**MCHB/NHS September 22, 2006 Webcast**

**Audiological Diagnostic and On-Going Assessment for Infants**

KATHLEEN WATTS: This is Kathleen Watts. I would like to welcome all of you who have joined us for this webcast. Today we're fortunate to have three great presenters. Some of you may have seen at least two of these people and some of you may not, but the first speaker that we'll have will be James Hall who will be talking about and presenting information about diagnostics for infants. And then Roger Ruth will be sort of following up on the same topic. And then Diane Sabo, who will be addressing more along the lines of what you do after the child has been diagnosed. So behavioral assessment, cochlear implants, hearing aid fittings.

For those of you who are on the call and not just on your computers, you need to be sure to keep the phone on mute. And at the -- the best way to get the questions to the presenter are to go through the instructions on screen and follow it that way. If you are one of the people who could not be at a computer at this time, if you would wait until the end of the presentations and then ask your questions, that's the way we'd like to work this. So having said that, I guess I can turn this over to James now for the presentation.

JAMES HALL: Did you say my name, Kathleen? There was a beep just as you were saying it.

KATHLEEN WATTS: Yes, I did.

JAMES HALL: Welcome, everyone. I don't know if anyone else is experienced with webcasts but I can say for myself that I've never done one. So if this goes off smoothly I'll be mildly shocked. I'm going to just provide a quick overview on the electrophysiologic diagnosis of hearing loss from the slides downloaded on the website. When I finish with my review of this topic, if you have any questions about the topic, Dr. Roger Ruth might be able to answer them in his presentation, although that's highly unlikely. But we'll have time for questions at the end and I actually have read some of the questions that Kathleen has emailed to us and they're interesting and I'm sure they'll generate some really good discussion. As you know, for the last four or five years we've lived in the era of universal newborn hearing screening. We're challenged to diagnose hearing loss in children at a younger age than many of us thought possible.

We're screening children in the hospital before discharge and having to essentially document their auditory status no matter what their problem within the first few months after they're born. We can't wait around, of course, to accomplish this important task because intervention, as people have demonstrated, intervention must start before the child is six months old. There are really two techniques that are essential now for documenting hearing status of infants and then there are two or three other techniques which should be included also in the test battery. The two essential tests are auditory brain stem response and the auditory steady state response. Both techniques are similar but certainly there are some distinctions. The other techniques in the test battery for that

very, very initial assessment or first few assessments within the first six months are, of course, auto acoustic emissions and very emitence measures.

My short introduction will focus on the ABR and the auditory steady state response. If you'll go to the second slide, let me highlight a few of the important basics regarding the ABR. Number one, everyone evaluating children with ABR should be utilizing insert earphones. There is only one type of patient for whom insert earphones are not appropriate. The child who doesn't have an ear canal. Other than that insert earphones are clearly the standard of care for doing ABR in children. In my opinion and maybe we'll have some discussion about this later, I think there is a very important role for both click and tone burst signals in evoking the ABR. The click signal, although it's not frequently specific can provide valuable diagnostic information in a matter of a minute or two. With a click ABR we're familiar with the waveform and know what the latencies should be for each individual wave, wave 1, 2 and 5 and the intervals between those waves and we have 30 years of experience with this and millions and millions of babies, we can quickly differentiate among the major type of hearing loss with the click ABR.

Normal hearing, sensory hearing loss or neural hearing loss. With the click we can recognize almost always recognize auditory neuropathy by detecting a cochlear microphonic. It is an excellent beginning to a pediatric ABR. The tone burst signals, which are available on any piece of equipment you would now purchase and even some of the older systems, are essential for at least estimating hearing sensitivity throughout the audiometric frequency. And even though we live in a time where there is the auditory

steady state response, the tone burst ABR has -- continues to have real value in the estimation of hearing loss in children. In fact, I don't have time to cite specific cases in detail but just within the last week, this happens almost every week as I record both ABRs with tone burst and ASSR I run into discrepancies in findings, major ones, only detected by the use of both ABRs and tone burst. I would recommend the ASSR results you get on children be validated with tone burst ABRs or vice versa.

In the air conduction, bone conduction stimulation is also feasible and has been used for over -- close to 30 years and is very useful clinically. Obviously it's important for us to differentiate between sensory and conductive hearing loss in infants. The management is very different. The impact on communication and speech and language development may be different. So that should be done and can be done. So you'll want to have in your test battery up your sleeve of techniques that you're comfortable with bone conduction ABR techniques. And then I'll just mention while we're talking about bone conduction, masking. Masking is, of course, the bain of most audiology students and even some Audiologists. You wonder how can you make decisions about the level of masking necessary in doing an ABR. If you can obtain a clear wave I component from the electrode located on that ear you've essentially performed electro cochleagraphy and documented that the test ear is actually the ear that's producing the response. The wave one is generated by the auditory nerve near the cochlea. If you're stimulating one ear and have an electrode on that ear and detect wave one you don't have to put masking on the other ear to prove you're activating the test ear. There is nothing wrong with using masking in the other ear but for some children it may not be possible to get the right amount of masking into the other ear.

Moving on to the next slide and we're really skipping over many of the important stimulus parameters that we could cover, if you want to read more about that I have an excellent textbook that I can recommend to you that will be coming out in November. And I would be happy to email anyone a flyer. Moving right on. Acquisition parameters you see are standard for ABR with a few exceptions. For infants you always want to include the low frequencies. You notice the high pass filter setting HP filter setting in the slide is 30 hertz. 30 hertz encompasses low frequency energy known to dominate the infant ABR. And as we get into tone burst stimulation for ABR we'll encounter even more low frequency energy. That's important and not using the notch filter is equally important. That removes frequencies around 60 hertz but that's exactly where a lot of the energy is in infant ABR. How many stimulus you should present is determined not by some magical number like 1500 or 2,000 but instead by the signal to noise ratio. The size of the ABR you're recording in comparison to background noise. At high intense tease in a quiet infant who has reasonably good hearing you shouldn't have to present more than 300 or 400 stimuli before you'll see a nice, clean response.

In continuing the stimulus repetitions beyond that is just a waste of time. You want to present enough stimuli to produce an adequate signal to noise ratio but no movement as you get near threshold you may need 1500, 2000 or even 3,000 to detect the response. I mentioned insert earphones a moment ago. I won't go through them in detail but I have in the next two slides some of the advantages of using insert earphones. There are so many that you just can't avoid using them. It's really essential to use them in infants. Skip down

to the slide that says pediatric ABR analysis principles. Let's assume we've used a good protocol and we now, of course, have 30 years of experience with ABR leading us to a very useful protocol that works with infants. You use the right protocol you're 80% toward getting a good ABR right away. Let's say we've done that and haven't run into any technical problems or if we have, we've solved them. And now we have an ABR waveform that we're ready to analyze. Of course, with the traditional ABR using click stimuli or tone burst stimuli the operator, the tester, the audiologist in most cases actually is doing the analysis, it's not automatic.

Well, again, if we were using a click ABR we can immediately begin to get diagnostic information from the analysis within the first few minutes of the ABR session. Delayed wave one almost always means conductive hearing loss. And with conductive hearing loss when the cochlea is normal, once you have a high enough stimulus intensity to overcome that conductive loss the waveform morphology, the appearance of the wave is normal looking. The wave one is clear and reliable. At the distinct difference from a sensory hearing loss where the cochlea is abnormal where even at high intensity levels particularly with a severe loss, the morphology or appearance of the waveform is very abnormal. It may be almost impossible to detect a wave one. So if you record at a high level a very small or absent wave one it almost always means there is a sensory hearing loss at least up in the high frequencies. Obviously if there is a wave one and a wave two with the latency between the wave one and Wave V it exceeds what you would expect that would be a sign of a neural disorder.

I mentioned age. That's very important with infant ABR analysis. The ABR is not mature until 18 months so therefore any time you're evaluating a childless than a year and a half old you need to take age into account as you analyze the latencies for the response. Just to give you kind of a ballpark figure, when a child is born at term age 40 weeks, gestational age the one to five interval should be five milliseconds whereas with an adult it's four milliseconds. But we do expect delayed interwave latencies and delayed absolute latencies for infants. Always take age into accounts. Typically once we've identified each of the components of the ABR for a click at a high intensity we've analyzed the absolute latencies for wave one, three, five and the interwave latencies and made our differentiation between conductive, normal, sensory and neural or maybe mixed, then the next step is to drop the intensity level down to estimate threshold.

Another way you can save time, time which can be then be used for collecting more data, is to quickly drop down to posted threshold. If you see a good response at ADDB all the waves are apparent and the latencies are normal there is no sense in going to 70, 60 or 50. You can drop right down to 40 or even 30. And if you're a gambling type you might even go down to 20DB and still see a good response. Always attempt to record a response down to 20 DB unless, of course, it's not apparent at higher levels, because getting down to 20 decibels and still detecting a wave five will help you to rule out any communicatively significant hearing loss. If you decrease the intensity to 35 or 40 DB and don't go lower, you still could be missing a child with a 25 or 30 DB hearing loss which would affect communication. If you can record a clear wave 5 down to 20 DB and the latency within normal limits for click and tone burst you can essentially rule out serious

hearing loss in that child. As a rule, the way we normally record ABR clinically the behavioral threshold for the child or any patient will be about 10 DB below or better than the lowest intensity at which you record a Wave V. If you can record a Wave V down to 20 DB you're saying there can't be more than a 10 DB hearing loss in that range. Take age into account as you're analyzing Wave V or interwave latencies.

As we move from just general ABR protocol to frequency specific some of the parameters are shown on the next slide. The insert earphones, tone bursts as your type of stimulus and four audiometric frequencies. Clinically I always want to make sure I've recorded an ABR at 500 hertz and at 4,000 hertz out of the extremes of the speech frequency region and one or two frequencies in between in addition to the click. You might say we don't have that much time in our clinic. But if you're using your time effectively and not over averaging at high levels and not wasting time between intensity levels and if you're always averaging, never just sitting looking at the screen or thinking about what to do next, in a normal hearing infant that typically takes between 20 and 30 minutes to evaluate an ABR. Obviously when there is a hearing loss when you need to use bone conduction, when the thresholds aren't the same at all frequencies will take longer. 45 to 50 minutes will help you to estimate hearing frequencies and use bone conduction stimulation if there is tone loss. Normally it's referred to in cycle, two cycles of rise time, no plateau. That's what the zero stands for. Two cycles of all time. This minimizes the spectral splatter or the unnecessary frequencies and still produces a true frequency specific stimulus and a reasonably good-looking response. We typically use rarefaction -- but for frequency specific stimuli you can use alternating or rarefaction. The stimulation rate is a factor that

you need to consider. The faster the rate, the better as long as it still produces the optimal ABR. Using a rate of stimulation in the high 20s will quickly get you an average response. If you're using 1,000 or 1500 stimulate for most of them and in less than 30 seconds you'll get a nice response. You'll still typically record a high-quality waveform. If you were to go up to 75 or 80 stimuli per second the waveform would begin to deteriorate in young infants and you lose that advantage. On the other hand, if you drop down to 11 stimuli per second you would just be unnecessarily wasting time because you would be collecting data at 1/3 the rate of 27 to 30. You gain nothing for it.

Intensity. We could talk for a long time about intensity but the bottom line here is that we have no way at this point with most commercially available systems, of estimating the intensity level in the ear canal of the child we're testing. What we do with intensity is essentially biologically calibrate the intensive level of our systems using a normal hearing adult and then that number for threshold in normal hearing adult becomes our reference for intensity with infants. There are flaws with this strategy involving the size of the ear canal and therefore perhaps greater effective intensity in infants but it's used universally and doesn't seem to produce serious errors in the child's ear. So you as a clinician need to document the intensity levels of the stimuli that you're using, that means tone burst, clicks and bone conduction clicks. With a group of normals in your clinic where you'll be recording the ABR in your system and then once you've established 0DB NHL you'll use that with all your patients. Moving along to the acquisition parameters, I won't repeat what I've said about these already except to say that when we get to tone bursts, particularly for the lower frequencies like 1,000 hertz and 500 hertz the ABR is generated in a more -- the

traveling wave time to get to that point will add to the latency of the response. The worst case scenario if you're evaluating an infant that is not mature, a term infant and using a low intensity 500 hertz or 1,000 hertz tone burst the latency in a normal infant may be as long as 10, 12 or 13 milliseconds. The analysis time should be 20 milliseconds in order to encompass the entire waveform including the Wave V and the trough that follows Wave V. Few routinely use ten mill seconds time you'll be very discouraged because you won't see low burst. They'll be beyond the time frame that you're using. That's an important distinction between frequency-specific ABRs and click ABRs, a longer analysis time. As I near threshold I'll use at least two runs or two separate waveforms and sometimes three to verify there is a response there. Reliability is very important in infant ABRs particularly near a threshold.

Electrode locations we've gone over. It's my opinion, not everybody would agree, that using a non-inverting electrode up on the high forehead, middle of the forehead is perfectly acceptable with infants. You don't need to have an electrode on the top of the head. You want an electrode near the ear. I'll put it on the ear lobe, not on the mastoid. Because the ear lobe will produce a slightly larger wave I. It's easy to scrub and attach an ear lobe electrode. Filter settings we've already discussed.

Moving on to the next slide just to comment that there are many very well-conducted studies by a person cited in the slide and good researchers, who have demonstrated without doubt that it is possible to record frequency-specific ABRs and to reasonably get close to behavioral threshold by using these frequency-specific stimuli. So there is a

strong research and clinical history for the use of frequency-specific ABRs in infants. I'm going to skip over the steps and calibration. I've mentioned that. Basically use the protocol that -- the kinds of protocols we've discussed. There are many sources for that information. Most of you have taken workshops where good protocols have been described. And then make sure that you've estimated hearing used -- for your stimuli in your clinic with your equipment. Find a young infant or two, practice on them and you'll be off to a good start. And remember, in this day and age, 2006, the -- it's not acceptable to rely exclusively on a click. You must be using tone burst to estimate hearing threshold. Quickly talking about bone conduction, the protocol is somewhat different than what you would use for air conduction. You need a bone vibrator that is dedicated to your ABR equipment. Sounds like somebody's hearing aid is creating a little feedback. B70 or B71 vibrator but make sure you're only using it for ABR. It should be placed on the mastoid but doesn't need to be placed right next to the ear. It's good to separate the electrode, which is located on the ear, and the bone off the ear which can be located an inch or inch and a half behind the ear still on the temporal bone. One advantage of an ear lobe placement for the inverting electrode it allows you to get some distance from the transducer, remember this little piece of plastic, the bone oscillator, will generate all kinds of electromagnetic artifact if the electrode is close to that. The other way to reduce it is click.

Using bone conduction sometime lace we want to slow the rate down. The slower the rate, the bigger the wave I. Recording a wave I from the channel with an electrode on the stimulus ear is critical to determining that the ABR is ear-specific. So everything you can do to record a wave I you should do. Just as the low frequencies were necessary for tone

burst and clicks, air conduction clicks in infant are very important for bone conduction stimulation. Keep that high path setting down at 30 hertz if you possibly do it.

Moving on to the next slide, we'll talk about the auditory steady stays response very quickly. The auditory steady state response has been around for a good solid 20 years described in the early 1980s but not until the era of universal newborn hearing screening that there was a great demand for -- even in children with severe to profound hearing loss. That's one of the big advantages of the ASSR. Since we're using tonal stimuli, we can get up to intensity levels of 120, 125 DB.

The first slide, the general principle slides makes that point. The actual response that is being detected automatically by the equipment is actually being generated by the very rapid change or modulation, in either the amplitude and/or the frequency of this ear tone signal. The pure tone signal is activating parts of the cochlea, the 250 hertz region but the response that's automatically being detected is not being detected from the cochlea, it's being detected from the brain, the brain stem or cortex and it's energy that is being produced by this modulation of the stimulus. Most ASSR devices permit automatic detection of the response. It's at first a very appealing advantage of ASSR over frequency-specific ABR. You don't have to learn how to interpret waveforms. Nothing is gained without something being lost. Without seeing the waveform you lose a lot of the diagnostic value of ASSR. It's impossible by just recording ASSR an analyzing the response to differentiate between a conductive loss, a neural loss and a sensory loss. It's impossible to

differentiate from an auditory neuropathy where there is no response from a profound sensory loss when there is no response.

I won't go into how the ASSR is analyzed. There are just two approaches that are most common. One is the phase of the response in the brain produced by the modulated amplitude or frequency. Phase of the response as compared to the phase of the stimulus. The other approach is a spectral analysis of brain frequency and that's illustrated in the slide on the left. The regions of the cochlea and the brain spectrum on the right. The clump of energy, the lower frequency region is the ongoing EEG brain activity. Then the lines in the higher frequency regions correspond to the energy at the modulation frequencies used to elicit the state. There are articles and entire issues of certain journals like the JAAA devoted to the ASSR and actually I've got a big section on the ASSR in my new book. Notice I'm just slipping that out. There are actually some total entire books devoted to the ASSR which are written as we speak. I'm going to stop at this point. I'll conclude by saying that as we consider our different test techniques for evaluating hearing in infants, don't ask the question which technique is better than the other, which one should I use exclusively. Think in terms of a test battery where you are maximizing the value of each of the major electrophysiologic or objective techniques. OAE, measurements, ABR and ASSR using all four but relying more on one or the other, depending on the degree of hearing loss and type of hearing loss in the infant that you're evaluating. So I'll conclude my formal remarks at this point. And are you there, Kathleen?

KATHLEEN WATTS: I am here.

JAMES HALL: I was beginning to think that maybe I had been cut off and been talking to myself for the last 20 minutes. How unusual. [LAUGHTER]

JAMES HALL: I'm going to stop there and I'll be around. I'll probably take a little nap while Roger is talking but I will wake up and be around for questions.

KATHLEEN WATTS: Okay. That's great. So any of you who have any questions on James' presentation or other things that, you know, hit you as he was talking, go ahead and keep those questions. You can type them into your computer and use the webcast system. If you'll hold onto the questions until the end, then we'll answer everything at that point. And now I would like to turn it over to Roger Ruth. Roger also presents in our workshops on infant diagnostics. So Roger.

ROGER RUTH: Okay. Thank you, Kathleen. You know, actually, I'm almost speechless. I did say almost. But both because I agree with most everything that James said, so some of my slides will be a little redundant.

JAMES HALL: You actually took those from me, didn't you?

ROGER RUTH: And secondly, because that was the longest 10-minute talk I've ever heard. We'll try to make up some time.

JAMES HALL: Not the longest 10-minute talk you've ever given, though.

ROGER RUTH: No. Anyway, the first of my slides that says the one thing that you need is membership in the international peak pickers association, the IPPA. The reason we note that, and James had mentioned this as well. When using ABR clicks and particularly with tone bursts and low frequency tone bursts in infants near threshold levels the waveforms you see will look very different from those that you're accustomed to with the click stimulus at a high intensity for normal hearing adults. You have to develop some pattern recognition skills to know when you're viewing a 500 hertz tone burst response in an infant in particular you should look for certain types of waveform patterns and that those would be characteristic of either normal or abnormal response. Part of that is just kind of getting used to the process. And if you move down to the ABR response parameters Jay has mentioned this, I have down the electrode placement CZ which is on top of the head and I would agree as well there is very little difference between using a CZ as opposed to a high forehead. CZ may be a teeny bit larger but insignificant for the types of testing we're doing. We often use a CZ response.

This might be a good time to mention the types of electrodes that you could use, Jay had mentioned putting electrode on the high forehead and at each ear lobe. Depending on how you're testing these kids, how old they are, for example, if they're older than, say, five or six months. We'll talk about issues in a moment. In some cases you need that under the guidance of a nurse anesthetist. Then we can use needle electrodes and they are -- it sounds more invasive but are less invasive than using -- than scrubbing the skin to try to

get a low enough and balanced impedance on the electrodes. The averaging window I would agree with Jay as well, sometime between 15 and 23 milliseconds or so in that vicinity. Certainly the longer windows for the lower frequency tone bursts in an infant as you get near threshold, which would sort of -- because we've all been taught, especially people like Jay who have been around longer than most of us, that the ABR occurs 10 milliseconds following stimulus onset. But those conditions are not the same as those that we encounter with infants, of course. We also use a stimulus delay so we start the average usually about two to three milliseconds after the sweep starts and you do so by just typing in a negative number into the delay window on most of the systems that are available. Anywhere between one, two or three milliseconds. It gives you a little bit of an idea of what the baseline is like. Allows you to see any stimulus artifact and to know that events that occur thereafter helps a little in identifying cochlear microphonic there. Artifact projection of course should be used and notch filter.

And one thing I would like to mention is the display gain. That is how large the waveforms are on your screen, it is surprising to me that I still encounter people who say do I have to leave it set at that particular display gain from high intensity to low intensity without changing it? I would argue that's not the case. You're really looking for patterns of response so as you get near threshold and as that response becomes smaller, you can, in fact, increase the display gain because it remains -- your system remains in calibration in terms of microvolts on the vertical axis. But it allows you to see if there is a replication of the response. So go ahead and increase or decrease the display gain as necessary. If you go to the next slide with the stimulus parameters Jay referred to most of this using the

non-linear envelope of blackman or -- usually blackman. Wanted to mention something to follow up on what Jay said about intensity and requiring a biological calibration for either the click or the tone burst that you're using, whatever stimulator you're using under those same conditions, we do not have ANSI standards and I guess I'm partially responsible for that. I think Jay is on the committee so he's also responsible. In 1983 ANSI established a committee to develop calibration standards for these kinds of signals for ABR and the potential testing and we were unable to do so over about the next ten years while I was chair of that committee and another man has since taken it over and we still don't have a standard so it's his fault as well. But nevertheless, that does require that we use the biological calibration as Jay said. It turns out that a 0 DB in HL or normal hearing level which is assigned to that non-ANSI standard designation is about 35 DB or so pressure level. For a click and 20 to 25 for a tone burst. But you'll be just looking at the actual dial settings and establishing a biological calibration in that manner until such standards are available. If you jump down to rate as well, we use a slightly faster rate than Jay had mentioned. We were using rates around 27 and 28 as he was for a long time and I guess over about the past year we've increased that to the 39.3 per second and close to the 40 hertz for middle latency responses that were talked about in the early 1980s. That allows us to, of course, accumulate these waveforms quite a bit faster and still have the resolution we need, the faster the rate, of course, the less clear the waveform, the poorer the morphology but we've been able to do it pretty clearly up to about 40 so above that it begins to look a little bit less clear. But anywhere in that vicinity as long as you're fairly consistent. That will change the pattern of recognition. Again, if you're going to put the surface electrodes on for the younger kids especially, then obviously do so, we do it

before they go to sleep and before they feed and if you have them -- the parents sleep and food deprive the child which is the bain of parents' existence. On the ride over to the clinic that's one of the most tranquil times that the parents have. If you get them to keep the child awake they might go to sleep under six months of age in our experience. And using inserts the right size. One of the questions that somebody has is what size inserts and they fall out from time to time. Occasionally we have to put a little piece of tape across the insert across the ear to hold it in place for some kids but finding that right size, you know, is necessary. As Jay mentioned, knowing whether the response is neural or not.

In the next slide, whether if you reverse polarity, a rarefaction click, you can change it to condensation and anything that changes from a positive to a negative value at the same point in time is not a neural response. Neural responses are a relatively not sensitive to the polarity of the stimulus.

And if you jump to the next slide, finding a Wave V that's clear and decrease intensity, I would agree with Jay, we usually move in 10 DB steps but if you see a clear response at a high level. Go ahead and drop down. We like to see a few levels, though, of sort of a latency intensity function without repeating, I think as Jay mentioned as well. If you get a clear waveform at 60 DB, you can do so with fewer than 2000 stimulus presentations, maybe that's between 500 and a thousand if it's a normal system. Maybe drop down to 40 DB and obtain another one. When it's clear to you, continue going down. You need to replicate the response and that's what you'll rely upon to determine if it's there. Sometimes if you go down below threshold when you do not see response it can help you identify the

level just above that is, in fact, threshold. And the question of masking. Jay had indicated you may not -- you probably don't need to mask as often both because of the use of insert transducers and because of the -- the infants that you'll be testing have greater intervention. In some cases it's safe if there are high levels of stimulation to use a little masking. We just put in broadband noises 20 DB below the stimulus presentation.

And let's see, the next slide if you're finished with the ear connection. You see that down to 20 is -- as Jay mentioned, that's very likely indicating hearing within or near normal limits and probably not as significant. That's partly what we're trying to do, of course, is separate those kids who need more follow-up both in terms of additional testing, including behavioral testing as well as intervention from the kids who are less likely to have a very debilitating in terms of communication type of hearing sensitivity. And then bone conduction as well. And I have on slide 43 here the reasons not to wait for doing bone conduction. People say maybe we should wait and see if things change. Bone connection is a little harder to do. You have to figure out how to hold the bone vibrator in place. You don't want to mass load it. If you grab it too much you'll mass load it and squeeze it too tight or place it with too much force. The ANSI standard for the testing is 550 grams of force. In head band can precisely do that on an adult routinely but nevertheless just trying to -- not to mass load it too much. And we -- let's see, jump down to maybe 45. So for tone burst testing whenever possible obviously when the child is still sleeping, if there is a problem that's noted, any threshold above 20 or so by click stimulation you need to follow up with tone bursts to determine the nature of the configuration of the hearing loss and the frequencies as Jay mentioned, looking at those usually after doing a click we'll generally

look at a low frequency. 500 and a low frequency, 5,000 and fill in the middle as well. We also do tone burst testing even if we see more normal ABR, we see a response down to 20 in the presence of patients who -- kids who are receiving chemotherapy or have a family history of hearing loss, speech delay or maybe behavioral results disagree with our findings and this 547, why do tone burst testing, slide 48. This is why. It's one of our patients.

Slide 49. This is the ABR for this child and you can see there that the response fairly nicely is the intensity function. Response replicates at 20 DB in HL. This child happened to be receiving chemotherapy. That this -- that this is perfectly normal. Then we did a 2000 head tone burst at time of response and threshold down to 50 DB and went to 4,000 and found a response at 80 DB and did a sound field audiogram. The high frequency hearing loss there. We communicated those findings to the physicians who were administering the chemotherapy and they, in fact, because of her response to the chemotherapy, had been so positive at that point they came out in order to preserve as much hearing as possible. So even in those cases sometimes it's even if the click is there it was relying more on the lower frequencies for that threshold and it is still good to have it in your S battery the higher frequency.

Slide 53 talks about the accuracy and Jay had mentioned that most of the responses in previous studies had been found to be within about 10, certainly within 20 DB. Slide 54 is some data from a couple of my doctoral students who were comparing the audiometric findings at 5,000 and 4,000 hertz in this case to tone burst ABR at those same

frequencies and we find a pretty high correlation for the 4,000 and .84 for the 500 hertz. We also did in that study the steady state response for the same frequencies and found a poorer correlation overall. Really it didn't do exactly what we had expected it to do. This was actually in an adult population. Then we compared the ABR to the steady state response and found -- these are also significant correlations in all cases but it looked like the tone burst ABR did a better job of predicting hearing sensitivity in this population, anyway.

Slide 57 is actually a slide from Jay that shows the relationship between -- hypothetical relationship between steady state response and pure tone thresholds and shows that as most studies have found, that there is a -- suggests a better correlation generally with more severe or profound hearing losses of the greater degree of hearing loss the more likely the steady state response is to predict a more accurate behavioral threshold. When we get down to normal hearing or mild losses it's more variable and will tend to over predict a degree, over exaggerate.

Then slide 58 can we test infants without sedation? Certainly we can and we find, as most of you have found as well under about six months of age, as long as you have the parents keep the child awake and in a fairly good state you can test them usually without sedation. But over six months it's more problematic and as they approach a year it's -- it really is a problem. Under three months almost never. I should mention on slide 59 just to note that American Academy of pediatrics and anesthesiology agree you need to focus attention on the types of -- what you're doing when you're giving sedation for these things. In the old

days at the University of Virginia hospital I had my own drug box at the pharmacy that said Dr. Ruth on it because I'm addicted to anything but in that we had various chlorohydrate and various narcotics that you would have the nurses give to the child. We didn't give it to them but it was part of audiology. We shouldn't have done it then but didn't know better. Children should receive the same standard of care receiving sedation and monitoring those under general anesthesia. Airway crash carts and all kinds of things have to be available and the personnel doing that has to be there as well. Slide 60 is the ideal characteristics of any sedation that's used and that is these are obvious, it should have a rapid on set, short duration. Rapid recovery, so forth.

And if you jump down to slide 62, which is levels of sedation, I just wanted to point out as well that really the sedation -- the various levels of sedation from nothing to general anesthesia are on a continuum. You can achieve a general anesthetic state with something like chlorohydrate and Jay has done so with alcohol for himself before but basically depends on how much you get. It's not safe to do so with these things but it depends. What you have with a conscious sedation is someone who is easily aroused either vocally and by sound. That's a state we don't want. We really need is a deeper hypnotic dose in which case the individual is not easily aroused because we're presenting sounds to them and we don't want them to wake up while we're doing so. But at the same time their airway -- when they're in a deeper sedation they're more susceptible to airway obstruction and morbidity as a result. So I think the last two slides are just sort of -- make common sense, I think. I'll sort of end mine there and Diane has -- actually, you have five

slides here but she says 34 more slides she hasn't put on here yet but I'll turn it over to the more important stuff which is Diane and answer any questions later.

DIANE SABO: Thanks, Roger, 34 more slides? Probably not. You guys took up the whole hour already. I think this is the part, and most of you probably have had Judy give the talk on the behavioral assessments and Shane moody, who couldn't be here today. Talk about the amplification and hearing aid fitting. I'll try to address both of those areas and why I don't have a lot of slides. I want to remind everybody that we obviously cannot rely on physiological responses forever. At some point we need the functional behavioral response from the child. We need to understand how the child can take the signal and is using the signal and need to find out about their thresholds using behavioral tests. We can't wait to fit the hearing aids until we have the behavioral responses. They won't give us those responses until five, six or older depending on the complexity of their medical condition. We need to rely on the tests to have confidence in the physiological test so we can start the hearing aid fitting as quickly as possible and it may be we do not have complete information on every single thing that we need to get the process going.

We will need repeated testing. We'll need to do behavioral testing and fill in the gaps in order to fine tune that hearing aid fitting. Things to kind of recap to think about is the VRA protocol that we'll be using when the child hits five to six months of age. And that's not chronologic age, it's a developmental age. How is this child functioning? What is the developmental age? We need to have multiple reinforcers. We know we can get more responses out of the children with the more reinforcements. If the child is not truly

conditioned we won't be getting good response levels. We need to start at moderate levels. Somewhere less than 40 DB. 30 DB has been found to work well. You want to work efficiently and quickly. You're only going to get a limited number of responses out of the child. You need to work quickly. When the child gets a little bit older and gets at that in-between age the video reinforcers is a way to keep their attention longer. 18 to 30 months of age incorporate video reinforcement as well as the animated toy reinforces.

Older children seem to like them. It keeps their attention. A lot of those kids like the light animated toys and they say I'm done. The video reinforceer looks like something that we can use to attract their attention longer before they're ready for play audiometry. That's an important thing to get to when they're 2 1/2, 3 years of age. What we don't want to child to do. We don't want to use a lot of verbal instructions with the child. We want to model the behavior. So we have to combine these behavioral tests with other physiological tests. It is important to look at the middle ear system. For young infants four to six months of age we need to use 1,000 hertz and make sure we get acoustic reflex testing. Oftentimes it helps us really fine tune a little bit more what we may be getting behaviorally. That's really just kind of a recap, I think, of behavioral assessment and really the fitting portion. What we need in order to fit the hearing aid. What I'm going to do now is kind of address some of the questions that were submitted prior to today's webcast, I guess that's what this is called. I'm going to start with the first slide or second slide then which is unilateral hearing losses.

One of the questions was if you have tone burst that is normal in one ear, are hearing aids being recommended? There is a lot of questions still about unilateral losses and what is the best approach especially for infants. If you remember back many years where unlateral losses were picked up on the preschool screening or school age screening as most of those children looked fairly much like they were functioning okay. We know from research that's not always true. They were at risk for problems and did not perform as well as children with bilaterally normal hearing. So hearing aids -- hearing losses, unilateral losses are being found quickly because of the universal newborn hearing screening. People feel if you can balance the two years that's better than having a unilateral loss. Many people put a BTE hearing aid. Anything that is -- when you start getting into the severe losses that's when people are questioning. You start having an imbalance between the two ears even when you put an aid on.

The question is does that interfere with the child's ability? We don't have a good enough research and that is a problem. There is not good research really telling us what is the best management strategy for these children. In school settings if they're older we do know that FMs help these children. They are a great asset. We don't know for young children what are the benefits and BAHA is being thought of as a way to fit the very young children or who have severe hearing losses in one ear. Again, it is something that's out there. It is being used. The soft head bands with the Baja is being used but we don't have a lot of data to support yes or no in terms of the fitting for unilateral losses. One of the questions is if you're aware of the loss and everyone is aware of the loss is that enough of a habilitation management? We need nice, controlled studies with enough children with

unilateral losses. Because one of the areas of the unilateral loss that was not fully investigated is what is etiology. We don't have a lot of information when we look back through the studies of what was the etiology of these losses and does it play into any of the outcome data. Again, more research. If anyone wants a topic it's a good topic to look at.

Moving on to the next question. Really had to do with minimal response levels and hearing aid fittings. The question was, for example, a 17-month-old who provides reliable responses but has not had an ABR, what does -- how does the minimal response level fit into the hearing aid fitting? And I think one of the things we want to first concentrate on a little bit here is the definition of the response level and at what age you're seeing minimal response levels. If you have a 17-month-old what we know is that children, by 10 to 11 months of age their performance does not change that much in terms of the levels that you are getting and these children will respond at levels very close to threshold. The more likely what you're getting is an accurate indication of how well, again depending how well the child is performing on the test. If you have a child with many false positives and is not a good responder, then yes, you have to really worry and you may need that ABR to confirm those levels. But if you have a child who is really right on giving you really accurate responses, those responses are going to be very close to threshold and that is what you're going to enter into the whatever hearing aid fitting program that you're going to be using.

The other question had to do with coupling of a hearing aid. Are you going to couple the B to E and the ear mold to the I.P.E. coupler which is a suggestion in the audio scan when you're using the VERI fit or better to couple the BTE with the tubing? If you're doing an RECD and coupling with the ear mode. If someone wants to clarify what they asked. The question has to do with the coupling. If I understand it correctly by using the ear mold to couple to the ITE coupler you're using the ear mold in the measurement twice and that's not what you'd want to do. Next question had to do with estimating hearing levels as an adult. This has to do with when you -- and Shane does a wonderful job of the VERI fit. I'll get to him to get directions and post them on the website. You can actually take the SPL -- the HL values that you have obtained and look at them as the child -- as if the child were an adult. We know the ear canal acoustics whether look different when they're an infant than an adult because the child's ear is growing. If you've insert earphones you'll see the hearing loss will look like it is getting worse when, in fact, the hearing has not changed. And so there is a way with the VERI fit to predict what your HL values will look like whenever you have an infant and then going to the adult. What you have to do is gather the -- you put in your HL values, get your SPL values, then you're going to take the SPL values and put in the RECD adult values and it can predict your HL values as an adult. I'll get Shane to write down the exact step-by-step way of doing it so we can post that for you. Use -- that's acceptable. You can use that. Most people don't bother to do that and just use -- they just either attach it to the ear mold if you don't feel really comfortable with inserting the tubing -- the pro Mike, if they aren't comfortable inserting it and the ear mold. Some people will attach using -- there are various methods. People have saran wrap or comply wrap. You need more like paper tape, comply wrap would be too thick. Anything

like that you can attach it to the ear mold. And insert it that way. But it is acceptable to use a vent to do that. And let's see, the essential test battery.

This is a question about someone who sees a lot of 2 to 3-year-olds and their question was, they have undiagnosed developmental disabilities. The question was if you do reflexes and TYMP and move into the booth many of the kids have had it by that point. The question has to do somewhat with the order of testing and what -- how to maximize getting the information from the child. If the child is -- most people like to do the behavioral first because that's where most children fall apart. The reversal in order of tests may maximize getting more information about functional responses to sound. Most of the time children will settle down a little bit and be a lot more comfortable by the end and they actually sit still or better for the other things at the end. Versus at the beginning. So I would just suggest that in order to look at these children for more well-rounded use the behavioral techniques first and go into the more physiologic testing. Those are all the questions I had beforehand. If I haven't addressed the question you thought you wrote in regarding either hearing aid fitting or behavioral testing please clarify your questions because we'll have more question and answers now for the next 40 or 50 minutes.

I think there are a few more questions that came in today. Actually I will address this one. This one was in regards to CMV and the question was; were any states routinely screening at birth as part of newborn hearing screen? Currently there are no states doing this routinely. There was a study that will be starting up shortly. A multi-center study and this will be routine screening for children for CMV. 1,000 babies will be entered into the

study. There will be routine screening, as I said. Once we have a little more information about that we'll share information about hearing loss and what we're finding. The question is if it's symptomatic or asymptomatic what about it affecting hearing? Symptomatic and asymptomatic children both have progression of hearing loss. They both have progression of hearing loss. You aren't safe even if it's asymptomatic. Most of the time we don't know about asymptomatic hearing loss.

Symptomatic children need to be monitored every three to six months. The other children unless tested while they were a newborn you won't know that they have CMV. And they have been shown to have onset of hearing loss into their teenage years. So it's not -- there is no safe time to stop and say no, we don't need to monitor anymore. As children get older and can verbalize more any changes you can drop down the frequency to six months and then to yearly evaluations. Our physicians routinely treating patients with CMV and other antivirals always as a routine symptomatic children are getting much more routine care in treatment using antivirals. There are multi-center studies going on looking at the benefits of these and other antivirals and looking at not having to do an intravenous way of giving the child the drugs. So we'll have more on that hopefully through some of these studies that are currently going on. I think that was it for most of the hearing aid behavioral questions. We can open it up to all questions now.

KATHLEEN WATTS: Yes. There are some questions that have come in and so I'll just let you know what those questions are and then whoever feels they should answer can do so. I think the first one is either for Jay or Roger. And the question is, what

recommendations would you make for an ABR result when you obtain an observable latency intensity function down to 20 decibels but the morphology of the waves is poor?

JAMES HALL: Well, I'll take a stab at it and I am going to assume that the questioner -- can the questioner amplify the question if we need that, Kathleen?

KATHLEEN WATTS: I don't know if this is one of the people who is just on the computer.

JAMES HALL: Well, the question I guess that I would have of the questioner would be is he or she saying that there is a ABR down to 20 DB at clicks as well as for tone bursts? Let's assume it's not just clicks but also a nice definitely a response down to 20 DB for most of the frequencies in tone burst and clicks. If the interwave latencies were normal I would assume the poor morphology probably was due to movement or the child wasn't totally anesthetizeed. There there was a response at 20 I wouldn't raise serious concerns. I would probably follow the child but I would also probe the history to determine whether or not there might be some type of other neurologic or developmental problem. I got the information I needed that there is no clear neural disorder and auditory thresholds are adequate for speech and language development.

ROGER RUTH: I would concur with that. There is no evidence at this point that poor morphology by itself in the presence of a detectable response of 20 DBR normal level that would indicate any kind of neurological problem or central problem. Although it's possible, but we don't really have any good data on that. More likely, as they said, it would probably

have to do with the impedance of the electrodes if it was in the imbalance or the presence of some movement or myogenic activity.

KATHLEEN WATTS: Thanks, Jay and Roger. I think the next question is also for both of you. And it's what are your thoughts on interpretation of an ABR with a normal latency intensity function of Wave V down to 20 decibels, normal hearing loss, yet wave III is delayed compared to norms at all intensity presentation levels.

JAMES HALL: It's a vairvation on the same them. I have a definite opinion about that. I'm interpreting the question as meaning that the ABR looks normal in all respects accept wave I is not -- wave III is not at expected latency. This concern has been around for years. And I recall one time when I was at Vanderbilt recording some ABRs when I was actually preparing the first book and I was trying to find people with weird hearing losses like rising patterns or a rising pattern, then loepg in the high frequencies and I had a couple of people who had notches in their hearing at 6,000 hertz. Good hearing everywhere but a little notch at 6,000 or 3,000. When I started looking at the ABR waveforms I noticed some of these people had wave IIIs that shifted around. Sometimes no wave III at all. Different wave, wave I, wave III, Wave V are more dependent on different regions on the cochlea than others. The wave I more generated from -- that must influence wave III but other than that, it's not a problem. So in a case like that I would run the OEs, if they were normal I wound pay attention to it. If the OEs were very abnormal in a specific frequency region I would want follow up. But I don't think it would require awed logic management at the time.

ROGER RUTH: I would agree with that as well. The only caveat if you were to see a condition like that with a normal I to V interwave interval but a delayed I to III there a convenient a couple of people noted that there are some small tumors that have produced what otherwise if you were just to look at the I to V interwave interval would be normal. That is unlikely and no report of that in children that I'm aware of. I would agree that it likely has to do with possibly a little peripheral. We've seen some of that as well.

JAMES HALL: Another option. I thought of this as Roger was talking would be for the audiologist to use a horizontal arare where the electrode is still on the stimulus ear but the one on the forehead is on the other ear. It enhances some of the early waves and maybe wave III would become clear and resolve any question at all.

ROGER RUTH: Or in the contra lateral.

JAMES HALL: Right.

KATHLEEN WATTS: Okay. Thank you very much. Next question. Can you suggest a way to get comfortable with bone conduction ABR testing?

JAMES HALL: I assume what they mean is that the tester is comfortable and not the patient. Otherwise I'd say just lighten up a little bit on the tension of the bone oscillator. Well, you know, practice -- the only way you really get comfortable doing anything is to do

enough of the procedure and in different types of patients. The first thing I would always recommend for the technique is not to find a middle aged adult like your spouse or friend to -- then try to do bone conduction hearing. Your maximum output is 50 decibels NHL. If you have somebody with a 20 or 25 DB hearing loss in high frequencies which might not be of any consequence you're limiting your effective output for the bone oscillator to 20 or 25 DB. Find a well behaved young child. None of Roger's children but somebody in the 5 and 6-year-old level that has normal hearing and just get them to lie still for a while and then you'll probably record a very good-looking bone conduction response and then the other thing I recommend and there is nothing illegal about this is if you've got a newborn hearing screening program in your hospital and you're routinely screening babies, make the ABR system up and follow up a screening one day with an ABR where you're backing threshold down to 20 DB with a sleeping infant with normal hearing and do bone conduction. My experience is, in a normal infant or young child, the ABR for bone conduction typically jumps right out at you assuming they're well behaved. If you aren't getting a clear response and too much artifact it's probably the protocol you're using. Make sure you're distancing the electrode and the bone oscillator. Make sure you're not holding the bone oscillator with your hand and make sure the filter settings are adequate. That the rate is reasonably good, etc. But I work with students all the time and with the right protocol and a very quiet child, where hearing sensitivity is normal, the bone oscillator will typically produce a pretty good response.

ROGER RUTH: Just to amplify that a fellow by the name of Bruce Webber who was at Duke University for many years did some nice work early on in potentials. Did a couple of

studies looking at bone conduction responses in newborns and, in fact, he had advocated using a bone conduction stimulus rather than air conduction as a screening tool. That tell by the wayside and not his best idea but you are able to get these very nice responses especially in newborns or certainly infants under three months of age that jump out at you with a bone stimulus and, in fact, the latency in an a typical adult. The latency of a bone conduction stimulus at this same level is usually a little later than the same Wave V, let's say, in using an air conduction stimulus at the same stimulus level. But in infants it's actually the same as air conduction or a little sooner, actually, in time. There have been some discussions as to why that may be the case. Nevertheless, the bottom line is that you can get nice bone responses doing so.

KATHLEEN WATTS: Okay. Let's go on to the next question for you to also. Is there a more important measure to obtain if you have to choose a single measure, click versus tone burst frequency?

JAMES HALL: Well, listening to Todd speak at the pre-AAA workshop on a Wednesday before the AAA this past year in Minneapolis Roger and I were both there. Todd said that he's routinely not using the click but instead beginning with a 2,000 hertz tone burst. I'm still a big proponent of using the click for two or three minutes to get that information I talked about earlier. However, if you just had to use -- this is a hypothetical situation. If you could only use one stimulus, there is some rational in using a two or 4,000 hertz stimulus. With the 4,000 hertz stimulus you're getting information on hearing sensitivity at 4,000 hertz. Most hearing losses tend to affect the higher frequencies first or only, not the low.

And therefore the 4,000 hertz would detect a problem. The click ABR, of course, is giving you really good response because you're stimulating a broad range of the higher frequencies in the cochlea and the latency of the 4,000 hertz tone burst. The waveform looks like a click so you could get all the interwave latencies. The latencies are about the same as a click, slightly longer, less frequency region of the cochlea is contributing but you could at least get information on whether or not there is a conductive loss. From a hypothetical point of view, I hate to say this because then some people will say all I need to use is 4,000 hertz and that's not what I'm saying. That's the direction I would go.

ROGER RUTH: I would be loath to do that as well to pick just the tone burst. Largely because we, for whatever reason, have seen our fair share and more than our fair share of auditory neuropathy. We have almost 20 kids with auditory neuropathy implanted with cochlear implants now in our program. We've seen a lot of kids with varying degrees of auditory neuropathy because we're looking for them now and we know something about it and obviously we had seen these kids all along earlier in our careers and didn't know what was going on. Assumed it was some unusual sensory problem. But it's a little harder to detect that with a tone burst stimulus, much easier using mono polarity.

KATHLEEN WATTS: Thanks. I think this is -- I know this is a related question. You may have already answered it but it is from someone else. If you were performing an ABR and find elevated click thresholds but the child is beginning to wake up, which would you opt to do next, bone or tone burst testing?

JAMES HALL: Well, for my answer to that I would definitely not do bone conduction because just the fact that the ABR is elevated doesn't imply that there is a conductive hearing loss and that I could get from tymponetry. I would try to get a response for 1,000. I got it in both ears, by the way, I would probably get a response to -- try to get a response for 1,000 hertz or 500 hertz before the child woke up and then at least be able to provide a sample of information in the lower and higher regions of the speech frequency range.

ROGER RUTH: I agree.

KATHLEEN WATTS: Okay. Thanks. The next question is for Diane. What tool do you use for assessing functional listening behaviors for validation of hearing aid fitting and why?

DIANE SABO: Very good question. The tools are, to say the least, not plentiful for the very young children. The elf is one of the better ones to use. Ooh part of the problem is they aren't very specific and they're good guides in terms of looking for what to look for, what types of changes you might see over time but the problem is they are questionnaires. And so while they will provide -- the young ages. I think the elf is good. Life is another one to look at for young kids. Those are very good questions because we as a profession don't have a lot for the very young children and we don't have, you know, there aren't any formal tools and that's expected in dealing with children up to three years of age. The formal tools are missing to assess them in any capacity. The best we have are questionnaires. It's a matter of sometimes parent observation and reporting in journals is another way to really get parents to look at their children and get workers who are working

with the child to document things. So they may need to have some -- they may need to have some very formal guides such as using some of these but at the same time using some observation may help just as well.

KATHLEEN WATTS: Okay. I have another question for you, Diane. Did you say that the animated toys are better for the younger kids and video reinforcing better for the older than 18 months?

DIANE SABO: Yes, that's what it appears to be right now. Again what we needed -- we need more research on the very young infants to see. It might just be the type of video reinforcement used with the young ones. They respond well to the animated toys and it looks like what we're looking for right now are ways to entice those children back into using VRA as a tool until they can get the play audiometry. You have to look at the video reinforcement and make sure it's animated or colorful enough so that they will respond to it. And it's familiar to them. A lot of what the child does whenever they're very young is get that motion. It is really the motion that sometimes is what they're looking for whenever they look toward the response. So right now that's the information we have. Some of that came out of some work people did at Vanderbilt. How good is video reinforcer? What are the youngest ages we can use it and try to come up with strategies to maximize the number of responses we can get out of these kids.

KATHLEEN WATTS: Okay. Diane on another subject. How early would you consider fitting a child with unilateral loss and what are your thoughts regarding the cost of fitting or

not fitting and cost is in quotes of fitting or not fitting a child with unilateral loss as opposed to waiting for school and considering FM use?

DIANE SABO: That's again a good question because we don't have the data to support in terms of saying you need to do this or else this is what the problem is going to be. I think you have to look at each child as individuals. One of the reasons I say that. Is this a child with chronic OME? Is this a child with other problems? If you have children who have other issues and not just the unilateral loss, no middle ear, etc., then we're looking at different types of children. Let's say for children who have either multiple medical conditions or may be cognitively challenged or have chronic Otitis media, those children need to have something in the other ear to give them the best benefit to try to maximize their potential. Now if you're talking about a child who really looks like they're clean in every capacity. I'll say it that way, then those are the children where it's really a question, what is the benefit going to be and we don't know what the detriment would be. I think if you're doing a lot of language stimulation and teaching parents. I don't think you send the kid home and say fine, he has hearing loss, goodbye. You need to spend a lot of time with parents making them understand about noise and language simulation. If you can get intervention to help with these things and it depends on your early intervention whether or not they will service a child with unilateral loss. I understand that. But families need to understand about language. Language development and the impact of noise and the unilateral loss has on the child. I think if precautions are done, I think children can wait until they're older and get into the schools and use the FMs. You'll have to monitor. You need a baseline language evaluation and look at these kids to make sure we aren't

missing anything. I don't think I have a pat answer of yes always fit or no never fit. As for the youngest age, that gets back into other whether or not they are children who have other problems or children who don't have other problems. If they do have other problems there is no reason to wait.

DIANE SABO: Okay. Thanks. This question is for whoever wants to answer it, I guess. It's TELAE or DPOAE, do you have a preference?

JAMES HALL: This question comes up on a regular basis and nowadays where we have plenty of options we may not even have to make an artificial decision between one or the other because you can buy pieces of equipment that have both transients and distortion products and use them both if you want. There is some evidence from basic scientists that the mechanisms or the generators and the origins of these two types of responses actually may be different and that would argue for using both. I'm almost always exclusively using distortion products for most of the applications and adult in our clinic because the distortion product OAEs will allow you to assess at much higher frequencies than the transient. The upper limit for transients is 4,000 to 5,000 hertz and with the distortion products it can get you up to 8,000 or 10,000. A manufacturer will generate a probe in software for clinical use to allow you to evaluate up to 20,000. That certainly can be done with experimental devices. The other advantage of the distortion products with babies and young children is that the noise both physiologic noise generated by the child and ambient noise is going to impact on your measurement at right around the frequency of the distortion product. For the transient OAEs you tend to end up detecting all the

frequencies as you're trying to record them. You can be a little more selective with distortion projects where there isn't much noise and still get valuable information on the cochlea. For applications like monitoring newborn screening, of course not a pediatric problem but assessing tinnitus I tend to rely more on the distortion products.

ROGER RUTH: I would agree with that as well. If you had to use one, although more often than not in our clinic we do try to use both since they're both available to us. If we had to use one, the distortion product would be what we would rely on.

KATHLEEN WATTS: Okay. Thanks. We have a question for Jay. Do you have a simple way to explain the difference in ABR and ASSR testing to a parent?

JAMES HALL: Well, to a parent, I tend to not get into much detail on the details of techniques or even the details of findings because they tend to not remember. I try to tell them what I think they -- it's most important that we remember. It really focuses more on the outcome of the tests for their child and what we're going to do for their child. I would -- we do, though, nowadays, get more children referred for ASSR specifically. So I would explain it something like this. There is two types of tests that we can -- more than two, but two that we normally will record from children that involve putting sounds in the ears and recording a response from the brain and with one of them that is the auditory brain stem response we're getting detailed information about the ear as well as some information on the brain and -- but we can only do this up to certain loudness levels. For the other test we aren't getting much information on the ear or specifically on different regions of the brain

but we can get to much higher intensity levels. Together we can evaluate auditory -- define auditory sensitivity in almost every child. Nowadays we're using ASSR quite a bit and Roger is having this experience in infants and very young children in determining who will be a cochlear implant candidate almost instantly rather than recording -- trying to record an ABR, not getting a response and relying strictly on their response to amplification before we make that decision.

ROGER RUTH: I agree.

KATHLEEN WATTS: Great. Okay. Thanks. For one of you two, what about doing bone conduction on a newborn whose skull sutures haven't come together?

JAMES HALL: Actually, from my point of view that's the ideal to do bone conduction on. As long as you're stimulating the temporal bone you're presenting an effective stimulus. The advantage of using bone conduction in an infant whose skull bones have not fused is that the chances of crossover of the stimulus to the non-test ear are much lower. I don't think there are any disadvantages to stimulating the mastoid in an infant. If you were to stimulate one ear, trying to stimulate one side trying to actually activate the other cochlea or using a forehead placement, that would be a problem. You may not get a response in a child whose cochlea was normal.

ROGER RUTH: Agree.

KATHLEEN WATTS: Okay. When you see a good bone conduction response for 500 tone bursts and tips to do this.

JAMES HALL: I was going to mention this earlier in another question. Some would disagree with me, maybe David and some others, but normally in a clinical setting if I can get air conduction results for the different tone bursts plus the click and a bone conduction ABR for click I would feel comfortable. I'm using the bone conduction, click stimulus to indicate if there is a conductive loss or not and in general what degree of loss rather than trying to reconstruct an audiogram by bone conduction. It is certainly possible to elicit a bone conduction ABR with tone burst but not clinically feasible in most cases because you won't have enough time with a child sleeping or anesthetized or sedated to really do that routinely.

ROGER RUTH: I would say in David's laboratory conditions he may have the time to do this using several test sessions but for most clinical applications it is probably not worth the additional time that you would invest in it. And you may not have that anyway. So I think getting the air conduction and bone conduction, the click and the tone bursts will fill in most of the information that you need.

DIANE SABO: I have to agree with you on that one.

ROGER RUTH: Thank you.

JAMES HALL: That's the only thing she agrees on. [LAUGHTER]

>> That brings up a general principle. Parents sometimes ask why we're doing the test if it involves sedation? The answer should be because it will affect our management and I don't think getting a tone burst at 500 hertz for bone conduction in most cases will affect the management. If there is a conductive loss we know what we need to do even if we don't have the information for 500 hertz. If there isn't, we have the information we need.

>> Thanks. To your knowledge have you found any new research with progressive loss and hyper bell a bilirubin without transfusion on full term infants from someone who says they periodically see children with this history.

>> With progressive loss, is that the question?

>> Yes.

>> Return of normal, improvement of hearing is certainly seen on a regular basis, or can be seen.

>> Right.

>> I'm not familiar with that, Diane, of a person with -- I would suspect in a case like that it may not be the hyper –

>> A lot turn out -- if you have hyper bilirubin -- progressive losses is not one of the things you see with that condition and as Jay said you see improvements, or can see improvement. Not always, can see. Some of that has to do with improvement in the ABR. You can go from morphology to much better of the phase after the child has an improvement in the Billy levels.

>> Where do you obtain the video reinforcers?

>> I know there is one company making them now. Intelligent hearing systems in Miami, Florida is making a video reinforcer system. They have videos that you can get from them and then if you're -- if you ask them nicely they may give you hints on getting video clips as well to put in. It is adaptable. You can put other video clips in so you can customize it if you know a child likes Elmo, get some Elmo things and put it in. There are ways to customize them to children who have particular wants and needs. They're based out of Miami.

>> Okay. And we can open this call up to people who are on the call and have questions. If you could just sort of, you know, once one person stops and someone starts if another person would stop so that we can have it be somewhat organized, that would be helpful. But those are all the questions that I have had through the system. So if you want to -- if any of you who are on the phone have questions for any of the presenters. Caller: I have some questions.

>> Okay. Caller: With doing frequency specific ABRs a lot of times I can't see wave I. At what age to know when the mask? At what age do you definitely have to start masking?

>> You're talking about using the air conduction stimulation? Caller: For both.

>> First of all the lower the frequency the less likely you are to see a wave I. I wouldn't worry about that. Normally what you're going to rely on in the tone burst ABR is the Wave V in estimating threshold. That's the wave you really want to make sure you're detecting confidently. This is why I use a click to begin with, once I've gotten a wave I in the click ABR for a particular ear, say the left ear at a high level, then I know which ear I'm stimulating. And I don't worry about stimulating the other ear by bone conduction. I guess you could come up with a scenario that might happen but they would be very unusual. If you do have an ABR in each ear so you know there is hearing in each ear there is no reason why you couldn't put masking in the other ear. With insert earphones, very often masking is not that much of a problem but the insert earphones also mean it's harder to get your masking noise or -- it's easier to keep your masking noise in the non-test ear. You could put 50 to 60 DB of noise in the other ear to verify they are coming from the ear you're stimulating. Caller: I have one more question.

>> Go ahead. Caller: You mentioned something about using -- to determine cochlear implants. How do you determine that?

>> ASSR you said? Caller: Yes.

>> Well, let's -- this is a scenario that evolves quite a bit. It happened to be just within the last week doing ABRs in the OR. I start out with a click stimulus, try to record an ABR and all I get at most is a tiny little Wave V kind of delayed and only at the highest intensity, 95 DB for the click. I then go to tone burst and I systematically find threshold in the region of 85 to 90 DB at each of the frequencies. I usually go from 250 hertz up to 4,000. Then I know there is hearing at 90 DB. If I record no ABR for clicks, no evidence of cochlear microphonic, simply nothing, there is no evidence of conductive loss and I then go to ASSR and go to 125 DB, 120 DB and absolutely record no response at any frequency that child would not be a hearing aid candidate long term. We still need to go through the obligatory trial use but it will begin thinking about and talking about a cochlear implant and beginning to get that child in the process of being evaluated for a cochlear implant.

>> I would add to that we do see quite a few of these kids and I think another scenario would be if you see absolutely no response to either click or tone burst ABR at maximum levels, but then you can actually fill in between that 80 or 85DBHL hearing loss and 120 so you have that ceiling up there to determine whether or not there is -- they have any residual hearing that be with appropriate for amplification trials and that you would anticipate some potential success versus those kids who do have residual hearing. So it gives you a much better idea of where you are if you have that additional head room to estimate what the hearing sensitivity is across frequency and whether or not there is

actually an equal distribution or low frequency response and nothing in the high frequency, for example.

>> Thank you.

>> Any other people on the call who have questions? Caller: I still have some questions, if I can.

>> Okay. Caller: All right. What kind of -- we do have the ADARA and I have not had any success using the -- it seems extremely sensitive to any movement or anything. You recommend any other equipment or have you found any success with other?

>> I'll jump in. We use the ADARO routinely and have since it was a prototype and have had very good success with it. I think the problem that you're encountering is not unique to that machine it's unique to the way ASSR is detected. It's detected using a statistical with an algorithm and statistical -- it's conservative. If there is noise the device will err in the direction of saying there is not a sponsor too much noise to detect a response confidently. If you're using another ASSR device say the master system by biologic or one of the others you would be encountering the same problem. I tend to almost always, unless I'm dealing with an infant less than a couple months old, require sedation for the valid use of ASSR to estimate hearing threshold. You can get an ASSR at a high intensity level on a normal hearing person without sedation but to get down near threshold with the response

is very small and it is being detected in the presence of background noise, I think you really need to have sedation.

>> Understand, too, that we have both the biologic and the ADARA, we use both. Probably if there is noise in the system, it is not as quiet as you might like, that the biologic may have a slight advantage of the of the fact that it can accumulate a larger number of samples as an opportunity to improve the signal to noise ratio better but they'll both be problematic. Caller: My last question is with bone conduction placement a lot of time I have a hard time putting a head band. Would this be a disadvantage if I have the parent actually hold it and how accurate or inaccurate with changing the pressure?

>> That's a good question and I'll jump in as usual. If the child is, you know, not an infant but maybe six months or five months, very often -- I'm all by myself in the OR, I'll use -- I'm not all by myself but I'm the only audiologist there I'll use the traditional head banding take a towel or sponge or something and use it so that it fits the child's head. You can also use other devices to hold the bone oscillator in place for younger children. I typically will hold it myself if I'm -- rather than relying on a parent and I will not hold the actual bone oscillator but hold the band and turn it inside out so I can press the oscillator on the mastoid only while I'm averaging and then as soon as I stop averaging I'll take my hand off it so I can operate the equipment. Most parents probably aren't going to have the feel and the technique down for doing -- holding a bone oscillator on properly for the length of the stimulation.

>> I agree.

>> Okay. I have another question that was submitted -- several more, actually submitted through the webcast system. So let me go back to that. About auditory neuropathy, can you touch on the ABR and what to look for regarding the cochlear microphonics?

>> Well, we both are probably saying the same thing. It's not very difficult. You deaf fitly want to use -- don't use alternating polarity. Use a high intensity level. Try to get the electrode as close to the cochlea so if you use the ear lobe instead of mastoid that's good for older children I'll use a tip troe where I'm putting the electrode in the ear canal. What you're looking for is that periodic waveform that reverses in polarity.

>> One thing that will help differentiate it is to make sure -- it's not as much electromagnetic energy generated by the transducers but there is still some. What we try to do is keep, for example, we take the insert transducers usually and bring those up over the front of the child over their chest and bring the electrodes back over the back and try to keep those -- the recording electrodes separate as much as possible from -- and distant from the actual box transducers themselves and that will help.

>> Very good point. Even keeping the wires that lead to the electrodes and lead to the transducers separate is a good strategy.

>> We clamp. We'll do a control run with a clamp on so we leave the stimulus on.

>> So that expectation there, then, Diane is that if it's really cochlear microphonic when you clamp the tube there is no sometime list it will go away. If it is still there it must be electrical artifact.

>> We do that, too. In the fast majority of cases where we've done that it has not been artifact.

>> We have had artifact so it's always good.

>> I would agree. I think it's just -- I think your colleague, John, has ranted and occasionally about the fact that it may largely be artifact. I would disagree with him. I think that these cochlea microphonics. There is a little difference that occurs later in time.

>> It will keep going for a long—

>> In some cases it will go out to five or six milliseconds. So we have the bizarre cases. Why that's happening is speculation, I suppose, at this point. But they clearly are reversible, 180 degrees out of phase to see that that cannot be neural. That is impossible. Responses don't care what the polarity of the stimulus is. Transducers, I mean cochlea as a transducer, that the cochleas are phase sensitive as reflected.

>> Thanks, all of you. I have another question. Can you comment on your experiences with oath owe toxic drugs and hearing screening protocols for infants and toddlers birth to three?

>> Sure. There aren't any good protocols.

>> You have it.

>> Part of the problem is there really has not been a lot of good research. We know that whenever the meds are mixed with diuretics, those seem to have a little more of a synergistic effect and we'll see more hearing loss in those cases. Other things given in the doses they're given don't seem to be posing a huge problem. But what we don't know is there is also the might owe condree all disorders only one dose of that can wipe out hearing so we're also looking to genetic factors that they're now discovering and how that plays into the monitoring and giving some of these drugs will be interesting to see how it plays out in the future. So right now I would say that most people who are doing newborn hearing screening do not have protocols for doing extensive follow-ups on infants in the NICU getting the medications. If there has been a concern on drug levels that seems to be the kids that get followed routinely. But I don't know Roger and Jay, if you know what else if anything else is going on routinely.

>> I would agree.

>> I think we need -- we certainly need some protocols evidence-based. Perhaps the new joint committee on infant hearing statement if we ever see it will have -- address that. There are so many back force. Factors that change the degree from one child to the next there won't be one fixed protocol that will work for all drugs for all children.