REALTIME FILE

NCHAM-AUDIOLOGY 101
INTRODUCTION TO AUDIOLOGY FOR NON-AUDIOLOGISTS WORKING IN AND SUPPORTING EHDI ACTIVITIES-(ADOBE 4.1)
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WILLIAM EISERMAN: If you have just signed on your in the right place for today's webinar that will begin in about 10 minutes at the top of the hour. This webinar is being brought to you by NCHAM the national Center for hearing assessment and management at Utah State University. Once again we will be starting at the top of the hour. For those of you who have just signed on, you're in the right place for today's webinar entitled audiology for non-audiologists, working in and supporting EHDI activities. We will be starting in just a few minutes here at the top of the hour. For now just get your volume adjusted to your liking and you should be set to go. You do not want to select fullscreen mode. Do not select fullscreen mode, as it will eliminate your ability to view the various slides and other components that have been prepared for today's webinar. So do not select fullscreen mode. The aware that today's webinar will be recorded and posted on infant hearing.org in the next couple of days so if there's anything that disrupts your full participation in today's webinar you will be able to access it in the next couple of days and/or share it with others who you think might benefit from this. You are in the right place for today's webinar that will be starting in just a moment. Terry are you still there?

TERRY FOUST: I am, thank you William.

WILLIAM EISERMAN: All right great. Looks like we've got all of our components functioning well today so that is... Always nice. I am going to initiate recording of today's webinar and then we will get started. Good day everyone. I'd like to welcome you to today's webinar brought to you by the national Center for hearing assessment and management. Also known as NCHAM at Utah State University. NCHAM services the national technical resource Center on EHDI and is delighted to be hosting this webinar along with a series of webinars for newcomers to the EHDI or the early detection and intervention system. Today's session is one of four that will review basic information

about key components of the EHDI system. Across the four systems you will have an opportunity to learn about the history of EHDI the act of 2017 that establishes EHDI as a national system, the key components of the EHDI system and the various stakeholders and funders. In another of these four sessions we will focus on the role of family members and adults who are deaf or hard of hearing within the EHDI system. A third session will focus on the most recent development in EHDI that was brought to us through the reauthorization of EHDI act of 2017 to expand the focus of EHDI to include the identification of children up to three years of age who are deaf or hard of hearing and in today's session we are going to provide basic information about audiology from, aimed toward the perspective of non-audiologists. As I mentioned, today's webinar is being recorded. So know that you can access this at another time. I want to give a shout out to our captioner today. That is a real live person there who is providing us with this extra feature so that our learning opportunities can be as accessible as possible. Once our presenter has wrapped up his comments for today, we will open up the screen for, into which you will be able to type your text questions and have our present to respond. My name is Will Eiserman and I'm the associate director of NCHAM and I may lead to introduce my colleague Terry Foust, who is an audiologist and speech language pathologist presenting on the topic of audiology for non-audiologists working in supporting EHDI activities.

TERRY FOUST: Thank you very much. It's a pleasure to be with you this afternoon. I'm going to go ahead and get started because I have a lot of information to get going with you. I will say I am a pediatric audiologist and speech language pathologist and have been long involved with EHDI and I'm glad to have you with us this afternoon. I know it is after lunch so we really appreciate your attention and attendance this afternoon. With that let's go ahead and dive right in today.

We are going to cover the following information. We want to define and discuss the types of hearing loss the people and children have an experience. We are going to talk about the types of hearing tests that we use to diagnose a hearing loss and then we are going to discuss the audiogram, or how we visually map out hearing. Then we will wrap up by discussing treatment and intervention for hearing loss and specifically we will talk about amplification including hearing aids and cochlear implants.

But before we do that, let's define the various hearing related providers, because it can be really confusing.

So outside of general medical or practitioners and providers is a specific hearing related providers here on this slide. Let's talk about those. One that you might be pretty familiar with is the ENT or otolaryngologist. This is a medical doctor who is a specialist. Someone who specializes in the medical treatment and or surgical therapy and prevention of disease or disorders that are related to the ear nose and throat. Including sinuses and upper respiratory airways. They have specialty training at medical school. It is five years in addition to medical school and then they are required to have board certification. So that is what an ENT or otolaryngologist is.

Now an audiologist, they are a hearing healthcare professional who is really specifically trained to evaluate hearing and hearing loss and related disorders and to that for most of us includes balance or disorders of the inner ear, things such as tinnitus or ringing in the ears, and also focused on rehabilitation for individuals that have hearing loss and related disorders. So an audiologist will use a variety of tests and procedures that we will talk about today to assess hearing and balance functions, and then also to fit and dispense hearing aids and other assistive devices for hearing.

As you can see here, they have clinical training at, that ends in a terminal degree of a Dr. of Audiology and you can see those professional designations there.

Now there are other professionals that help support hearing health, and I have listed those under an audiologist because most of them work either directly under the supervision of or in consultation with an audiologist in the various programs or areas that they may be employed in. The first is in audiology aid. That really is an assistant or technician who has been trained to complete certain tests or support tasks by and for an audiologist and as I mentioned they are directly supervised by an audiologist.

An audiometrist --- a machine that is used to do pure tone audiometry. They are usually supervised by an audiologist or ENT, or other provider, and it is a title that you may find more commonly used outside the US. The third is a screener and a screener is someone who is trained in administering a hearing screening test. And they are usually trained by an audiologist or somebody who is experienced in the screening method to use the screening equipment. They are trained to place any ear probes appropriately and to run the screening test while they may make a judgment as to whether or not someone passes a hearing test, in most cases the test procedure may be automated and they do not interpret results of any full testing. Again they are usually supervised or overseen by an audiologist.

The third one is a hearing instrument specialist, which you may know more commonly as the hearing aid [dealer] and this is someone who provides services for the testing, the selection and fitting of hearing aids as well as the ongoing care of hearing aids and the fitting and counseling. These hearing instrument specialists usually pass a state examination to be licensed, then they meet appropriate licensing board training requirements.

WILLIAM EISERMAN: Now Terry, I often refer to and introduce you as being a pediatric audiologist, even though there isn't an official designation as a pediatric audiologist it is important to highlight that there are many audiologists that serve older individuals, but we are particularly interested in identifying and collaborating with pediatric audiologists. And you speak for a moment about that difference?

TERRY FOUST: Really great question William. Out of most of the audiologists in the US the vast majority actually serve adults. And there is a very small or significantly smaller percentage of us that work primarily with children and that is a very different work environment and a very different perspective that we take with children. And so we

have, those of us that work in pediatrics really focus on a battery or a variety of tests that allow us to test a baby that can't provide a response for example like an adult could. And we also are really trained and in tune to the factors that we would want to take into account for the rehabilitation and the fitting of pediatric hearing aids. So it really is a specialty focus for us even though at the moment we don't certify pediatric audiologists separate from those that work with the adult population.

Okay now so moving on, this goes hand-in-hand with what we just talked about. Because when we talk about newborn and early childhood hearing loss we are really guided by benchmark standards of care. These are guidelines that have timelines attached to them so that we can intervene and help at as early an age as possible. And the standards are developed and updated regularly by a group of experts known as the joint commission on infant hearing or JCIH, as you see I have abbreviated here on the slide. And these standards are really used around the world as a standard of care and I would like to note that these timelines are minimums. That the earlier we can do them the better. So we have a 1, 3, 6 model, as you see here. By one month we want to have hearing screened. This is by one month of age. By three months of age we want to have anyone that has not passed the hearing screening, we want to have their hearing evaluated and we want a complete diagnostic audiology and otolaryngology examination. We want to have that really checked out. And if we indeed diagnose the hearing loss we want to fit hearing aids as soon as we can if necessary.

Then by six months we want to have these children enrolled in early intervention services. So again, these are our benchmark guidelines

WILLIAM EISERMAN: you will often hear people refer to the one, three, six goals. That is often commonly discussed and referred to so when you hear that you know we are talking about this timetable of trying to get children screened and identified and then to services.

TERRY FOUST: Exactly. This time frame is really critical. In fact let's talk about why it is so important. And I really cannot emphasize enough that the earlier we can intervene the better. The reason is that the rate of growth and development in that first year of life is just unmatched by any other time during postnatal or afterbirth development. So as a baby grows her or his brain is developing and tiny little synapses or electrical connections within the brain are forming. So the amount of stimulation that your child receives directly impacts the amount of the electrical connections or synapses that are formed within the brain.

It is important to note that the creation of these connections are virtually complete after the first three years of a baby's life. So what you see here are findings on a PET scan. These findings that I have just mentioned are supported by different brain imaging techniques. This specific one is a PET scan and as you can see as you look across this, look at the amount of orange to dark red that occurs. That is the growth in those connections and you can see how that changes from one month to a year. So what I

would like to leave you with here is that the first years of life are the most important in brain development, which impacts communication and language.

So now let's talk about hearing itself. Hearing loss is described by the parts of the ear that are affected and we will talk about that in more detail. We described it by what parts are affected of the auditory system. We talk about whether the hearing loss is temporary such as you might see with a possible your infection, where the hearing comes back to normal as the your infection clears up. It can be permanent or it can fluctuate. And then even mild and moderate hearing loss significantly can impact your ability to hear speech. And can affect speech and language development.

Then we are going to talk about the audiogram. This is really I think hard thing for some people to understand at first. It just looks so foreign and can be intimidating but it really is just how we grasp hearing sensitivity and it will incorporate all these other items that you just see here in the key points. So it is important to understand what it means. We will talk about that.

Let's start with hearing tests.Let's talk about those for a moment. We use hearing tests to get information about someone's hearing, just like we talked about and the hearing test helps us know exactly how much or significant the hearing loss is. Is it a mild or moderate or severe to profound hearing loss. It also tells us what type of hearing loss it is. That is where does it occur across the auditory system and we talk about what type of hearing loss it is. Then, third , it determines the configuration of the hearing loss. What I mean by that is how are each of the different pitches or frequencies that we can hear across the range from low to high affected.

So for example in a sloping hearing loss that might mean we hear better in the lower frequency and the lost slopes down and are hearing is worse than the high frequencies. We use all of this information then to make treatment and intervention recommendations.

So now let's take a moment here and just look at the ear. This diagram is probably familiar to most of you or all of you but let's take a moment to review the ear. Let's start by looking at how sound, as the sound travels to the ear. See you can see the sound waves there. That is the sound that is coming in the ear. The first thing we see is the outer ear or what is called the pinna. But it is simply your outer ear, the fleshy portion that we hang earrings on and put sunglasses over. But we do want to look at how well that is shaped and if it is normal or not that can indicate of the problems. Then we look at the opening of the ear, that is called the external ear canal. Okay and so the outer ear funnels down into the ear canal and it hits the eardrum what we all know as the eardrum or tympanic membrane. The sound moves that the member and now if you remember him school the three little bones, the hammer, and Leinster those are right there if you can see the red arrow. So the movement of the eardrum moves those three little bones. And the last little bone, the stirrup, pushes and on the Inner ear which is called the cochlea. You can see the blue snail shaped portion and that is really where the sound is

processed into low to high pitched sound before it stimulates the auditory nerve, which you can see is the last part. The nerve takes the sound pitches up to the upper auditory centers of the brain stem and brain where then we interpret it into sound and its associated meaning.

We will come back to this in a bit. Okay so let's talk now about the types of hearing loss that we have. And these will correspond to the ear. If we have hearing loss that occurs due to the outer ear or the ear canal, the opening, in there or the middle ear space so it is really that first, those first three parts the outer ear, and canal and the middle ear, if we have hearing loss there we call it conductive because something is stopping the production of the sound to get through the rest of the system. That is called a conductive hearing loss.

Let me give you an example. If we go back to the example of an ear infection with fluid in the middle ear, that fluid may impede or stop the sound from fully getting through the rest of the auditory system. So we might have a temporary conductive hearing loss. It is a problem in the conduction of the sound through the system. Now the second one is a sensorineural hearing loss. That really pertains or refers to a hearing loss that is associated with the inner ear, the cochlear snail shaped portion or the pathways that go on up. That would be called a sensorineural hearing loss. Sensory is for the inner ear, and the neural is all the pathways that go up through the brain.

Then we can have both. Both can occur, and in that case we have a mixed hearing loss. Where we have outer and middle ear involvement as well as inner ear, so we can have both.

Now on rare occasions we can have a problem where everything works fine and conducting the sound through. But the problem is in those upper processing pathways. And in that case we call it an auditory neuropathy spectrum disorder. And that is a problem in the pathways in the processing. Of sound.

Now just another couple things. If we have a hearing loss in one ear that is called unilateral. If you see the word unilateral that is one ear. Bilateral is two ears. We can have hearing loss that occurs just like that. You can have a baby with normal hearing in one ear and loss in the other or a loss in both ears.

All right. Now as audiologists we have a variety of tests that we use and they generally fall into two main basic types. We have objective tests and we have subjective tests. So this slide is going to talk about our objective test, but I'm going to preface it with just saying a subjective test is one where we as an audiologist have to make a judgment based on an observation of behavior. So for example if we start with the classic hearing test where we, with all of us where we put headphones on and have you raise your hand and we heard a sound, that is where we are looking for the indication that you heard it and provided the appropriate behavior or gesture, which is raising your hand. So an objective test we don't have to make an observation of a desired auditory behavior.

And so as you can see there is requires no observation or interpretation of a behavioral response. And then you use the test to determine the functional status of the auditory system. And we have objective tests for middle ear, to look at function of the middle ear. We have objective test that look for inner ear function as well as the function of the central pathways of the brainstem and auditory complex.

Let's move on here and talk about the tests. When we talk about these tests, they are going to correspond to the portion of the ear as I mentioned that, along the auditory pathway that they assess. So you can see how they look at each part of the hearing or auditory system. If we start with, so let's start with one I don't have on the slide and that is simply looking at the outer ear. We look at that and look at the canal with the light. Make sure that things look normal and we do not see anything blocked. Now we are going to look at the middle ear function and for that we use a test called tympanometry. It is simply a measure of middle ear function how well does the middle ear work? it evaluates pressure in the middle ear, and we use it to determine the status of the middle ear system and to confirm or rule out any conductive or temporary hearing loss. The next test is called otoacoustic commissions or you may have heard it commonly known as OAE testing and this one is really indicative of inner ear. Function. It looks at the snail shaped portion of the inner ear. And what it does is it measures sounds that are generated by parts of the middle ear, specifically little sensory hair cells. And we can measure and record these in the ear canal.

The third one is auditory evoked responses. Again you may have heard this more commonly as ABR. and this is where we get a response beyond that inner ear. Now we are looking at responses that we are recording at the level of the brainstem. What we are doing is recording the waves in response to sound. And behavioral, testing that is the more subjective test that I talked about in the beginning.

WILLIAM EISERMAN: while all the tests are used by audiologists for diagnostic purposes meaning to actually diagnose more definitively the presence of hearing loss or not, these tests are also commonly used in different combinations as a part of screening programs, as the first step in a diagnostic process. Now as Terry pointed out earlier, screening procedures are not diagnostic, but identify children who should go further in the process by having an audiologist continue with the testing procedures just for the purpose of identifying a possible hearing loss

TERRY FOUST: exactly in fact all four of these tests have the capacity to be used as screeners and then we have the ability to change test parameters to get specific and use them diagnostically. So let me give you an example. There are many programs including school-based audiology where tympanometry, a basic tympanogram, or just a quick administration of a look at the ear pressure, the pressure in the middle ear, is part of the screening program. One of the best screening methods is otoacoustic commissions. This is one we can use at all ages from newborn on up and we just have set parameters and it can be automated. And the same with ABR, auditory evoked responses. You may see the acronym AABR, which really means we are using

automated auditory evoked responses with that screening parameters but if we have a problem we can use it diagnostically and get very specific with the test parameters that we need to use to look at that.

The same with behavioral testing. Are screening levels can be set at a screening level that would help us identify those at risk and we can screen but if we have issues we have all kinds of ways to diagnostically look at pure tone testing for example. So there's a screening and diagnostic element to each one of these.

WILLIAM EISERMAN: for behavioral screening we typically see that use with most children during the pure tone audiometric screening or the headphone screening that you have most likely participated in yourself

TERRY FOUST: Exactly. In fact we will talk about that coming up here in a little bit more detail. So let's just come back to the ear here really quick. And I want to again just have you look at this. So a tympanogram or tympanometry is going to look at middle ear function so it is going to go from the tympanic membrane or the eardrum through the three little bones. And that space there. OAE screening or diagnostic testing is really going to focus on the inner ear or the cochlea, and the ABR testing is going to look at the progression of sound from the auditory nerve up through the brainstem.

Okay let's talk about otoacoustic commissions. This is one of my favorite tests in our test battery. It's fun for me to talk about. The otoacoustic commissions are really just a measure of inner ear function. It is a relatively recent addition in the history of audiology to our test battery it has been around quite a while, but in the full evolution of tests it is fairly new. The existence of the omissions was discovered by David Kemp in the late 70s, but it really was not seen as a routine part of clinical testing until the late 1990s. But very simply otoacoustic commissions, they are sounds that are generated by the inner ear the little sensory hair cells that are in the cochlea, and does response, the sounds generated can be recorded in the ear canal with a small microphone.

So very simple just to explain it a little bit, what we do is put a small probe snugly in the ear canal. Then there's a sound sting Alyssa goes into the ear, that goes into the ear canal and if the eardrum and middle ear system is healthy and the inner ear is normal, then we are able to record a response. There is a response or echo from the inner ear that can be measured. This is ideal for young children. Babies are the easiest to test when they are younger and to use OAEs it's just a great test for young children or even sometimes children up to three or older that are not able to be tested by other methods. Okay let's go to ABR. So what is an ABR? We discussed it briefly but it really looks at how well sounds travel along the hearing nerve. So after it has left the inner ear how well it travels along the hearing nerve pathways from the ear to the brainstem. And what we do is we want to measure the response at the softness or quietest sound that the child can detect at various pitches. The child's ears are detecting at various pitches so we actually look at pitch or frequency specific information.

I do want to say sometimes the term auditory brainstem response can evoke a little bit of fear in some parents. And I just want to start off by saying the ABR test is safe and does not hurt. It can be completed in sleep. In fact we really do need, in order to complete it we need to have the child sleeping or laying still, relaxed with his or her eyes closed. So if your child is younger than six months of age, than the ABR test can usually be done while she or he naps. But if your child is older and older than six or seven years, the ABR test can usually be done while they are awake as long as they can relax and lay still. And we do that especially in a sound treated suite in the audiology department.

Now for children between six months and six or seven years we may need to do the ABR test under sedation which means the child will need medication to help them sleep through the test? And often in larger testing centers the ABR is with sedation are done through the same day surgical center because we want to monitor and be very careful with the sedation.

When sedation is needed, there are usually some special instructions that we need to follow for eating and drinking in the hours prior to the test. And in most cases if those instructions are not followed, then the test may not be able to be done that day.

A full ABR, diagnostic ABR test will take about an hour to an hour and a half but your appointment, most people will need about two hours without... Excuse me without sedation, and it could be up to four hours if the child needs sedation due to the recovery time before they would want them to release them.

How we do ABR, what we do is we attached three or four small recording discs that we call electrodes onto the head. We put one close to each, either behind that ear or on the ear lobe and we usually have another one on the center of the four head. Then we insert really small earphones into the child ear canal. Then when we do the test we are going to administer different sounds into the ear at different pitches and different loudness levels. And then the electrodes will measure how the child's hearing nerves respond to the sound. So when we are doing that, then we are really going to be looking for the softest intensity or loudness level at which the waveforms we are looking for appear. And that will correspond to the child's hearing level in the frequency range or pitch.

I know that's kind of confusing so let me give you an example of what this may look like. None of you will ever need to interpret these but just for a quick orientation, this is an example right here of any normal ABR response. At the top right here there is an arrow and you can see the waveform going up and down and up and down and then you see a big down right where the green arrow is. That is a very important marker for us and that lets us know that the response is there.

In this example this is coming in at kind of a quieter conversation level and we see the nice big dip. The second wave is a little smaller because we decrease the sound. So it is quieter. Now we are at about 30 dB, which is kind of a loud whisper. Then we reduce

it. We even make it smaller and look, the waveform is still there. So this is indicative of normal hearing. Then we go extremely quiet here. This is quieter than we would normally screen and we have a 10 dB. So this is a normal auditory brainstem response test. What you need to know is we are looking for certain waveforms and we try to see how quiet we can still get the waveforms.

So now let me give you an example of how one may be missing.And again, this looks really complicated, but let me just go over it for reference. So one on, what I will have is on the left we will have one consistent with normal hearing and on the right one that is consistent with a mild hearing loss. So in both, the very top wave where you see the big dip, that's normal conversational level and then we make it quieter and quieter. The one on the right now at the very bottom just looks like scribble. It is not there. And that is consistent with some mild loss of hearing. We can't get it adequate at the level of a whisper there. We are not getting it. Where on the left we have the response that we are looking at.

So that is really an example of ABR. But what we are looking at is t going up to the brainstem and we want to see how the response is a different level of intensity or loudness that can coordinate with hearing loss.

Okay now let's talk about the behavioral tests. These are all the ones, again, where we are looking for a child's response to sound. So it's not a physiological response, where we are looking at something tied to their body or analogy that we measure response from but we are looking at the child's response. I have them listed here in terms of development. So the first one is visual reinforcement audiometry or VRA. And this is where we will use an enticing visual reinforcement such as light or moving images or toys to pair a response to the sound. And we typically use this in children six months to two years. So if I were to give you an example, I might have a child in a sound booth sitting on mom's lap. Okay as you can see in that picture that is on your upper right. And as we present a sound we will do it at a pretty loud level Ist and the black box there may light up and show a toy and as soon as the sound is off the box goes dark. But what we teach is the head turn that we look at for example in very young children. That response can become very strong and we are able to see the quietest level that we might get the response.

Okay then as the child develops or is older we may be able to move to what we call conditioned play audiometry. Let me back up. Visual reinforcement audiometry is typically used in children from about six months up to two years depending on development whole level and other factors. Now conditioned play audiometry is very similar only we use the task that is a little bit more advanced. Here we use a play task to condition to the pairing of sound. So for example we will try to pair a response that just putting a toy in the container or rings on a holder with sound and once they have the task down then we go as quiet as we can where they can still provide a reliable response. We typically use this with children ages 3 to 5 and again it is appropriate to

the individual child. Then the last one is the one that you are probably most familiar with. And that is pure tone audiometry.

This is used with children who can reliably raise their hands or otherwise give a response such as pushing a button on an indicator. Usually it is raising your hand or other response to the perceived sound. We use this with children that are able to do it at three on up through adulthood. Okay that's a lot of ground to cover. And we are going to do one more hard thing here.

WILLIAM EISERMAN: can you just clarify for a moment which of these behavioral tests we might see performed by screeners versus by audiologists?

TERRY FOUST: Yeah. Thank you. So the first two, let's start visual reinforcement audiometry requires specialized equipment and really some experienced observational skill. So you will not usually see that as a test instrument that is used for screening, almost never. Conditioned play audiometry is often used with young children as a screening test. As well as pure tone audiometry for those that are able to raise their hand on up. So the last two, conditioned play audiometry and pure tone audiometry are commonly used for screening children that are able to participate in those tasks. Thank you, William. That's a great question.

Okay so now let's go ahead and dive right into the audiogram. I promise this is our last, it can feel somewhat intimidating part.

So here we go. Here's our graph. You can see this right here. So in audiogram again is simply a map of hearing. Okay and as we look at it, you can see these arrows here that go across the top and down the bottom. So what we have is across the top is frequency or pitch, and that goes from low to high. So if you look at the numbers, 125 Hz is a low pitch number and then it goes right up, 250, 500, 1000, 2000, 4000 the higher pitches are up there. So it goes low to high, left to right. So that right there is pitch, or how low, or how high the sounds are. Then second, on the left is loudness or intensity. So you can see it is very quiet. Zero is very quiet. The quietest. Then we go down and we get louder as we go down the graph up to very loud sounds. You can see there between 110 and 120 we have a jet airplane. So we put these on here so you can get an idea of where some common things would be. So you can see in the first gray shadowed area is actually a bed with somebody sleeping with Zs. So what that is is a quiet bedroom at night should be somewhere around 30 dB. Most people listen to music at about 80 dB. So that is where most people listen to music. If you look at the lawnmower, that is coming in at about 100. That's pretty loud. And a leaf blower is even a little louder. It is between 100 and 110.

Now you can see this swoosh there. That is what we call the speech banana and let's go to that very specifically here. Okay here it is right here. Again. So again, across the top quiet allowed on the slide... Excuse me across the top low to high pitch and across the site on the left is quiet to loud. We call this the speech banana but you can see all the speech sounds in English are right here. So let's do a couple of these and think

about them. If we got m it is a low pitched sound and let's go up a little higher. We can do an O. then let's go up between one and 2000 and let's do CH. CH. Now we have lost the voicing. We don't use our voice anymore for the particular sound. So it is moved up higher in the pitch range. Again it is higher evening than we have K you will notice all of those sounds now from 2000 up have no voicing. They are actually sounds we make by constricting or using airflow in different parts of our mouth. So they become very high-pitched sounds with the highest being FS and TH.

This is important in that our goal is to make speech audible for children with hearing loss if they choose to use amplification with hearing aids or cochlear implants.

Now let's match hearing to the audiogram. So when we plot hearing, anything that's in the yellow we consider to be within normal limits. So that would be 20 dB and quieter on up. Anything from 20 to 40 is considered in the mild hearing loss range. So we go on down with 42 about 55 being considered a moderate hearing loss. The 55 to 70 moderately severe and 70 to 90 is the severe hearing loss range with 90 and above being pretty profound or profound hearing loss, where we may not have any residual hearing.

Okay so now let's go back to the audiogram here really quick. I want to show you the normal conversation in speech occurs about the red line, between 50 and 60 dB. So can you see how much of the speech banana is actually quieter than the range? Most of it is. So we need to amplify or bring, ensure that the sounds can be audible there. Anything below the red line makes it really difficult to hear speech. You just really are missing almost all of those sounds.

WILLIAM EISERMAN: by below we actually mean below, not on this graph, but above on this graph, but below in terms of the actual intensity.

TERRY FOUST: thank you William. I appreciate that. If we have any hearing, hearing loss that cannot hear sounds like we said below... Meaning sounds that are quieter than 60 dB, then we are missing all of those in speech. So thank you for correcting that, William.

Okay. Now let's go to treatment intervention. Now that we have talked about hearing and where the sounds of speech fall. So for medical intervention , depending on the hearing loss and where it occurs we may be able to provide surgical treatment. So for example if there's a problem in the middle ear, we may be able to do a repair. For example sometimes there can be a problem with the three little bones and that can be surgically fixed and often we can bring hearing back to normal limits.

We also provide treatment for chronic middle ear disorders. So we may treat with medication. We may also place pressure equalization or PE tubes that help treat the middle ear disorder. Then we also provide intervention for amplification of sound. So how we can bring all those speech sounds, how we can make some loud enough for them to hear and develop oral communication skills if that is the family’s goal.

So in that case we work with fitting hearing aids. We work with cochlear implant systems and we work with FM systems. So let's quickly go over those.

And I think I'm going to move right here to talk about hearing aids. Hearing aids simply take a sound and the amplify it. And in the most simplistic description we actually are able to get pretty specific with certain frequencies and areas but most hearing aids have a microphone that gathers the sound. They amplify it with the power of a battery and then the sound is put into the wearer's ear through a little speaker. So that is a simple explanation of how the hearing aid works.

Then you know I think a lot of people may not really realize that we can fit hearing aids as young as a month of age. We can really intervene early. So I want to just stress that it is possible to proceed with amplification almost as soon as a diagnosis of hearing loss is made. Knowing the benefits of early amplification as we talked about earlier we can educate and encourage parents as they take the first step in habilitation.

WILLIAM EISERMAN: that ties back to when Terry referred back to the one, three, six goals. The faster we can do that the faster children can be provided with the support that they might need around communication and hearing. And if it can be as young as one month of age, all the better.

TERRY FOUST: Yes, thank you William. I can't emphasize that enough. Now here you can see a variety of hearing aids but what you see, if you look in the upper left, you can see the red piece. That is called, in that child ear and just below that you can see outside of the ear, that is called the ear mold. That fits into the ear in the ear now and through the tubing that goes from the hearing aid and through the ear mold the sound is delivered. You might ask why did they need that big mold in there? But there are acoustic properties that mold can help offer to the amplified signal. So it is important, the molds are actually really important. Then the side as you may hear parents constantly talk about the need to, especially as the child is growing that they are always redoing the ear mold so they cannot where the hearing aids right now because the ear molds don't fit so that's a common challenge and when we encourage them to work with the hearing health care provider with in order to ensure that the molds fit well and I resized as quickly as we can.

Okay let's move now to cochlear implants. A cochlear implant is an electronic medical device that replaces the function of the damaged inner ear. So unlike hearing aids which make sounds louder, cochlear implants actually in all functionality they do the work of the damaged parts of the inner ear or the cochlear or the snail shaped portion you see in the picture to provide sound signals to the brain. So it works by using special electronic technologies to take the place of the nonworking parts of the inner ear. And it is designed to mimic parts of natural hearing. It works like this. We have a sound processor which is number one and it picks up the sound. The sound is picked up by the tiny microphone which is sensitive to the direction that the sound comes from. Number two, there that is the digital signal. So what that does is takes the sound

collected by number one and it sends the signal across the skin to the internal implant. So this is done with technology that is similar to the way a radio station would broadcast its signal but on a much smaller scale. Then the third part, number three is the electrode array. So the internal implant converts the signal that is come through the skin into electrical energy and it sends it down through an electrode array inside the cochlea. It is threaded through the cochlea. You can see the little gray dashes.

And then those electrodes stimulate the hearing nerve. They bypassed the damage hair cells in the brain perceives the signals of sound.

Okay so now during the exploration as they look at options, parents of some infants may ask if their child is a candidate for a cochlear implant. The criteria for candidacy has changed over time and it is actually changing now. So this slide shows the current candidacy. However, as I mentioned it is currently changing. So current guidelines as you see here have been that we will consider implants, approve implantation from age two and older that have severe to profound deafness. But in May of this year the FDA just lowered the age for the cochlear nucleus system . So certain types of implants to nine months. And I would anticipate seeing that follow across the manufacturers.

Okay so it is not only age and degree of hearing loss though that is the candidacy requirement the child must have no other contraindications and must be committed to the therapy and oral training that would come with that. So learning to listen and an appropriate educational program, and then they also look at the family factors, how motivated are the family and do they have realistic expectations.

WILLIAM EISERMAN: this means the children need to be a relatively close proximity to a service provider who can help with all of those things.

TERRY FOUST: Exactly. And lastly the frequency modulated radio systems that the intent is to reduce the impact of background noise by providing a direct link from the speaker, so in the lower picture that is the teacher. She has it clicked on. So it is close . It picks up her voice, sends it through the air through frequency modulation to the hearing aid of the children that are up sitting at the desk and it cuts out the background noise. So it improves the ratio of the primary sound or signal to the background noise and help the child get a clear perception of sound. An FM system's primary use is an education and normally difficult listening situations. Some of you may have seen in movie theaters that hearing aids can switch to FM, and they can directly get the feed, the auditory feed, the audio from the movie and cut out picking up anyone speaking to them or the sounds around them.

What does all of this mean? I think I have alluded to that earlier when we talked about the speech banana but what it really means is that we want to get speech sounds amplified and hurt so that understanding and production of speech can occur if possible and the parent chooses.

A couple things to think about with hearing-impaired children is distance. And this is actually really key because sound if you have to distance between the source of the sound and the child's ear, then the sound increases by 6 dB. So if you are 4 feet away from a child and you are talking about at the level of a whisper if you now bring the child two feet at the same level of speaking it is now 36 DB, or so it is 6 dB louder. Then if you bring that child 1 foot away, than they are the same level of speaking is now 42 dB.

So what I am really saying there is we want to be close to our kids, we want to encourage the close physical distance because we are actually helping increase the signal for them.

And I will just show you here. We call it the listening bubble, but we want to be in the range of where they are hearing best. So we actually do distance tests to find out where the hearing drops off and we may know with a certain child we may want to be within 8 feet. And another listening bubble may be 6 feet. But there are things to consider and these are things the audiologist can help the family and educational system do to support their children.

And then we want to highlight the visual environment. We want to provide optimal seating, positioning. We want to make sure the lighting is great and we want to direct attention to language sources. These are all things that audiologists can comport with in order to help have the best listening learning environment possible.

And then finally, we manage hearing loss, we monitor and manage it. So hearing can change over time and get worse much more often than we would hope. We can help plan for future needs. So if hearing is progressive or changes then we want to ensure that we fit with amplification that is flexible so we don't have hearing aids that no longer work and we want it to last.

We monitor the function of their amplification, their hearing aids and cochlear implants so we help troubleshoot and we can provide educational input and consultation, things we have mentioned before with classroom modifications, FM systems and educational strategies. And with that, we just made our time. I apologize that we did not have time for questions.

So I have opened up the queue questions field on the left. If any of you have questions or need for clarifications we would love to have you type those in and we will ask Terry to give us a, some insight about that. The first question is, is it a conductive loss due to no ear canal if there is a level of loss like mild, moderate etc.?TERRY FOUST: oh good question. So if I understand right we have an ear that has no ear canal or that your canal is closed. In that case it is considered a conductive hearing loss. We are blocking the signal from getting all the way through the system. And often that can be surgically corrected. And an ear canal can be opened up. It can be opened up and allow the sound in. So yes. It would be considered a conductive hearing loss.

WILLIAM EISERMAN: the next question Terry is do you have any insight about why insurance companies do not typically cover hearing aids?

TERRY FOUST: yes actually most insurance companies are now covering hearing aids. It is becoming the exception not the rule to not cover amplification. In most cases it is limited to certain time periods. For example, you may only be able to get new hearing aids every two years, or as per the plan language but most insurances including Medicaid will cover hearing aids.

WILLIAM EISERMAN: the next question is if my child has normal OAE tests, but ABR shows mild hearing loss does that mean the auditory nerve is damaged somehow, but that the inner hair cells of the cochlea are functioning?

TERRY FOUST: great question. Yes. This is a more rare finding between the two tests. But that is exactly what they measure. OAE will look at inner ear function and if it is normally means the sensory cells are firing or responding the way we want. But then the problem can be further along the system with the auditory nerve and up to the brainstem. So yes.

WILLIAM EISERMAN: the next question what is the minimum test battery for accurately diagnosing children?

TERRY FOUST: great question. I really like that question because we don't want to make decisions based on one test alone. I actually recommend that we do all four categories of tests. We want to test the middle ear and rule out any issues. We want to assess inner ear function and we want to assess the brainstem function as it exits the auditory nerve up through the brainstem. So I would consider a full battery would be needed in doing diagnostics with children from all of those categories of tests.

WILLIAM EISERMAN: the next question is Terry, can you introduce the audience to VRA, and differentiate between whether a child is just the movement or light with its peripheral vision?

TERRY FOUST: Yeah visual reinforcement audiometry. And it takes skill to do this. And it has to do with the timing of training the response. So the light or the movement is never presented before the sound and we time and work with those lags and then we also have techniques to look at the reliability and how many times a response needs to be repeated. It has to be repeatable.

WILLIAM EISERMAN: the next question is can you talk briefly about Baha and when would this be used versus hearing aid or cochlear implant?

TERRY FOUST: yeah... So a Baha is an implant system. And it is different in that that is a bone conduction type of solution. So it uses... So a cochlear implant, we put electrodes into the cochlea or the inner ear system and we stimulate it there. Bone conduction, a bone conduction implant system is trying to overcome a conductive problem. So for example, if we went to the earlier question where there was no ear

canal, but all the other inner parts were normal, we could do a Baha, or bone conduction implant system and stimulate the inner ear by bone vibration. And that is what a Baha system is. It is a bone conduction implant system.

WILLIAM EISERMAN: can you clarify how a visual behavioral hearing screening works, if a child is enticed to think that a visual cue will show up with the sound?

TERRY FOUST: Okay I'm going to back up a little bit here. We are going into diagnostics... That will really be well within a pediatric audiologist's realm, and probably, and it is not used for screening. And so... There's just a lot of training involved in the and so I think it would be best left in the realm of diagnostics which we could probably approach in a different discussion

WILLIAM EISERMAN: we are going to wrap up shortly here but I think that response, Terry, is an important for all of us who are not the audiologists to remember that we don't have to know everything about audiologists. We can get into the so-called weeds unnecessarily where our time might be better spent learning about other things. The next question is if a child is fitted with a cochlear implant at a very young age do they need to go back later for additional surgeries to update the size as they grow?

TERRY FOUST: usually not. What will happen is we may have a failure of one of the components before whatever we would need to do anything due to growth. there. So that would not be a standard need.

WILLIAM EISERMAN: A couple final questions here Terry. Would there be a reason for a second ABR when the first one confirms the hearing loss?

TERRY FOUST: Yes, there are reasons. One of the primary reasons is for the parent or primary caretaker's comfort in wanting a second opinion to confirm and also professionally if I use myself as an example, I may be looking at some various factors that I may not have been comfortable with in the conduction of the diagnostic test and I may want to repeat it. So perhaps I was testing a child where they just were moving a little bit too much and I just wasn't confident. So I may want to retry again.

WILLIAM EISERMAN: what could cause a child to pass an OAE but fail a behavioral test?

TERRY FOUST: Really great question. That happens a lot. Let's go back to the concept that the OAE is an objective test so we are looking at a physiological response from the body from the inner ear. So that does not require the child to do anything and they can pass the OAE and have normal inner ear function. But when we take the same child and want to test them under headphones and try to get them to respond to either play audiometry or pure tones they may not be developed enough with their overall development to do so. They may have cognitive limitations or other mitigating factors. They may have language barriers to where the instructions for the test are not understood so there's a lot of variability in behavioral testing that we just do not have with OAE.

WILLIAM EISERMAN: Thank you very much, Terry and to all of you for the excellent questions today that was Dr. Terry Foust who has given us an overview of audiology for non-audiologists. We hope that you will share the link to the recorded webinar if there are folks in your world that might benefit from this, whether they are EHDI professionals are parents or others. Thank you to the captioner today for your services and for those of you who provided some feedback on the captioning. We will try to improve the way that this appears. So thank you for your patience with that today. Before you all go, if you could click on the highlighted text in the middle of the screen to give us some feedback, and also to get a certificate of attendance for today's webinar. Thank you everybody. Have a good day.