift from 1,100 to 800. But with the next followup like a seven years, we also discovered further progression of hearing loss. So next, that change in the cross-over frequency had to be done. And when we looked at the history of these changes, we started like five years after activation. So we started with the frequency of 1,100 Hertz and slowly we end up with the frequency of 2,050 Hertz. After 10 years of doing a slow changes because we wanted to keep the "meet condition" despite the pathology, despite the progression of hearing loss. So let's actually now look at the speech outcomes. How it can be correlated or how it may be referred to what we did in terms of fitting.

So here after two years, when we discovered this progression and we fitted with the hearing aid part of a dual system. So we fit the dual system. What we can see clearly that there is an improvement in a monosyllabic speech, discrimination in noise. However, in quiet, we couldn't see any changes because she was at the ceiling. She was almost a perfect 100% of speech discrimination. But looking at the noise, we can see that we actually achieve a nice progress and we actually work against this pathology, this progressive hearing loss. But after six years after activation, we discovered that there is a mismatch. There is a difference between the calculated cross-over frequency and what she used. So this actually produce a gap between acoustic and electric hearing. So there was no "meet condition" at them all. So we can see clearly that she actually deteriorate in terms of a speech discrimination. So changing, there's actually again, the changing the cross-over frequency and allow her to improve her again and be in excellent performance of 95% of speech discrimination in noise. So let's now conclude this case presentation. So we believe that we learned something. First of all, there is need to monitor our audiometric threshold after
implantation in partial deafness. With a hearing preservation about the followup, the followup of also in terms of fitting should actually be combined with audiometric threshold measurements. So if there is a progression, if there is a change in threshold, we need to increase the gain of hearing aid part of the device, but also it needs to reduce cross-over frequency. But there is no possibility to reduce this in a big step. We need to apply small step. So we apply a strategy of small steps like 50 Hertz and we allow this listening for this 50 Hertz per two months. And there is another solution, we can think about the overlap at the activation. So we can actually fit the overlap at the beginning. And if we do that, especially when there is a deep electrode insertion, we can actually think also about that there are some electrodes which are in the acoustic region of the human cochlea. So how do I actually estimate this position? You can find in our recent paper about this case. So thank you very much for your attention.

- So I appreciate everybody being able to join us today. I’m gonna present to you two cases that we felt were sort of complimentary and would be interesting to a general audience focused on programming in cochlear implants. So first I’d like to just acknowledge the wonderful cochlear implant team that I work with at MUSC CI. So we’re gonna first talk about our case. We’re gonna call him JO. He is a 49-year-old male with progressive hearing loss, supposedly due to Meniere’s disease. He was actually implanted quite some time ago in 2003 with a Med-EL Combi 40+ standard array. He is one of those patients that is not great about following up, so we all have those in our clinic. He pretty much came in whenever something was not right and he needed some troubleshooting or equipment issues or whatnot, but we really didn’t see him all too much on a regular basis. But in 2014, he came back and reported visual disturbances, including nystagmus and also oscillopsia. He also reported severe vertigo episodes and more so when his implant was actually turned on. So this was sort of an interesting presentation. I should also mention that, so this was a patient that actually was ex planted and reimplanted in 2004 for a device that had failed and kind of said that, "Yeah, things haven’t been great "since then." But they had just gotten progressively worse and to the point that it was really affecting his quality of life. So we
referred him for vestibular evaluation. He saw one of the cochlear implant surgeons and managing neurotologists here who did refer him for a vestibular evaluation, which did reveal some bilateral hypofunction, not a complete loss, but definitely hypofunction of both semicircular canals. An additional review of a CT scan and a repeat CT scan did actually identify bilateral EVA as well. And again, you can see from that dizziness handicap inventory, he scored 84, which on a scale of zero to 100 means that he was really being severely affected and significantly affected by these dizziness symptoms. So when we step back, there’s a lot of different reasons why this patient really could be getting dizzy. He had some other medical issues as well which I’m not getting into here, which again, busy patients can be dizzy for a lot of reasons. But he also hadn’t been programmed in quite some time. So we put him in the booth before we did any programming to sort of get a baseline of where he was. So this was in 2015. He’s in OPUS 2 processor, HDCIS configuration with 500 pulses per second, pretty low, but otherwise pretty normal perimeters. The detection thresholds with his implant on in the booth look good and where they should be with a Med-EL device. And you can see he’s not the best performer. He gets about 40% on CNCs, 70% on an easy file, but he is getting something out of it and subjectively feels like he hears okay with his implant. Next what we did is we did some programming, right? He hasn’t been programmed in a while. Let’s hook up his processor and see what that looks like.

Okay, so this was the map that this patient had been wearing for a very long time. And I think that to anybody who is familiar with Med-EL cochlear implants, I think it jumps right off the page. So I’m just gonna highlight that Y-axis there that shows you the charge unit. So if that font is a little small for you to read, that basically says that his end levels are up charge units, which for those familiar with Med-EL devices is exceedingly high. We would expect that for most people who have acclimated to the device end levels, they’re gonna be somewhere between 20 and 40. So that being said, I think that this was a case where the managing audiologists looked at that and thought, "Well, we need to sort of verify those "to see if those are actually accurate," which they probably were not. And so in that case, I think this is a map where you look
at it and you think, "Please somebody do ESRTs on this patient "and validate what we're actually seeing here." And so that is exactly what this clinician did. I'm gonna take just one moment and talk about ESRTs. I'm guessing that those who tune in to a lot of these online presentations as part of CI2020 are gonna hear a lot about ESRTs. So I'm just gonna take a moment to explain just the basics here to give people a refresher in case you're not exactly sure about them. But they are sort of consistent responses that are observable at levels that are very highly correlated with recipients C and M levels depending on the device that they have. So there's a number of studies that have shown that that when you can repeatedly record an ESRT that they tend to correlate pretty well with where those upper stimulation levels should be. There are some corrective values that you do have to apply depending on the device. So there's a number of those recommendations out there, this is just one of them. But colleagues recorded the following offset values depending on the device that they have.

So if we just take, for example, a look at a patient that hasn't been device, wherever those ESRTs are coming in, you wanna offset those values by approximately 3%. Other clinicians will just leave it wherever that ESRT is and that's also pretty close to it as well. The managing audiologist in this case did just that. She was able to measure ESRTs on electrodes one through 10. Trying to measure ESRT on electrode 11 actually resulted in facial nerve stimulation and we knew previously that electric 12 was extra cochlear so it wasn't measured. So what you're seeing here are these new M levels are the ESRT levels. The red horizontal line that you see is where his prior map was. So you can see that there's a reduction of M levels by almost half. Interestingly and in a very positive way, as soon as we reduce the M levels in this patient, the vestibular symptoms, like the nystagmus that was observable with the implant on all went away as soon as we reduced the end levels. So that was a positive thing. Immediately after the program map was given the appropriate ESRT levels, the clinician put that into the booth and these were the results that we got. So this is about any time for adaptation or anything like that. They showed stable thresholds, still consistent with what is appropriate for Med-EL devices, but significantly decreased speech understanding as
you can see here. So just as a reminder, ESRT scores, CNC words were 40% and now he’s all the way down at 24 and more significantly easy. It used to be 70%, and now this individual with his new ESRT map is coming in at 21%. And he was not all too happy with his prescribed sound diet as we like to call it. So this is unfortunately not too uncommon. Oftentimes patients who spend a long time listening in a map where it’s providing some overstimulation have a really hard time adjusting to a more appropriate map. Sometimes it does result in immediate improvement in speech recognition and in other times, in this case it doesn’t. And the hope would be that with time they’re able to sort of realign to some more appropriate levels. So we actually ended up seeing this patient back. The following year he came in and he reported speech is much too quiet and still not adjusted to it. And so I think the clinician did what any good clinician would do at that time is really work with the patient, right? We know that the stimulation levels previously prior to doing ESRT were too much. Since lowering those M levels, all of the patient’s vestibular symptoms that he had been reporting had subsided.

So we felt pretty confident that it was simply sort of the overstimulation and really that current spread that was really affecting some of those are causing some of those other issues for this patient. But subjectively he hated it and really felt like it was much too quiet. So the clinician then sort of globally adjusted those M levels and then loudness balance, still keeping them reasonably below where they were at his first appointment. So still not causing any sort of vestibular symptoms, but at least a little bit higher. So the patient felt a little bit better about the benefit that he was getting from his cochlear implant. Unfortunately I don’t have a pretty ending to a story for you because this patient has since been lost to followup. So one can assume, given his history, I should say that he must be happy, right? He tended to be somebody that only came in when something was wrong, so if we haven’t seen him then maybe everything is well and hopefully his vestibular symptoms have regained and he’s hearing okay according to his standards. But yeah, one can hope and I’m sure we’ll see him back one day. So I think that that was a case in which ESRT, it was obvious that that was what you
needed to do. And it was an obvious case in which behavioral loudness scaling really wasn’t the best approach for that particular patient. And it was really affecting both speech recognition also was affecting a lot of other things unrelated to audition at all. But sometimes these ESRT cases are a little bit more sneaky and they’re not as obvious as that case that we just heard. So I wanted an example of that as well. So let’s look at our next patient. So this patient is a little bit different. 41-year-old female. She has progressive hearing loss since early childhood. She reported that she had started using hearing aids at the age of four. She was implanted with a cochlear freedom device in 2012. She consistently followed up. She was a great user with her device and subjectively very pleased. So she, by all accounts, was a huge success with her cochlear implant, which are reflected on the next slide by her scores. Just to give you a representative example of how well she performed and why she was so happy, these are her scores about six years post activation.

So you can see that her aided thresholds in the booth look great for that device. CNC words, she’s at 76%. AzBio in quiet, she’s at 77%. And when you compare those scores to preop scores, she’s gained significant benefit from her cochlear implant. So CNC words with her hearing aid before implantation were at 8% and AzBio scores were at 16%. And I also think that, as a clinician, you look at this as sort of a whole person and you think, "Well, for somebody that had prelingual "or apparent lingual hearing loss, this is a great benefit "and a great outcome for somebody with that history." This is what her map looks like at that time. So when she was achieving fairly good scores, 76% CNC, this was the map that she used. You can see that by all accounts, she's got pretty standard program settings. So the Ts and the Cs look fairly typical for this device in light of normal anatomy. And she's got all the standard defaults for the speech processor as far as rate, maximum pulse width, and all of that is concerned. But because she had never really had the ESRT performed on her at the time and the clinician thought, "You know what, let's do it. "We have time, let's see what the patient thinks of it." And so that's exactly what she did. So she was able to measure ESRT on a number of electrodes. You can see on the left, there's the initial
map before any changes were made. And then on the right is the approximate ESRT map for this particular individual. Not that much different, right? There's a little bit of change it looks like in the thresholds as well. A little bit of change in the contours and overall level for those C levels, but otherwise, looks not like it's a huge, huge difference. However, when that patient was placed back in the booth for testing with her new map, you can see again that behavioral thresholds look great, but look at those speech recognition scores. So previous to this ESRT map, she performed at 76% for CNC words. And that score jumped up to 96% with this new ESRT map. And same thing with sentences in quiet, not as big of a gain, but from 77% to 88% and subjectively she felt like it was clean and it was clear and it was better than the previous map that she had had. So in conclusion, we all know from a lot of evidence that has come out recently that ESRT really can be a powerful objective tool when assessing where M and C levels should be for a particular patient. We know, I think, with a fair amount of confidence, and I think all of us would really agree that they should be used to assess patients when clinicians feel that behavioral testing is inaccurate.

So for example, in pediatric population and older adults that maybe cognitively are losing some function and you might suspect that they are not able to provide an accurate behavioral response, ESRTs are fantastic. I think sometimes where they're overlooked is in cases where you have somebody that's sitting in front of you that is performing great. And we all work in very busy clinics. I think sometimes this is something that we don't see as a priority, but I think the case in the second patient can sort of prove us wrong in that thinking sometimes that even if we don't feel like the program levels are way off or that there's anything wrong with the way that the person's responding, that sometimes these ESRTs can also give us pretty surprising results and take somebody who was performing pretty well and make them even better. So just keep that all in mind. And I thank you very much for allowing me to present this data to you today. Thanks so much.