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NCHAM

Electrophysiological Procedures for Infant Auditory Assessment:
"The Big Picture," by Dr. James Hall
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(Film).

>> MODERATOR: Okay. And we are going to get our slides up and then he is here with us.

>> SPEAKER: Can you hear me okay?

>> MODERATOR: Yes. Scott is going to get your slides up here. Perhaps two seconds. The slides are moving, so we should be set to go here in a moment or so. Without further ado, Dr. Jay Hall.

>> SPEAKER: Thank you very much. Well, I hope you all enjoyed that videotape, or if not enjoyed it, at least learned something from it. It was done very well. I'm not talking about the lecture itself, but technically. The sound was good, I thought, and the video, some of you, I have noticed, have asked questions whether you can get it printed out for review it again on your own, and it sounds like that's possible. So I encourage you to do that.

And I'm going to today, Karen asked me to have a 30-minute, half-hour overview of some of the main points I wanted you to remember, and I'm doing this to prompt you for questions. Hopefully, you've thought of some or even jotted some down from the video. And so I'll quickly go over -- I've got about 35 slides, so it's not a long talk, and again, it will just highlight some of the main points from the video, but please, one of the important things about this whole concept is to have this somewhat interactive, so please, type in questions, and what I'm done when I'm done with the lecture part of it, I'll go back, scroll back, and start answering the questions that you've typed in. So all of us will get a lot more out of it if you do ask questions.

Now, the questions may be prompted by something I say in this 30-minute overview, but certainly, it's appropriate to ask anything about infant auditory assessment, even if I don't happen to comment on that particular topic or concept or principle in my 30 minutes.

Okay. So let me begin by giving you an update on where I am and what I'm doing, very, very quickly. I'm serving as an adjunct faculty member at numerous institutions. This is more and more common these days in institutions. It's a bit of a problem for younger faculty, because it's hard to make a living as an Adjunct because you don't get benefits, but I want the freedom and to write books, write articles, do things that most universities, unfortunately, don't pay you to do anymore so you have to do them on your own time instead of playing golf or something else.

So I'm an adjunct professor at Nova Southeast University which is in Fort Lauderdale, Florida, about five hours north to St. Augustine, Florida, and also an adjunct professor and Salus

University in the Philadelphia area, and I do still teach the distance learning courses at the University of Florida.

And then my favorite title, of course, is Extraordinary Professor at the University of Pretoria in South Africa, and I hope to get there every few years and will be there in the spring, and one of the things I'm quite happy about is there's a videotape, you can find it on Youtube, of me giving a lecture and in the same videotape, Nelson Mandela is speaking. Of course, we lost him earlier this week, or last week.

If you want to reach me, here's my e-mail address, may want to jot that down. And I do have a website, so much of the information in this workshop, and many other topics, you can found on that website. I'll advance to the next slide and give you an overview of the topics I'll be discussing.

First, I'm going to identify the objective measures from A to Z, literally, we will go from A to Z, and as we mentioned at the beginning of the video, but I'll reinforce it, because it's important, the rationale for using objective techniques for measuring hearing. And I'm a strong proponent of reminding everyone, whether it's a student or a practicing audiologist like you, about who contributed to the development of any procedure, because these people need to be acknowledged.

So as I talk about the people who developed some objective measures, I'll give you background information about each of these people and try to bring them to life. Then I'll talk about the cross-check principle very briefly.

Essentially, the videotape you just heard or an video lecture was an ongoing lecture for the timelessness of the cross-check principle, that it's still as important today as it was when it was first articulated in 1976, and it's probably the most important to keep in mind as you evaluate an infant.

The more test procedures you have that are objective or behavioral and pointing in the same direction, the same set of findings, the same conclusion, the more confident you can be that you're making a proper diagnosis. I'll highlight some of the unique contributions of the procedures when we're diagnosing hearing loss and I'll give you an update of the measures we're talking about.

So you'll find this is a little bit redundant if you were at the workshop in Idaho or any of the NCHAM workshops, but I think it will prod your memory to ask a few questions. So the website is audiologyworld.net. So audiology world is all one word. No stopping it. And then net. So there it is.

Okay. And remember, ask -- write some questions down so we can get to them at the end, and I'll keep an eye on the clock here. I've got 3:40 on my computer, so we got off -- we started this about 3:35, so I'll go until about 4:05 and then we'll save the rest of the time for questions. And, of course, if anybody from NCHAM wants to join in and correct me, they can. And we go from auditory A to Z, auditory brainstem response, cortical response, and Z is for impedance.

The aural measures are tympanometry, of course, and one thing I'll comment on and that is wideband reflective and it has some real advantages and then acoustic reflexes. Those are old, the first reference to them goes to the late '20s and early '30s, believe it or not, but as a clinical measure, they've been available since the 1970s and they're still as available as they were today. In fact, I would argue, in some respects, due to the pressure on all of us to be more productive and more efficient and reduce test time and the emphasis on auditory assessment of younger and younger children, I would say that acoustic reflexes are actually more important now than when they were first discovered and introduced clinically.

Of course, an essential measure of any evaluation of any child in the rationale, the reason why we use it in value but also essentially because it's recommended strongly by the joint commission on hearing and medical otoacoustic emissions. If you had to take all of those listed in front of you and isolate it, say, which of the measures is most important, which would be impossible to get along without, it is the ABR.

All of them are important, and I'm not saying the ABR can be used exclusively, but when it comes to measures auditory in infants, we need to do it objectively if it they're infants, the ABR is the one test that helps us reach that goal. The ASSR is also very helpful but can't be used in isolation.

I mentioned in the video -- pardon me -- the resurgence of ECochG, and I'm going to emphasis that again in a few minutes. Then we get to cortical responses, and many of you until don't record in audio cortical responses, and you can do that first hearing aid fitting without them, but the evidence is mounting that they can be used to measure auditory functioning in children at levels above the brainstem, and that's critical. If we're limiting ourselves to the ABR and these other measures, we haven't evaluated where auditory processing is, a lot of the auditory processing is taking place.

So the emphasis on the cortical auditory response is to get us close to the complete comprehension in infants and young children rather than measures things that aren't -- we need more than our outer hair cells to hear, and even the ABR is not a test of hearing. We know that off of someone who is heavily sedated and not hearing a thing, off someone who is comatose, off someone who has major problems with speech perceptions, and inversely, we can also not record an ABR in somebody who has perfectly normal hearing sensitivity and can understand quite a bit. So the cortical auditory evoked responses will be important.

So I think I made this point pretty thoroughly in the video, but I want to emphasize certain points here. On objective measures, and by that, I mean, techniques that are on previously slides, are highly site-specific. You can usually describe where it is, and that's a big advantage. In fact, it's essential for managing the patient, medical management as well as audiological management, so we need to know where the dysfunction is located. Behavioral audiometry provides very little information, so even if we can do the tests, the objective tests still have value in determining where the problem is in the complex auditory system.

Objective measures are highly sensitive as well, and this is a rare combination. Usually you get more sensitivity, you lose specificity. In other words, the more sensitive procedure to auditory dysfunction, the less specific it is for differentiating among dysfunction, but when it comes to combining the measurements, you get the best of both worlds, you get a test battery that is site-specific, but a highly sensitive test battery. So we know that immittance measurements are far more sensitive to middle ear than tone or bone and we almost always know whether or not there's a middle ear dysfunction or not.

We know that OEs are highly sensitivity to cochlear dysfunction and they can be abnormal when the audiogram is normal. We know it can be highly sensitivity to otoneural responses, and we know, of course objective measures are quick, too.

That's a huge benefit in itself. I can take a little infant, three or four months old and can have tympanometry, even a quick ABR in that child, if they're sleeping, before most audiologists could complete behavioral audiometry on a child or certainly for a slightly older child what would be audiometry, so the objective measures are very, very quick, and when I say simple to perform, they are. Obviously, the interpretation requires some skill and experience.

Automation is a big advantage of objective measures. We wouldn't even have it without that feature, and that allows us to search for, you know, many, many more children who might have hearing loss than we normally could and we could focus on the diagnostic assessment. We don't need to be involved in the routine screening like we used to. Devices can be used for that.

Many children are hard to test, difficult to test, sometimes plain impossible to test, and the problem with that is if we are relying on behavioral measures, we can't get them to sleep or cooperate because that will eliminate any other response, but that's not true for most, with the cortical can be done under anesthesia or sedation.

Behavioral tests are always influenced by listener variables -- attention, cognition, memory, processing speed, cooperation of the patient, motivation, and their state of arousal, whether they're at work, sleepy or actually asleep, while though factors don't influence most of the objective measures with the exception of some of the cortical responses, so that's strong rationale for including those measures and relying on them for auditory function.

Okay. Quickly, we'll go through some of the people who made important contributions to the development of these. Hopefully you all recognize this person. She's a little younger, her hair wasn't gray. Here she testing a child. Look at that speaker in the background. You don't see those anymore unless you're at a rally and someone is using a bull horn.

This is, of course, none other than Marion Downs who could be called the mother of pediatric audiology. More than anyone else, Marion Downs focused people's attention in the '60s and '70s on early identification. She was a lonely voice in the world but never gave up and sooner or later, people began to realize that she was right, that early identification and diagnosis and treatment was essential. Marion Downs will turn 100 years old in January. Should be a big birthday party for her in Denver then.

James Jerger, my mentor, also needs to be mentioned. When it comes to measures, James Jerger studied each of them. We'll talk about his contributions to impedance measurements, how he single-handedly in the 1970s made them a clinical procedure in audiology in the United States, and his studies were of -- of immittance measurements were large, clinical trials, textbook examples of how to collect data and apply it clinically, in a very straightforward, clinical way that people could actually use the data, and did tympanometry work and acoustic reflexes. He edited the book here, published in 1975 and a second edition was published in 1979. So we certainly need to give plenty of credit for James Jerger for how we now evaluate the hearing dysfunction in children.

Don Jewett was involved in that, as well as Robert Galambos, but Don Jewett discovered it, but he also recognized how important it would be clinically. And it revolutionized hearing assessment. Without that discovery, there's no way we could be identifying hearing loss in infants. We would still be waiting for children to be, you know, 2, 2 1/2, 3 years old before we tested them. That was an enormous contribution to audiology.

You know that Don Jewett is not an audiologist. He is also still alive and well.

In the interests of time I won't comment much on this slide, but in my books and in my full presentations, using ABR and hearing loss, I talk about this paper, and it's so far ahead of its time. The response was shown to be very, very reliable, the waves were clearly identified and labeled with Roman numerals, and showed that you can use fast stimuli to collect an ABR and now we use that to speed up our test time so we can collect data on multiple areas and sometimes bone conduction and believe it or not, Jewett showed that tone bursts could give accurate results and how the electrode location affects the ABR.

Robert Galambos was Don Jewett's mentor at Yale University and was well aware of Jewett's discovery, even before the results were published, and he then, Galambos, showed that the ABR could be recorded from infants as well as adults, could be used for newborn hearing screening and for estimating hearing threshold. So Robert Galambos, who died in 2010, deserves a lot of credit for where we are today.

You saw that slide in the video. This is Glen Wever, who discovered ECochG, just when you think ECochG is fading away from the clinic, it comes roaring back, and now it's been shown, clearly, that it's an essential technique for diagnosis of auditory neuropathy spectrum disorder, in differentiating outer hair cells from inner hair cells from auditory nerve and perhaps synapse abnormalities in the auditory system. So at least the principles needs to be applied whenever we're diagnosing hearing loss in infants, and the actual technique, really, should be used if a patient is suspected of having auditory neuropathy spectrum problems.

David Kemp in the early 1970s started studying cochlear physiology, and by the mid 1970s showed that the ear was capable of producing sound as well as receiving sound and that there were active processes in the cochlea. And the source of these active processes was primarily the outer hair cells.

So we've certainly got to give David Kemp tremendous credit, because OAEs, like the ABR a little bit earlier -- not much earlier. Remember, the ABR was discovered in 1970, 1971, so the OAE was only four or five years behind the ABR in discovery. But between those two methods, we had powerful techniques for diagnosis of hearing loss in infants.

Terry Picton, you probably don't hear much about him. He's from Canada, but of the people studying electrophysiology, he's important, and we should give him credit for his contributions.

Moving up, we have Daniel Geisler who discovered auditory middle latency in 1958, and his colleagues like Bob Goldstein and others from Wisconsin, are it is one of the most important cortical responses, because it comes from an essential part of the cortex.

Well, we can't have a review of important people without mentioning Hallowell Davis, the father of auditory evoked responses. He coined the term ABR and discovered the P300 response and influenced so many people who then went on to make important contributions to electrophysiology. Well, we talked about Robert Galambos earlier, so we'll move on.

And I'll quickly comment on the cross-check, since you are familiar with it. I teach a diagnostics course every semester; just finished it, actually, teaching it at Nova Southeastern University. We read the whole cross-check principle article from beginning to end. I think all students should be very, very familiar with this concept. It was, of course, described by James Jerger shown here on the left, and Deborah Hayes, shown here on the right. She was a Ph.D. student at Vail College of Medicine at the time.

And the cross-check principle is summarized in this slide. Basically, Jim Jerger and Deborah Hayes described a series of cases where behavior audiometry had led the audiologist astray. Sometimes the behavior audiometry suggested a profound hearing loss when in fact there was no hearing loss and in other cases, perhaps an even more serious error was made, where the behavior audiometry suggested normal hearing, but in fact the child had a very serious hearing loss.

So as they point out here, we found out just observing the auditory behavior of children doesn't always accurately describe the hearing loss. You shouldn't take any auditory test in isolation and rely on those events to manage the child. You should always confirm each auditory procedure with another independent auditory procedure and if all the results are in agreement, then you've got an accurate description of hearing loss. If not, you need to resolve the discrepancy.

Back then, the test battery was behavioral audiometry, or what they called impedance measurements but now we call immittance because it might be impedance or it might be admittance. They used tympanometry and only contralateral reflexes. Back when the paper was written, it wasn't possible to record ipsilateral reflexes. The technology hadn't been developed. And they talked about ABR with errant bone. Now, of course, we will include OAEs at the very least in our test battery and perhaps other measurements like ECoch or ASSR or even other cortical responses.

The contributions I think we've already touched upon, but I'll highlight some here. The aural immittance measures, as I mentioned, are the best way to evaluate function. If you're trying to determine whether there's conductive loss or them or you're trying to rule out or confirm a sensory hearing loss, immittance measurements are the way to go. I'll always trust immittance measurements.

I'm not going to use the air bone gap to determine whether or not a person has a middle ear abnormality. You can have middle ear dysfunction with no air bone gap and you can sometimes have an air bone gap with no middle ear dysfunction, but the aural immittance measurements will resolve those kinds of discrepancies. But procedures like acoustic reflexes are also very useful in diagnosis of auditory neuropathy disorder.

OAEs, of course, are critical. Actually, that bullet should be a little further out. They are a very sensitive measure of outer hair cell dysfunction. And just about everything that can go wrong with cochlea affects the outer hair cells. There are just a few exceptions which can be genetically based inner hair cell loss. Very rare.

But most problems with the cochlea first involve the outer hair cells, so first they are detected with OAEs. And of course, the ABR has many, many applications, and cortical responses, those should be further out, are also a useful adjunct to the test battery, very useful to supplement the ABR in these other measures.

Okay. In the last few minutes, I'm going to highlight some of the new things about each of these we've reviewed, and by new, I shouldn't say new. In some cases these are features of objective measures that aren't being used even though they have been around and I want to highlight.

The wideband reflectance is beginning to emerge as a valuable clinical procedure. It is a function of middle ear function, and if you're looking at absorbance, how much is absorbed? It's just the opposite, how much is being reflected. So a very high absorbance means low reflectance and vice versa. If you do a Google search you'll be impressed that there's a position statement on it, there are some papers with many, many authors that summarize clinical studies, and I'd advise you to check it out and the next time you're at a convention, like the one coming up in Orlando, stop by the manufacturers who have equipment to do this and learn more about it.

You can see here that the curves, the cross frequency and the measure of the middle ear function at different frequencies, the curves you get are quite distinctive for different disorders. So you can see here a -- the dark black line is a normal curve, so as we increase frequency, the absorbance gradually increases, or if we are looking at reflectance, it would be generally decreasing. And there's a little bump there, a unique little pattern for normal that we don't see with any of the other types of pathologies.

So fixation of the articulate change is different and disarticulation and fluid in the air or then negative middle ear pressure. So different types of middle ear dysfunction result in different patterns in absorbance, and this has great potential for not only detecting the presence of middle ear dysfunction but also in the differentiation among types of dysfunctions. And the big advantage here is you don't need to have an air-tight seal and it's very, very quick, and you're getting information at all these different frequencies.

I'll quickly point out, this is an old concept, but that you can predict hearing sensitivity, roughly, or at least differentiate normal hearing from a hearing loss, a sensory hearing loss, by just using the broadband noise stimulus to record acoustic reflex thresholds.

So the higher the acoustic reflex threshold for broadband noise, the more likely there is to be a hearing loss. And if you can record a broadband noise acoustic reflex threshold, ipsi or contra -- and this can be done in an infant, one or two months old -- if you can do that and get a threshold of less than 80 dB, 75, 70, 65 -- there's almost no chance that that child has a sensory hearing loss, and, of course, if you can record a threshold, there is no evidence of middle ear abnormality.

So this is very valuable and helps you to determine which patient should require a sedated ABR. And I published a paper on this way back in 1982, over 30 years ago. This is not a new concept. Now with the emphasis on earlier and earlier diagnosis of hearing loss, I really do think that predicting hearing loss from the acoustic reflex or identifying hearing loss or ruling it out has some new value.

Well, OAEs, we've already sung their praises. There are so many applications of OAEs in children that you just can't -- you always must include them in the text battery.

This is my grandson Charlie at the age of two weeks. He's now a little over a year old. I get to see them this weekend.

You've heard lot about tone bursts and chirps, it should be around 3,000 hertz, the audiogram. We must estimate hearing at sample hearing, at least, at different places from low to high and the only way to do that is with tone-burst ABR, and chirp ABR is a new development that helps us do that even better. For some reason, the chirps don't always come out. There's some distortion, recording the slides into this software.

But imagine a wave formed where you've got the low frequencies off to the left occurring a little earlier, about five milliseconds earlier, than the very highest frequencies. And the earliest frequencies reach the cochlea first, along the membrane about the same time as the later frequencies are reaching their destination. So as opposed to a click, everything reaches the cochlea immediately and with the chirp you're stimulating different parts of the cochlea at the same time by presenting first the low frequencies, then the slightly higher frequencies, then higher and higher.

So let me just jump right on to this slide. So it's possible to activate, get more activation to cochlea to the stimulus than you normally would, and a more effective activation to cochlea with chirp stimuli results in a bigger response and more air cells and more auditory nerve fibers in the frequency region of interest are actually be activated. And the bigger the response, the faster you can find threshold because you can more quickly determine there is a response at a low threshold without presenting as many stimuli. A bigger response means you can more confidentiality identify thresholds.

So on this slide, if we look down to the bottom of the graph where the wave forms are for the 25 dB tone burst stimulus and the 25 dB chirp stimulus, that's the next to the last two wave forms, you can see that it doesn't look like -- it doesn't look like any ABR is there for the traditional tone burst, but for the chirp, it jumps right out.

So this is where it helped us to more accurately reflect hearing thresholds, and information about chirp is coming out rapidly, so you'll find those at every meeting, and it's confirming. It leads to faster data collection and more accurate data text. We've talked about E cog and I'm going to emphasize that you wanted to be clicking about E cog whenever you have a child that might have auditory spectrum disorder.

They are now being used to validate hearing aid fittings, and this is work of a slide figures, worked on by Anu Sharma who is at the University of Colorado, and you can see the latency of this is well outside the normal region, and then as time goes on with this effective hearing aid fitting, the latency moves right back into the normal range, and you can see the actual wave, she calls it the P1 wave, but most would call it the P2 wave, the delayed responses getting shorter and shorter.

And you can use it in the same way to document the benefits of a cochlear implant or maybe to prove that the hearing aid isn't even the proper treatment and you need to go straight to the cochlear implant. And the auditory latent response can help with those with latent neuropathy to prove that there is some auditory information getting from the cochlea to the nerve to the brain even though the patient has no ABR.

And in the interests of time, I'll quickly breeze by this and this is showing the benefit of using the late response in a patient who is getting no benefit from a hearing aid to argue that cochlear implant is necessary and that would help the child.

Okay. We're at 4:12 and so we have time for questions and answers, and I'm going to just quickly look back here, and it looks like we've got a question from Becky. Can you review specific protocol factors you use to reduce the ABR test? Absolutely. That's kind of how I ended the video, but in the full workshop I spend quite a lot of time on that.

Here are some simple suggestions that each and every one of you can implement. And they're evidence-based. I want to emphasize before I give you the suggestions, we're not cutting corners in the sense that we're saying, well, we're going to cut test time but we might not get the same results or we can't be quite as confident in the results.

So first off, we know that you have to be very organized in performing an ABR. You have to be looking at the clock, very cognizant of time. So try to be thinking ahead, always. Have everything ready when the patient shows up. So you've got all the supplies and everything you need, the demographics are in the computer, and this is even true in the OR. The moment that child is quiet, whether it's the first time moment that they're anesthetized or the first time they fall asleep, you are collecting data within seconds.

Using a fast, faster stimulus rate for tone burst is a simple, simple way to speed up test time. So you really don't want to be using a stimulus rate any slower than 35 a second. I usually use 37 or 37.7. If you were using a stimulus rate of 11 a second, which people used for years, that's going to result in three times longer test time, all things being equal, to using a rate of, say, 37 seconds.

The other thing you want to do, when you see a response, when there's a wave 5 and it's in the proper latency region and it looks like a wave 5 and you repeat that wave 5 and it's still there, even though other activity in the wave function doesn't repeat, this does. You can stop averaging. You don't need to go to a fixed number of 2,000 or 3,000.

Instead, look at the response you're recording, the wave 5, in addition to all the background activity, which is just noise, and once you get a signal-to-noise ratio or background to activity ratio, you can stop. There's no value in going on, particularly if you're at a higher intensity. Your goal is to estimate hearing thresholds. The most important ABR you record is the one you record at the lowest level that produces the wave 5. That's what you should use more average.

So those are just simple little techniques, faster click rate, being more organized, not wasting any time, thinking ahead, and don't average any more than you need to average. The chirp stimuli, we can now throw those in, that technique in to increase test time.

And when you're doing ABRs, get a colleague or a child or six or seven and practice doing ABRs as fast as you can. Live a little on the wild side and don't estimate 2,000 or 3,000. Stop when you get an ABR and stop. You'd be amazed at how much time you can save. Things like good impedance and a quiet child are also very, very helpful in speeding up time.

Jessica has a question. With a conductive hearing loss, how do you use your bone conduction clicks to help you diagnose hearing loss? Are you just looking for the difference between bone and air? That's my first goal. My first goal is to answer this question. Is there any evidence of a conductive loss?

Now, notice I didn't say any evidence of middle ear dysfunction. If I want to know if there's middle ear dysfunction, I'm not going to use bone versus air ABR. I'm going to use tympanometry and acoustic reflexes. That can be done in any child. Even OAEs will help rule out middle ear dysfunction. If OAEs are present and normal, amplitudes in normal limits, there's virtually no chance of abnormal.

So is there a middle ear dysfunction that might be creating the conductive loss? What I do is I'll start with -- I've already done air conduction and found threshold with clicks.

Let's say I found it down to 40 dB but not at 35 dB, and I've got a delay in the wave 1, so I think there's a conductive component. I then start with bone conduction around 40, 45 dB, NHL, where I normally -- a group of normal hearing people would just hear that bone conduction click.

When you are using equipment, do not assume the intensity level on the screen of the equipment is equivalent to db NHL. It's probably not. The equipment may say you're at 70 dB for bone conduction, but that's impossible. That 70 dB on the screen probably corresponds to 40 or 45 dB, so if even if you don't have any norms, behavioral norms for bone conduction, clicks that you're using with an ABR, you can quickly, if you have normal hearing, get a quick estimate.

Anyway, I'll start it, try to get away at 5. Try to get a wave at 1. If I can get a wave at 1, that wave 1 is being detected by the electrode on that air, I know that response it coming. It's like doing an E cog. It must be that auditory nerve responding. So then I quickly drop down.

My goal, when I do bone conduction is to determine, is there an air bone gap that requires medical knowledge. So unlike some audiologists, I never do bone conduction for toddlers. I can almost always answer my question, is there an air bone gap that requires medical management by using airbonic for click. And if there is a difference in the threshold or I can look at the latency, find a comparable latency by bone conduction.

So looking at wave 5 and if there is a latency that's the same for air and bone, I need to know how much more to be the same latency with air and bone, and I know I've overcome that and that produces the same latency, that's your air bone gap. So mine in doing the bone conduction is limited.

Is there a conductive loss that requires medical management? I use the cross-check principle, and that's just one way of using tympanometry, reflexes, and OAEs to help me determine, plus any history.

Now, there's a lot of work on bone conduction and there's a faculty member at the University of British Columbia in Vancouver, Canada, and you can find some excellent recent articles and older ones on bone conduction that will augment the answer I gave. Becky asks a question, is there an ideal time to give this test, and I worked with an otolaryngologist back in the '80s, when I was at the University of Texas in Houston, Bob Jarster (phonetic), and he is retired now, a world-renowned expert on surgical repair of aural obtrusion. And he would see hundreds, hundreds of patients, and they were coming in on a regular basis, a couple a week.

So I really refined my ABR technique, and the ideal time to do a bone conduction, while the child is still in the hospital before discharge. If not, bring them back within two to three months after they're born at the latest when they don't need to be sedated and immediately do air bone, both ears with click stimuli.

The goal here is to prove that the aural, which could be a 40 to 55 dB loss is not effecting the cochlea, and many of your syndromes and nonsyndromic will have the inner ear. Cochlea develop separately, and you need to have two embryo logical problems at the same time to have a sensory component to the hearing loss unless, of course, the child needed to get ototoxic drugs on top of the intrusion. So the earlier the better, and why is the -- why am I emphasizing do it in the hospital if you can before the child is discharged or very soon after? Because that information will be valuable for management and also very reassuring to the parents.

If I have a child, a patient, who has aural obtrusion, I can prove that bone conduction ABRs are present at 5 dB, 10 dB, and there's a conductive loss by air conduction, then I know that child could benefit from a bone induction hearing aid, perhaps a Baja, or I would definitely recommend to the parents that think about surgically repairing the child's aural problem at some point, but even if one of my grandchildren had otoatresia, I would offer that as a problem, and the otolaryngologist would create an external ear canal and most with a good outcome would be normal hearing sensitivity for the rest of their life.

Okay. That's the question I just answered. Are there any other questions? We have another five or six minutes. Okay. Thank you, Becky, for asking these questions. She's typing now, I think. If I miss a question -- I did miss one. Where do you place the oscillator? I would assume in a bone conduction test. Good question.

First of all, the oscillator can be anywhere on the temporal bone. So in one of my slides I show a skull with a temporal bone, but you can find them online or in textbooks. It goes quite a ways above the ear, and you don't need to be limited by the mastoid bone. We use that in doing bone conduction because it doesn't have hair on it because we're testing adults, but you can hear equally and this faculty member, Susan Small, has proven it. You get the same good results.

By the way, when we're talking about aural atresia, it's not just because they don't need sedation, but the temporal is not fused yet with the bones of the head, so the energy just doesn't get to the other side, or if it does, it's very much attenuating and almost none of it gets to the non-test ear.

So I put the oscillator as far away, somewhere on the earlobe and put the oscillator -- if the child doesn't have much hair, that's another advantage of doing an infant, you can put it anywhere on the temporal bone and get the same good results as on the mastoid. You wouldn't want to place it on the forehead, although it's feasible, because you have a ground electrode up there, the ground electrode plus the noninverting, which is really the active electrode, you might say, so then you're going to go out of contact.

At what age do you use contralateral masking for ABR, Charlene asks. If I'm conducting the bone ABR and I get a reliable wave 1 and wave 5 and the response at higher levels and I'm confident that's wave 5 and maybe I did one simultaneously and there was no wave 1, then I don't do bone masking.

If I get a wave 1 on the ear I'm stimulating, the electrode on the ear I'm stimulating, I know that's the test ear. Now, you can use contra lateral masking at any age. There's no argument against it, and I always do bone construction with the insert ears already in there. Don't take them out. Keep them in and do bone construction.

That's another thing that Susan Small proved, the infants have no occlusion effect, you'll get the same results, probably better, with the insert earphones, because you're attenuating and you can use contralateral masking at any age.

The problem, is you don't know how much to put in. If I have a unilateral hearing loss, I put in 60 dB of masking and leave it at that. That 60 dB of masking with inserting earphones is not so much that it will cross over the test tube, but it will effectively mask hearing losses up to 40, 45 dB, maybe more.

So you can use masking at any time, but it's only really needed when there is no clear repeatable wave 1 when you're stimulating an ear and you have an electrode on that same ear.

I think we have time for maybe one quick question. Maybe not. We'll let our organizers decide. You know how to reach me by e-mail, so if you do think of something after the fact, certainly, you can do so.

I'll take this opportunity to thank all of you for joining this educational opportunity. If it's a success, and it seems like it is, we'll hopefully be doing another like this. It's another way of getting efficient information without getting on an airplane and traveling and leaving work for a few days. So thank you, one and all, for joining this presentation.

>> MODERATOR: I'd like to thank Dr. Hall.

>> Go ahead.

>> MODERATOR: For the fantastic session. There will be an e-mail link sent out with a survey and the link for a certificate of attendance for CEO purposes. Doctor, anything further?

>> No, that will go out shortly for the survey. Please complete it. It's very brief. And then you'll be given a separate e-mail to include your certificate and a copy of the handout for the video.

>> MODERATOR: Okay. And I'd like to thank Dr. Hall again for a great live presentation and a great recorded presentation. So it's a classic, I think.

>> SPEAKER: Thank you.

>> MODERATOR: And also attending. We'll be sponsoring another Webinar in February, and the topic will be Behavioral Diagnosis of Infants. So thanks again for attending, and that concludes the Webinar.

>> Thank you.

(End of session at 4:30 p.m.)