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Neural Response Imaging (NRI)

Presenters: Lindsey Shroyer, AuD, Francis Comtois, MS

Music

Music

Hey everyone. It's nice to have you join us today. Thank you for joining us to learn more about Neural Response Imaging. My name is Katie Vaden. I work in education and training at Advanced Bionics.

We're really pleased that you could join us for today's introductory workshop series. Today's topic is NRI and as a reminder, we do have some resources for you that you can download from Audiology. Online. You can find the slide handouts from today. There's a handout where you can take notes if you want to make any notes about clinical tips and tricks that you learn and any supporting clinical resources and research we've made available to you as well.

Here you can see the risk and benefits associated with today's training.

Here you can see the three learning outcomes for today, all focused on nri.

And here are the disclosures for the speakers that you will hear from today.

If you've joined us for this introductory course before or for really any AB event, you know that your feedback is very important to us. So because of this, we've created an evaluation for today's course. If you could go ahead and access the course evaluation using the QR code or the link in the chat this way it will be open and ready for you at the end of today's course so that you can answer three short questions. It takes only a few seconds to complete, so go ahead and get that open if you would.

And with that I would like to introduce today's speakers. So let's talk about how we'll spend our time together today. And we are honored to have Dr. Lindsay Schroyer from the Arizona Hearing and

Balance center as well as Francis Comptoir from the Hotel de Quebec in Canada. So based on their busy clinic schedules and potential time zone changes, we have pre recorded their presentation. However, our education and training from Advanced Bionics is here to answer questions live and to support today's course.

In addition to myself, you will also hear from my colleague Lori Hambrick, also in Education and training. And I'll also take this moment to share with you that we have created a hands on activity that can be downloaded after today's course. If you'd like some hands on experience with nri, we chose to offer this training live so that you could have the opportunity to engage with us. You can ask questions in real time via the Zoom Q and A. We will answer as many of the questions as we can today.

During today's hour of learning, you can learn from others so you'll have the Opportunity to maybe learn from the questions other people have. And we offer engagement through polls and surveys. So you'll have the opportunity to engage with us and participate in the learning, which hopefully will just increase what you remember from today's course.

It's time to get started, so we'll kick things off with Dr. Lindsay Schroyer sharing information about NRI. Dr. Sch, I hand it over to you.

Hi, everyone. My name is Lindsey Schroyer. I'm a clinical audiologist in Chandler, Arizona at Arizona Hearing and Balance Center. I am thrilled to be talking with you today about the next section of Advanced Bionics webinar series, Target CI. We're talking about neural response imaging today.

So what is nri? Hopefully, you'll find it as a good, useful piece of the puzzle in working with your cochlear implant patients with advanced bionics.

So for this session, the goals and what we're going to be able to do by the end is discuss the value that NRI has for your clinic and your patient population, describe how to conduct NRI in Advanced Bionics Target CI software, and then demonstrate how to apply NRI results to your map within target C. So let's dive in. First and foremost, what is NRI or neural response imaging? Other manufacturers may call it something different, but NRI is what Advanced Bionics uses for their terminology. It's an ECAP measure, so an electrically evoked compound action potential measuring neural response. We use the intracochlear electrodes in Target CI programming software to measure this.

And. And it is dependent upon adequate neural survival and synchronous neural activity within the cochlea. However, this does not mean, if you do not have an nri, that a patient will not have sound just means that maybe that neural pathway or that neural response is not active. But that does not mean the patient will not have sound. Okay, so it's a compound action potential, which is a small change in voltage resulting in the firing of neurons.

It's the synchronous firing. And we measure that and we will see responses. And it can be used. I'm sorry. It can be recorded in the AB implant system using the system's telemetry and the intracochlear electrodes.

So you don't need anything external other than the sound processor and the patient in order to record this compound action potential. And you'll see a picture of a wave example. It is the wave one noted during an abr. So you're going to see a trough and a peak across time, and that's what we're looking for. We have some more examples later in the presentation, and we're going to talk about those that are good measures and maybe some that are not so good measures of this action potential.

All right, so what is an electrically evoked compound action potential, or ecap? An ECAP is the response obtained when an electrical stimulus is used to record compound action potentials. Okay, you can see an example of this over here on the right. And what we're looking at is increased intensity in

your clinical units with an increased response output level. Okay.

So I like to watch these develop, and we'll talk about this a little bit later on in the presentation. I like to watch low to high information because then I can see the growth function of these responses, which is what we expect as we increase our clinical unit intensity. It is very similar to what you will see in an ABR. So if you're familiar doing ABRs, you'll. You'll notice an increased intensity output with that increased intensity stimulation.

Dr. Schroyer, I appreciate that comparison you just made comparing NRI to abr, especially since ABR is very commonly used by audiologists. How do you compare the ease of running NRI on an active awake CI recipient versus running an ABR on an active awake patient in the clinic? Great question. There's hardly a comparison. You'd much rather run NRI on an awake patient than try and run an ABR on a patient.

So NRI is not subject to movement and wakefulness and alertness. I can't tell you how many times I've been sweating in the office trying to run an ABR and a baby who doesn't want to sleep and is restless and so forth. But running an NRI is much, much more simple as it's not influenced by artifact movement, wakefulness. So you'll. If you had to pick between the two, you definitely want to pick the NRI on any patient.

Thanks for sharing that. As you mentioned before, since the ECAP is recorded from within the cochlea, that's what makes it so much less affected by movement and wakefulness. So I'm glad that that, of course, has been your clinical experience as well. Yes, definitely. Much, much more simple.

Certainly easier to obtain. Thank you. Great question.

So, first question, with whom should we use nri? Kids, adults, people who can't provide feedback? Kind of, what are we looking at in this population?

Any thoughts or questions? I think it's certainly worth trying to use on all implant patients. If nothing else, it's a way to kind of let the nerve know we're getting in there and doing some work. So oftentimes you can see small changes over time, but really it should be a pretty stable response. But I like to do this on all patients.

Again, if nothing else, just to let the nerve know, hey, we're going to get in there and do some work so that it has some access to sound right from the get go. So it is useful to try and obtain this information on all implant recipients.

We have a true or false question coming up. So true or false, and you can type the answers into the chat. The ability to measure an ECAP is highly influenced by neural survival, synchronous neural activity, and the level of environmental sounds. Take a moment and think about this and type that into the response, please.

This one is false. It does not need. It does not depend on the level of environmental sound. This can be done. It's intracochlear, so you do not have influence from external sound sources.

All right, so when we get into performing NRI in Target CI, there's a few steps and it's nice to kind of familiarize yourself with it from the get go. So we're going to walk through that now so you have a little exposure to performing a target CI. Now, if you're over 35 like me, and we won't talk about how much older we are than that, you cannot see these slides, but they are in the course handouts, so you will have access to this after the presentation. And it's a nice handout so that you'll be able to see these, unlike me, this morning or this afternoon. So these are in the course handouts that you'll have a reference for.

So we have a case study. This is Josh. Josh has an advanced bionics cochlear implant. His hearing healthcare team understands and knows that neural response imaging is a valuable tool and can be used to obtain objective measures that can assist both intraoperative testing and postoperative testing and programming. The protocol at Josh's center includes obtaining a baseline NRI within the first three months of implantation.

And today what we're going to focus on is obtaining and running NRI for his left cochlear implant. Okay, so this is. Josh looks very happy today. First and foremost, you want to make sure you have Target CI software. You can run it from free standing or you can use it within the NOAA module.

So Target CI, you're going to search and find your client or your patient. Search from your list, select the correct patient and you're going to open your fitting session. Okay. You want to select open. And this will allow any previous data on this patient to be loaded in as well.

So I think it's really. Especially when you're maybe not running NRI or you're seeing a patient subsequently, you want to make sure you open this session as opposed to starting a new one. That way you can look at previous data next. And what's really important is to connect to the instrument. So that's here at the top in the center.

That is where we start our fitting. So you'll hit connect, and then it will connect to whatever devices the patient has. So whether they're a bilateral cochlear implant recipient, a unilateral cochlear implant recipient, or a bimodal patient using acoustic technology and electric technology, so whatever equipment they have that's detectable in target CI will be detected. You do want to place the headpiece on the patient's head in order to achieve lock to the internal device. You can leave both devices on if they're a bilateral recipient.

When you're detecting that way, you can run impedances, as you've previously learned about with the AB series that you're on. But if you are running nri, you want to make sure you remove the opposite device from the head. So just take the headpiece off. You do not want to have artifact interference when having two cochlear implant sound processors placed. So make sure that you take the opposite side off.

If they are a bimodal recipient and using a hearing aid on the opposite ear, it is fine to leave that in place. That's not going to cause any sort of interference.

All right. To access your NRI screen, you are under the client tab. I think this is something you have to keep in mind. I think when we get into programming, we feel like everything is in the fitting screen. But your implant details, your impedances, and your NRI all live under the client tab.

So you want to make sure you access your NRI client tab. And then you see where we have a new measurement here. So we'll select new measurement. And as you can see, this is indicated with the blue L, meaning it's his left cochlear implant sound processor and internal device. And then we're going to.

You'll. You'll open up into this screen. And what we see here is all 16 electrodes, and we get to select which ones we're going to be measuring. Okay. Now, there are templates that are built in.

You can create your own template. So there's lots of flexibility here within the software to make it easy for you. You do not want to run NRI on electrodes that are shorted or open. So always I think it's pretty much standard now, it will automatically run impedance measures when you connect to the internal device. Always make sure you take a look at those that way.

If you have chosen odd electrodes to run your NRI, but you have 13 and 15 that are shorted or open, you can change your protocol or change your template to ensure that you're not stimulating on electrodes that are non functional. Okay, so your templates here are in the drop down menu. You can choose from odd electrodes, even electrodes, or, or which is operating room. And then you can see here the templates and what these show are your low values, your high values, how many data points and which electrodes you're stimulating. Okay, you can set them all to zero.

The or ones you can see. If you can see closely, those show values that are a little higher on your clinical units at the high end. And this is more for streamlining and quick run. And they also run high to low. That way, again, we can get a very quick response while we're under sedation.

Thank you for sharing this information, Dr. Schroyer, and also pointing out the difference in running NRI in the OR versus in the clinic. I wanted to ask you, do you use NRI templates and if you do, do you typically use the template as is, or do you modify the template that you choose to use? Great question. I usually do use a template when I'm working with patients. I feel like it kind of streamlines things and makes things a little faster and easier and then explaining to patients, hey, you're going to hear some sounds.

You may hear sounds, you may not hear sounds. But yes, I do typically use a template for ease of use and time here in the clinic. For me, I usually go with odd electrodes. As long as I'm not seeing anything shorted or open. For me, it gives a nice picture just to ensure that we're getting kind of across the span.

You can modify within running a template though, which is something I do like and sometimes I will have to do. I may pause the recording and then add in a couple extra data points if I'm not seeing a fully developed wa. So I usually use a template and then can modify if I need to. Great. Thanks for sharing your clinical experience with that.

Absolutely. So once you've selected your template and you've said, okay, this is what I want to do. You will have to select your template. You can look at your low and high values. You do want to make sure you have a minimum range of 150 to about 200 clinical units.

That way you can see this development of the waveform and you can again adjust those settings as you need it. If you need more data points, you can add more data points. If you need to up your limit because you're not getting a response, you can increase your limit. Target CI will tell you if your upper limit has exceeded the compliance level. So it won't allow you to go beyond that.

If you've exceeded that compliance level, typically five data points are what are default. You can add more. I wouldn't go less than 5. It does not take a significant amount of time to run when you're doing those five data points. So I think five is the minimum that you want to have.

Okay, stimulation level, again, we kind of touched on this already. You can run low to high, or you can run high to low in the or. Typically, running high to low speeds up the process. And again, we want to keep people as least sedated as possible. What I like to do in clinic is to run low to high.

And I do this for a couple of reasons. A, it eases patients into sound because again, they haven't maybe heard anything for some time in that ear. So allowing these neural responses to increase in intensity as opposed to just going straight, straight, high level, we ease them into it and allow that sound to develop. But you also can watch the NRI recording, which I really like to see. As that intensity increases, you can see that response develop.

And that allows me to also say, hey, clinically this doesn't look like a response. So you can actually unmark and NRI value that maybe target CI has marked that maybe you don't agree with. And I think that's really important so that you have a good response and good fit line for your NRI responses. So being able to clinically judge that is really beneficial. So you do have to hit start.

You can make this beautiful template. If we don't hit start, it's not going to go anywhere. So you want to hit start to start your NRI recording.

Always, anytime you're starting with an implant recipient, you want to watch for signs of discomfort.

Okay, you can hover. What I usually do, once you hit start, you'll have a pause button that that turns into. So I usually hover over pause. Or you can skip to the next data point or Skip to the next electrode.

So you just want to make sure you're watching the patient for signs of discomfort. Sometimes you're able to counsel them through it of hey, I know this is getting pretty loud. We're trying to measure certain responses, so if it is uncomfortably loud, please let me know and we can skip. But sometimes just talking them through, like, yeah, I know it's going to get pretty loud, but it will calm down, is enough to let them get that access to that high information, that high intensity. Okay, this slide is a lot of information going on, but this is what a completed NRI session will look like.

Okay, so you can see your data points that are here in the center of the screen. Okay. The little dark dots mean that an NRI response was measured. Okay. If you see the X which you see at the bottom of some of them, that means that data point did not produce an NRI response, which we do expect to see.

We want to have about one to two data points that are in the noise floor so that we can measure above that. That's why the five data points tends to be a pretty good number of data points to obtain. Okay, so down here on the bottom left hand side, you can see your growth function or your regression analysis. Again, the two X's on the bottom that can either be measured by target CI or if you do not agree that that was a response that's accurate, then you can double click on that and unmark that data point. I think that's really important because there are sometimes that an NRI response is marked and you don't agree with it.

So that is something that you can do within the software to unmark that, to change that regression analysis line. In the bottom center you can see your responses obtained and your clinical unit values. So as I said, I like to look low to high so that I can see these develop and you can see the waveforms that grow in response as we have higher intensity. So I like to look at that and that shows you kind of the average. And then at the bottom right hand side is where you can see that active wave that's being measured.

So I know there's a lot of information on this slide. It's a great, great tool and piece of information that gives you a lot of data.

We definitely want to make sure we're ensuring and picking up good waveforms for the NRI calculation. So again, that's why you can go through and unmark if there's something that you do not agree with.

Okay. And then NRI runs off of a regression analysis or growth function. So the output is plotted as a function of the input. Okay. And that's why we want to have two data point one to two data points that are below the noise floor, so that we're not just measuring inaccurate information.

And the X intercept on this is called the TNRI or the NRI threshold. And so you will see that on your screen as well. Down here you can see in the center, it marks it as your T NRI value. Okay. So you'll see those as we measure.

And as that growth function occurs, those numbers will populate as it's factoring that growth function.

Okay. We mentioned this before. This is an example of some of your waveform morphology you want to keep an eye on. Okay.

Softwares and data are designed to look for these responses and sometimes they will mark something that you do not agree with. So as we've kind of seen, we've seen a lot of good waveforms in the presentation, thank goodness. Right. But you may also see something that's noisy, no response or artifact. And so this is where you have your clinical judgment and can say, you know, that waveform on the bottom left looks really, really noisy.

I don't think that's a good response. And you can unclick and unmark that one so that it doesn't alter or change your TNRI value. Okay. Also, you know, there may be one that's marked because again, it's looking to factor these for you. That is no response, that we have a flat line and that doesn't really look like anything.

Again, you'd want to unmark that in your NRI measurement screen. Music thing with artifacts. You may be getting just kind of artifact from an electrode. That's maybe not what you want. You can unmark those as well.

Okay.

All right. So again, you kind of see the whole picture of what's going on in your NRI measurement here.

Once you have completed this, to whatever degree, you are happy. So maybe you have an adult who couldn't sit through all of this because of discomfort levels, having had, you know, hearing loss for a significant amount of time, you may have to save and close early. Maybe you have a three year old who's watching Moana and you know, can sit through all of these and you're thrilled. So you want to make sure you save and close your NRI measurement. This will save it to the database and save it so you can reference in the future.

What happens then is target CI does keep a record of the TNRI values from each session. Okay. So much like you can pick your date on your impedance measures and compare, you can do the Music thing to pick your date with the TNRI values here in target CI. That's again why we want to open this session when we're first starting to work with this patient as opposed to starting a new session each time. Because then you'll be able to access this information.

You can if you decide, hey, I. I want to compare how these responses on these Music electrodes function over time. You can copy and use the copy function right here, as you will see, and that will pull in the Music values that you ran. That way you have an apples to apples comparison. Okay. You can also delete them from here.

I would not suggest doing that unless I don't even know reason that you would want to do that. So just save those. That way you have them for reference in the future.

All right. True or false? NRI is a measurement of the electrically evoked compound action potential and requires the use of extra cochlear electrodes.

Take a moment. Type in the chat what you feel your response is.

This one is also false. We do not need extra cochlear electrodes in order to obtain an NRI measurement. NRI is all done intracochlear and all you need is your patient, their processor and a internal device and you should be good.

Thank you for sharing all of this information on NRI. Dr. Schroyer, your clinical experience is so valuable to the other professionals who are participating in this program and learning about working with AB recipients. Thank you so much. It's been a pleasure to work with this. I think working with AUB things are really nice and make a lot of sense.

So it's great to be able to present and talk about the clinical value that NRI has in working with patients, which I think is what we're all here for, making their lives and hearing improved. Absolutely. Thank you. Thank you. Fantastic.

That was a great introduction into AB's NRI. Next we'll hear from Francis Comtois about the clinical application of nri. Hello, my name is Francis Cantois. I've been a practicing audiologist since 2016. I began my career working with both adult and pediatric clients in a clinical setting for two years and for the last eight years have been privileged to work with the cochlear implant team at Lothar Surge.

I'm part of an exceptional team that includes 10 audiologists and four ENT specialists working together in a cochlear implant program that's been running for over 40 years. During my time here, I've performed more than 200 cochlear implant activations drawing on the extensive expertise of our experienced team. One key practice that I learned early on and continue to use daily is the importance of regular NRI measurements. Today, I'd like to share how NRIs are applied in clinical practice and why they remain such a valuable tool in cochlear implant programming.

NRIS can be measured intraoperatively and postoperatively. NRIS can also be measured by using the AIM Tablet or the Target CI fitting software. The AIM Tablet is often used in the OR for intraoperative surgical monitoring and for recording NRIs. Many centers will use the AIM Tablet or in the or. Because it is portable, it is easy to use.

The setup can be more convenient. It is also fast. For example, ESRTs can be obtained quickly and efficiently when using the automation within the AIM nri. Data collected with the AIM Tablet can also be imported into Target CI software for later viewing and record history let's start with a quick review of what we're looking for with NRI measurements.

Now here's a true or false question for you. If you look at the NRI tracing under option one, is it true or false that this NRI waveform indicates a good response? If you're on the live webinar, please respond to the poll.

Thank you for your answers. The correct answer for option one is false. The waveform is noisy and we can't see a clear N1 and P2. Now if we look at the NRI tracing under option 2, is it true or false that this NRI waveform indicates a good response? If you're on a live webinar, please respond to the poll.

The correct answer for option two is true. You can see that option two shows a clear N1 and P2.

Another true or false question here. Think about this statement. Post operative NRI should be run with high to low stim level ordering. Is that true or false? If you're on the live webinar, please respond to the poll.

Thank you for your answers. The correct answer is false. Any post operative measurements where the patient is awake should be performed with low to high ordering to avoid possible overstimulation and discomfort.

Now let's review what information NRI can give us and how it can be useful Clinically, NRIS can be useful in many ways during the programming process. One of its primary uses is to verify that the auditory nerve is responsive. This can be reassuring in the early stages after implantation. NRI also helps us confirm the M levels by providing objective data that will often support the patient's objective feedback. For patients who cannot give consistent feedback, like young children or individuals with complex needs, NRIS can be used to estimate M levels psychophysically.

It's also a helpful counseling tool, providing reassurance to families and recipients by showing that the implant is stimulating the nerve effectively. It's important to note that while ECAP measurements

provide valuable information about the auditory responsiveness, they do not predict a patient's overall auditory performance, such as speech understanding or sound perception. Additionally, a present or absent ECAP does not confirm the integrity or malfunction of the cochlear implant system.

Thank you for sharing some great information about how to use NRI clinically. Will you share what the NRI protocols are that you use at your clinic? Sure. As a center, we've decided to measure NRIs at every stage of programming, including the patient's annual or biannual follow up visits. At our center, we're also fortunate to activate the implant the day after surgery.

NRI measurements is an integral part of this activation the next day for all the reasons that we've previously outlined. During this initial stage, we typically measure NRI on approximately one third of the electrodes for adults and on all the electrodes in pediatric patients or individuals with special needs. At the subsequent programming session, usually about two weeks later, we re measure NRIs across all the electrodes. NRI measurements continues to be part of our standard protocol during annual or biannual follow ups, and at these visits we generally assess three to five electrodes to monitor implant performance and confirm stable nerve responses. Collectively, these data points allow us to build a longitudinal record of NRI values, helping us detect trends, monitor implant stability, and identify any unusual changes over time.

You've learned about the basics of NRI measurement and how to measure it in the Target CI software. Once you have these NRI measurements, let's take a look at how you can use them within your mapping screen. First, we will select the Fitting tab.

In Target CI. Users can easily view the TNRI markers on the map. When measured, TNRI markers will automatically appear in the recipient's map. They can also be hidden by using a right click on the mouse. The NRI levels will be displayed at the bottom of the programming chart.

These can be enabled and disabled using the right click of the mouse in the electrode column. In the electrode column or table, we're revisiting our client, Josh Inn. Josh is an adult recipient who can provide reliable responses during loudness growth measurements for M levels. However, it is valuable to obtain NRI measurements on some electrodes for this patient. Josh's audiologist plans to use NRI measurements to help guide device programming.

It's important to keep in mind the following NRI responses can offer valuable reference points for setting programming levels. Interestingly, a visual correlation can sometimes be observed between the shape of the M level profile and the TNRI curve. However, there is no exact correlation between TNRI values and M levels. On average, TNRI values tend to fall below M levels for most recipients. The TNRI level should be audible to the recipient but not uncomfortable.

Here are other points or tips to consider. Intraoperative NRI results should not be used to estimate M levels for programming purposes only. Post operative measurements should be used as a guide. NRI responses can also help to predict the contour of the map. For example, higher M levels in the higher frequency channels.

M levels set to NRI responses would ensure that sound is audible. Subjective responses remain the gold standard, but it is valuable to obtain as much information as possible when programming CI recipients.

In order to create an NRI Bayes map, you will right click on any channel and select Interpolation and then enable all.

You will notice that the M level markers will change to unfilled arrows indicating that they have not been measured.

You can set the M levels to the TNRI marker on all electrodes where NRI responses have been measured and are judged to be present or robust. Because interpolation has been enabled, the remaining channels will fill in. You will then select Play to start the stimulation.

First we begin by slightly reducing the global M levels to ensure the recipient is comfortable before starting stimulation. Then we gradually increase the M levels to identify the recipients most comfortable listening level, which typically corresponds to a level 6 on the loudness scale. This map would be used as a starting point and would then be verified in live speech for comfort using the age appropriate methods such as ling sounds or sound field detection, etc.

Once the program has been finalized, you can manage program settings in the Fine tuning tab and then select Save and close the session.

NRI based programming is now complete.

Let's take a moment to review. We've discussed the benefits of NRI and what information it can provide. But what if you try to measure NRI and responses are absent? First you may need to change recording parameters. You have the flexibility in target CI to adjust the number of averages, the gain and the recording electrode.

With that said, it's possible that some patients simply won't have NRIs. It doesn't necessarily correlate with performance. Some people may have absent responses and still perform well. You could try to obtain other objective measurements such as ASRTs.

Part of the reason it is recommended to obtain NRI on some channels for all patients, regardless of age or hearing history, is that the responses can change over time and it is helpful to have a comparison. For example, these changes can occur because of changes in impedances, changes in tissue or

cochlear status, changes in internal or biologic noise levels, or simply changes in the patient's health status, especially during the first six months post implantation.

As a reminder, NRI tell us about audibility and therefore is a guideline for setting ems. It can help us to verify subjective responses and it is a valuable counseling tool. You just mentioned that NRI can be an important counseling tool. Will you provide an example of a time when you've used NRI results to counsel a patient or possibly a parent? Sure.

I actually can think of many examples of where I used NRI results to counsel a patient or a parent. Although this is relatively rare, I have encountered situations where the presence or sudden disappearance or significant changes in the NRI values served as indicators of a possible implant malfunction or a shift in electrode array positioning in the cochlea. As mentioned, such occurrences are uncommon but certainly not impossible in our patient population. In these cases, I was particularly grateful to have access to a history of of NRI measurements which allowed me to compare past and current data. This comparison helped guide my clinical reasoning and facilitated communication with the ENT specialists who could then proceed with imaging or integrated testing to investigate my hypotheses.

But if I if I'm more I stay on the more positive note. I often use the presence of TNRI values on the map on my screen to reassure patients or parents about the functional integrity of the auditory nerve, particularly during the activation. Furthermore, I find it helpful to visually compare the TNRI profile to the subjectively measured M levels when there is a clear visual correlation between the two curves. It is reassuring for me, but also for the patient who may have been uncertain about the accuracy of their subjective input during the M levels measurement.

So think about whether this statement is true or false. Intraoperative TNRI values should be used for setting M levels. If you're on the live webinar, please respond to the poll.

Thank you for your answer. So the correct answer is false. Only post operative measures should be used for estimating M levels. Intraoperative measurements are taken under anesthesia or sedation, which can significantly alter neural responsiveness. As a result, it's common to see notable differences between intraoperative and post operative NRI values.

Additionally, surgical conditions such as changes in temperature, fluid presence, and tissue swelling do not reflect the typical awake and post operative environment where actual implant programming occurs.

Now think about this statement. NRI can be used to assist programming, determine the auditory nerve is responsive, and provide reassurance to patients and family. If you're on the live webinar, please respond to the poll.

Thank you for your answers. The correct answer is true. These are all benefits of nri.

Thank you again for sharing such great information about NRI and how you apply it clinically, and then also sharing some of your very specific clinical experiences. Before we wrap up today, what advice would you give a clinician who is considering using nri?

I would start by encouraging them not to hesitate to begin measuring NRIs at as many appointments as possible. The more you do it, the easier it becomes, not only in terms of using the software, but also in interpreting the results. It's not necessary to measure NRI on every electrode at every appointment, but I strongly recommend using at least measuring at least three to five electrodes each time. If you consistently measure the Music three to five electrodes over the years, you'll build a valuable record of data that can help you monitor the long term stability and functionality of the implant. This process takes very little time, offers reassurance for both you and your patient, and may prove to be extremely useful in the future.

That's really helpful information. I'm glad that you have had so much experience with NRI and found it so beneficial for your clinical practice. Thank you to Dr. Schroyer and Mr. Contois for sharing their knowledge and experience with NRI and how to use it clinically. I wanted to follow up and take the opportunity to just review some additional considerations that are helpful for you to know as you begin using and incorporating NRI into your clinical practice. So this is a review of some of the concepts that maybe were mentioned earlier in today's training.

Dr. Schroyer mentioned that you can move in the target CI software you can move the negative and positive markers so the N1 and P2 markers. So here you see an image of the N1 and the P2 markers. So NRI automatically will select those markers. But it's important that you as the clinician, always review them. Make sure that you're comfortable with the peaks that were picked.

We always recommend using the largest response to confirm. Confirm that the peaks that were picked are accurate and where you think they should be visually and you can Actually click on them and adjust them. So how do you know where they need to go? We recommend starting with the largest response for the cleanest data. So look for the most distinctive negative peak followed by the positive peak, and then set your markers to those areas again.

The software will do this automatically, but we recommend that you always analyze the data, even if something is picked automatically, and make the best clinical judgment that you can.

All right, Another good tip is to use the icons in the bottom right of this image. So you'll see three icons there, and those icons indicate view, copy, and delete. So let's look at the view function. So to the left, the far left of those three icons, you'll see the view function, which allows you to view and edit the NRI tracings. So if you've measured NRI in the past, or if you want to go back and look and an NRI measurement that you've made in the past, you'll use that view function.

The next icon in the middle of those three is the copy function. This allows you to copy settings from the selected measurement that you've highlighted in Target CI and you can use it again. So if you want to copy that, you can. And then on the far right, you'll see the delete option. So you can use this options if you prefer not to save an NRI measurement.

Let's say you've measured an NRI and you decided those tracings were all bad, or for whatever reason you don't want to save them. That's when you would use the delete functionality.

All right, so let's look closely in Target CI about how to edit an NRI measurement.

So we're going to use the edit function to access our NRI data. Click on a specific response visually, look to see if we're happy where those markers are placed. And if we're not, we can use the keyboard arrows to move the markers to the left or to the right. Now, as I do this, you can see how moving the marker also will impact the regression line. You can remove a response from the regression line that you can see on the left simply by clicking on that marker.

So you can toggle on and off that marker in the regression line.

Okay, let's put this concept into practice. So we're going to take a Look at this NRI response, this tracing. Let's review the negative N1 and positive or the P2 markers of this tracing together.

Would you move either of them? The N1 or the P2? Go ahead and type your answer in the Q&A.;

Okay, Some of you are indicating that you would move the P2. Which way would you move it? To the left or to the right.

Good. Okay. If you were thinking that you should move it to the left, I probably would do the Music. So here you can see. You can use your keyboard arrows to move that marker just a bit to the left to pick the more or the more robust positive peak there.

So that's probably what I would do as well.

Here's another example. Look at the N1 and P2 markers here. Would you move either of them?

All right. Everyone is saying yes, that you would move the N1 marker. I agree. Which way would you move it? To the left or to the right?

To the left. Okay. So here's what it would look like if we did move that marker to the left again, removing that N1 marker to pick the stronger negative peak. And to be a little bit more accurate, let's take a look at another example. What would you do if you obtained these results?

So here we're looking at the data from both our NRI waveform and the regression analysis for all the responses measured on this electrode review. Specifically the location of the orange marker at 233 current units right here.

Currently, that marker is not included in the regression analysis. Do you see there's a red X there?

Yeah. So what do you think about this NRI tracing? Is it good? We have some measurements in the noise floor. We always recommend that you get at least 3 responses that are accurate to create your regression line.

In this example, we are only seeing 2 Responses to Create the regression line. So if you think that this marker, which is indicated by the red X, should actually. Actually is a response. If we look in our

waveform window and think, yeah, there's a small negative and positive peak there, you could click on that marker and enable it to include it in your regression analysis. You would then feel confident that you would have sufficient data to form that regression analysis and estimate your TNRI value.

But if you're not sure and just thought, just to be sure, I want to get one additional measurement to be sure, you could always increase the high CU level for that electrode. So right now we're on electrode 16, and you would obtain an additional response for that regression analysis at a higher level. So you could do that as well.

Let's take a look at one more example. So what would you do if you obtained these results?

So I'll let you take a look, have a minute to study this NRI window. We have a nice waveform here. Look at the regression analysis just to the left of. On the left side of the screen at the bottom.

We mentioned earlier that it's important to have a few responses in the noise floor so we could actually decrease the low CU level to obtain some more responses at lower levels so that we can get some responses in the noise floor. We're not capturing the full window of our NRI response. So I think it's important to have at least one or two responses in the noise floor before we see our full regression line. So again, I would decrease the low CU level and run a few more measures.

Let's put this into a bigger practice and look at a case scenario. So here we have our patient, Lottie. She is an AB recipient with bilateral CIs. An NRI was conducted during her appointment, and the results for electrode 12 are below. So let's look at her response right away.

I would say let's look at her NRI waveform. What do we notice about that?

Well, if you've come to an AV training before, you know, we sometimes try to think of clever names for patients. Her name is Lottie Noyes. And, yeah, there's a lot of noise in her CI tracing. So that's actually the issue for her. Her tracing is very noisy.

Do you have a guess about what could be causing that? Go ahead and type your answers in the Q and A if you have any idea of what could cause that, that excessive noise in her response.

All right, I see some of you made some good guesses. The most common cause of excessive noise is because the recipient is still wearing their bilateral sound processor on the other side. So if she is a bilateral recipient, you're measuring NRI on one side looks like her right side, but she still has her left implant on. So it's important to remove the other sound processor before you begin your NRA sponsors or you will get very noisy tracings. Good job for everyone who guessed that.

I also wanted to point out, after you remove her second implant, you can see that the waveform cleans up. It looks great. She has a good response. But I also wanted to point out that with excessive noise, you can also see an elevated noise floor. So in the bottom graph or the bottom example is what it should look like with only one CI on.

But in the top image, you can see that the noise floor is elevated as well.

So what are some potential causes of excessive noise? We know from our example with Lottie that the presence of a cochlear lateral sound processor causes excessive noise. What about a contralateral Hearing aid. If someone was a bimodal recipient and had on their hearing aid while you're running nri, can that add noise to the tracing?

Make your best guess go ahead and type your answer in the Q and A.

Sounds a little tricky and the answer is no. A contralateral hearing aid does not cause noise in the NRI tracing. So it is actually okay to live on a hearing aid.

But what are some potential causes of noise? We know a bilateral implant can cause noise. Some of the other things that we see that cause excessive noise are high impedances, shorts or open electrodes. If there's electrode migration or translocation, sometimes that will cause a noisy nri. Sometimes muscle movements or any non auditory neural signals.

Electromagnetic interference from other equipment or machines in the room. OR sometimes. And again, a lot of these things are very rare. But there can be poor case grounding. Sometimes we see that in the or, but again, it's rare, but it can happen.

So what do you do to manage it? Well, the first one's easy. Just like Lottie's case, we remove the contralateral sound processor. The other thing you can do is increase the number of averages that are used to measure the nri. So make sure that the number of averages is higher so that it gets a more confident or more solid answer.

Sometimes that will decrease your noise in your tracing. You can try different equipment. Sometimes the external components may contribute. You can turn off any machines or equipment in the room that may be causing electromagnetic interference.

You can recommend the patient sit still if needed. Maybe they have some muscle movements that's contributing to that. Again, it's not common, super rare. But you could ask them to sit still. And if it happens to be poor contact with the case ground, you can ask them to sometimes like push on the area of your implant to have better contact.

Again, that's super rare. It's something we more commonly see in the or. But your AB clinical specialist will be there to help you manage some of those issues.

Okay, this is just a reminder that we have created a hands on activity that you can complete. It's available for download on Audiology online. If you want to level up your skills with NRI and just get some experience before you see an actual patient and try to measure it. It's a step by step guide that will walk you through performing NRI and target CI.

And we would love for you to complete that course evaluation that we talked about at the beginning of today's course. So go ahead and use the QR code to access the course evaluation or you can use the link in the chat. It takes under a minute. It's three short questions. And we would really appreciate your feedback on your learning experience today.

All right. I will wrap up today's call by just thanking again Dr. Scheuer and Mr. Comptoir for their time and expertise and sharing their clinical experience with us all. And for all of you, thank you for taking the time to learn with us today about nri.