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NCHAM — UTAH STATE UNIVERSITY  
UNDERSTANDING HEARING LOSS AND AUDIOGRAM RESULTS  
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>> Hello, everyone.

Welcome to today's hear 2 learn webinar brought to you by the Department of Communicative disorders and deaf education at Utah State University.

This webinar is being recorded.

Please note that handouts for this presentation can be found for download in the bottom left corner of your screen.

Today's presentation is entitled, understanding hearing loss and audiogram results, which will be presented by Dr. Kali Markle.

Dr. Kali Markle is a pediatric audiologist and a clinical assistant professor at Utah State University, majority of her time is spent in the clinic supervisor graduate students and seeing patients.

However, she also teaches graduate students -- graduate academic courses.

Dr. Markel provides diagnostic operation to children birth -- fits hearing aids, bone conduction devices and works with cochlear implants.

She oversees the newborn hearing screening programs at two hospitals and helps fit and maintain F.M. systems at some of the

charter schools.

Please hold your questions or comments until the end of the presentation.

At that time I will open a text field for you to submit any questions or comments you may have for our presenter.

Now I would like to welcome Dr. Kali Markle to today's webinar.

>> Hello, my name is Kali Markle and I'm a pediatric audiologist.

Today I want to talk to you about understanding hearing loss and audiogram results.

For this webinar, we have three learning objectives.

Individuals will understand degree and type of hearing loss and learn how to interpret audiogram results as well as how to use audiogram results for intervention.

Sorry, that clicked ahead.

Before we start talking about audiograms, let's talk about hearing loss and the types of hearing loss.

Sound energy is collected by the outer ear and travels down the ear canal to the eardrum.

The eardrum vibrates with changes in air pressure caused by the incoming sound waves.

And sends three middle ear bones into motion.

These mechanical movements create pressure against the cochlea or hearing organ.

The displacement of fluid within the cochlea creates waves that

send hair cells into motion and this movement sends an electrical impulse to the surrounding nerve finders and up to the brain to be interpreted.

As you can see, we designate three parts of the ear.

The outer, the middle and the inner.

A hearing loss can occur at any point within the auditory system.

If the outer or middle ear is affected, there is a conductive hearing loss.

If the inner ear is affected, it's called a sensorineural hearing loss.

If there is an issue in both, it is called a mixed hearing loss.

If, for example, a child is born without a Pina or outer ear, they will likely have a conductive hearing loss.

Think of a conductive hearing loss like a road block for sounds to get through.

If a child has chronic middle ear infections and tubes placed, they may also have a conductive hearing loss.

If a child either has damage -- if a child also has damage to the cochlea, then that would be a sensorineural hearing loss.

And if both parts end up being affected, that would be a mixed hearing loss.

The combination of both the middle and inner ear.

Information presented on an audiogram may vary depending on the child and the goals for that child.

All audiologists will use an audiogram for diagnostic purposes or to show the individual's hearing status in the unaided condition.

There are audiograms to show the aided condition which demonstrates how a child detects sounds with their devices on.

More often than not you would see this for cochlear implants.

First let's get oriented with the audiogram graph.

In order to interpret the audiogram we have to look at each axis.

The top of the gram will show the pitches or frequencies tested. Audiograms typically will range from 500 to 8,000-hertz, where hertz is the unit for frequency.

Audiograms focus on these frequencies as speech information is roughly in this area.

Some audiograms may go down to 125-hertz.

And some audiograms may include what we call extended high frequencies which go all the way up to 20,000-hertz.

These may be tested depending on what the individual needs given their symptoms.

On the side of the graph, you will see more numbers and these are in DB or decibels which represents the level or loudness of sound.

The normal range is plotted on the top area of the graph because these are the softest sounds where hearing loss is then plotted below this area lower and lower on the graph.

This means that the individual cannot detect sounds until they are much, much louder and they get lower on the graph.

Symbols are plotted on the graph and depict where the softer sounds are heard across the pitches and the symbols will depend on which ear is tested with a red circle or triangle for the right ear and a blue "X" or box for the left ear when using headphones.

You may also see carrots or brackets which represent the response to sound using a bone oscillator.

Remember I used the word road block.

The bone oscillator will bypass the road block using vibration.

This tells us the type of hearing loss present.

Now that we have the foundation of the graph, let's look at the diagnostic audiogram.

The purpose of the diagnostic audiogram is to determine the degree and type of hearing loss.

Understanding the specifics about hearing loss will help guide audiological intervention options.

It's important to be able to interpret the diagnostic audiogram so that the individual and their family can be empowered and advocate for their needs.

There may be a slight differences between audiologists but most pediatric audiologists will agree with that layout.

As you can see the degree of hearing loss is presented as a range.

The range of normal is from -- the range is from 16db to 25db.

The mild range from 26db to 40db.

The moderate range from 41db to 55db.

From moderately severe range from 56 to 70db.

The severe range from 71db to 90db and the profound range of greater of 90db.

Hearing loss may occur in both ears and now we are going to kind of put everything together.

Here are the symbols plotted and we have the degree or degrees of hearing loss.

In order to understand type of hearing loss, we look at the carrot or brackets from the bone oscillator and whether or not there is a gap or that road block compared to the hearing levels through the insert ear phones for the entire hearing system. The first audiogram has thresholds in the moderately severe to moderate range in both ears.

This is a conductive hearing loss.

There is an issue with the outer or middle ear or both.

The second audiogram is showing a mild to moderate hearing loss in both ears and is sensorineural.

You can see the brackets or carrots overlapping with the circles and Xs.

This tells us that the hearing loss is sensorineural and located in the inner ear.

The last audiogram is showing a moderate to moderately severe loss in the right ear and a moderate to severe loss in the left.

Both of which are a mixed hearing loss because there is both an issue with the outer middle ear and the inner ear as shown by the gaps between the brackets and the circles and Xs as well as the brackets falling in the range of hearing loss compared to the first audiogram that shows the carrots in the normal range.

And that will be the difference between a conductive and a mixed hearing loss.

Hearing loss can occur in two ears or in one ear.

In which case it's important to distinguish which ear is which.

Here is an example of the unilateral conductive hearing loss.

And this is in the moderately severe to moderate -- sorry.

We have to go through all of these again.

Here we are.

Moderately severe to moderate range.

And this is an example of the unilateral hearing loss just in the right ear.

You can see that there is not just a difference between ears.

The red triangles and the blue Xs, but also a gap between the

red brackets and the red triangles.

We can tell that this is conductive because of that large gap.

Next we have a unilateral slight to moderately severe sensorineural hearing loss in the left ear.

Excuse that typo.

Apologies there.

Hearing loss in the left ear.

Here we see there is a difference between blue and red.

So the right ear is in the normal range but the left ear is in the range of hearing loss in the slight to moderately severe range.

Lastly we have a unilateral moderately severe to severe mixed hearing loss again in the left ear.

I apologize that those two last ones are typos and there is only a 50/50 chance between ears, huh?

Here you can see compared to the middle audiogram is that there is a gap between the brackets and the Xs in that left ear, but that the brackets also fall within the range of hearing loss and that's what makes it a mixed hearing loss.

Asymmetrical hearing loss can be pretty tricky.  
This means that there is hearing loss in both ears but it's possible that loss is very different in both ears.

Here I show an example of a mild to moderate sensorineural hearing loss in the right ear and a severe to profound mixed loss in the left ear.

There is a difference between ears, but they both have hearing loss and that's what makes them asymmetrical.

The audiogram -- determining hearing status. Sometimes you hear people refer to hearing loss -- reviewed audiologists will diagnose hearing loss by degree and type.

For example, mild sensorineural hearing loss or moderate mixed hearing loss and so on.

There is a really grade tool that audiologists utilizing best practice would have access to and that may better explain the impact of hearing loss.

This is called the speech intelligibility index or SII.

This is a percentage of speech sounds that are important for audibility or what the person has -- audibility or what the person has access to.

The SII can be calculated and used as a discussion point for the child's access to speech.

This is sometimes easier to conceptualize than the degrees of hearing loss and may be seen as an up and coming way to talk about hearing loss.

Here you can see the percentage of speech accessible to the child with each hearing loss and the first audiogram is showing zero percent.

That means without a device on, this child is unable to hear speech at a conversational level.

The second audiogram is showing 35 and 36% for the left and right ears respectively.

And then the last one showing two and 3% for the right and left ears respectively.

While this is a helpful tool, you need to know the degree and type of hearing loss your child has or the child you are providing services to has.

For children utilizing hearing aids or bone conduction

hearing aids, the SII can be calculated for the child's aided audibility when using their actual devices.

An audiologist with a verification system and appropriate equipment can measure how the child's ear canal is taking in sound and then program hearing aids to a pre-descriptive target and see how much audibility the hearing aids provide.

Compared to without a device on.

Bone conduction devices have slightly different but require a *in situ* measurement how they hear sounds.

This data entered into the system and we can see how much audibility is provided with the bone conduction device on.

As you can see here, the audiogram is plotted though it is upside down to look at how much benefit or gain is given compared to looking at hearing loss or how much is not heard.

There are three stimuli levels for soft, average and loud speech, and they are shown in the green, pink and blue colors.

The yellow stars indicate the upper limits of equipment to ensure nothing is too loud or uncomfortable.

This technology is so helpful on understanding the benefits and limitations of amplification, so let's zoom in a little bit on SII.

Here you can look at the unaided SII in gray for each level of speech presented compared to the aided SII.

For this talk we will look at the average level of speech. For the average level of speech in the right and left ears the child can only access 44% of speech in the unaided condition.

Compared to 90% using their appropriately fit hearing aids.

Now let's look at bone conduction.

There isn't an unaided SII listed in my programming software with but we can -- software but we can retrieve that.

0% on the right and 0% on the left.

Here the colors are swapped but we are still looking at average speech and we can see that there is a huge increase to 80% and 87% in the aided condition compared to that 0% from the unaided

condition.

These are just a few examples but this is such a helpful tool to understanding hearing loss in addition to the audiogram.

So now you may be wondering about cochlear implants.

Cochlear implants are unique intervention for children with significant hearing loss.

They would typically have a severe to profound sensorineural hearing loss with an unaided SII of zero.

Note that candidacy criteria is based on the federal drug administration or FDA as well as Medicaid and Medicare guidelines and this may be subject to modification in the future or after this talk has been recorded.

A child who is a CI candidate is typically required to trial hearing aids and while we can program hearing aids to the best of our abilities, their aided SII would not be sufficient for providing audibility that supports spoken language development.

In which case we would say there is some benefit from hearing aids but not enough with hearing aids alone.

Here you can see that improvement as 34% in the best ear at average conversational speech.

And 34% of audibility at its best may not support listening and spoken language goals if that's what the parents have decided.

This child may be a candidate for and receive a cochlear implant which has both an internal electrode and an external -- with population.

The same -- population, the same way I showed you with hearing aids and bone conduction hearing aids.

So we use a detection audiogram or an aided audiogram.

The aided audiogram is marked with letters that represent

the softest sounds depicted.

While wearing some kind of hearing device.

As we just reviewed, this is most typically a cochlear implant because of the uniqueness of the device.

Though some audiologists will test children with other devices as well.

You may see an A to represent the aided response, or you may see the words CI designated as the cochlear implant as seen here.

Or you may see them use the letter R or L to designate right and left ears and maybe even a B for bi-let real -- bi-laterally worn devices.

The important piece is differentiating whether there is an improvement between the circles and Xs to now with the devices on.

The caveat to keep in mind when looking at any aided audiogram is that technology has advanced to the point where hearing aids and cochlear implant processors try to reduce any competing sounds or noises that they think are not important to speech and language.

The digital technology may not give you the most accurate understanding of how a child is functionally performing.

While this talk is focused on audiograms I would be amiss to not include statement about using other forms of validation in addition to verification of hearing aids and bone conjunction devices -- conduction devices and in addition to a CI detection audiogram.

This means using parent questionnaires for young children and speech reputation tasks for older children.

For children with hearing aids and bone conduction devices it would be useful to have the unaided audiogram, the SII for both unaided and aided conditions and a questionnaire reputation task.

Whereas for a cochlear implant user, we don't have an SII so we would have the unaided audiogram, the aided CI detection audiogram and a questionnaire speech per section task

depending -- perception task, depending on the child's age. That would be best practice.

As we have reviewed, the audiogram is necessary for understanding degree and type of hearing loss as diagnosed by an audiologist.

It helps for providers and care givers to understand and consider audibility or access to the speech spectrum for the child with hearing loss.

With this information appropriate recommendations can be made for intervention.

This likely includes amplification with either a hearing aid or bone conduction hearing aid or possibly a cochlear implant.

The audiogram provides a guide to programming these devices and therefore provide that audibility.

For other providers, the audiogram is a tool to understand areas of need with regard to listening and spoken language.

If a child doesn't use their devices during intervention therapies, the providers can better understand how much of the session will be audible and if strategy should be modified during that session.

This can also be motivation for learning to troubleshoot equipment for parents and providers.

Today we reviewed degree and type of hearing loss and how to interpret audiogram results including the speech intelligibility index and we reviewed how to apply this knowledge to intervention.

Thank you so much for spending the time with me and we can open it up to any questions.

>> Thank you, Kali, for your presentation.

At this time we are open for questions.  
Please type your questions in the Q&A pod that is open and Dr. Markel will respond.

After this webinar, if you still have any follow-up questions or comments, please e-mail me @nicole.Jacobson at usu.edu. And I can relay those questions to Dr. Markel as well. Loretta Jackson asking if you can give a brief explanation of a Baha.

>> Thank you for asking this question.  
Baha is a bone anchored hearing aid and I refer to them as a bone conduction hearing aid for children because they are worn on soft bands.  
And so if you look at the anatomy of the ear, a Baha is acting exactly as that bone oscillator is for our testing so the Baha will vibrate on the bone and send the signal directly into the cochlea so it's bypassing that barrier that may be microtia or atresia or it may be chronic ear issues or anything of that nature.

These are coming in fast, Nicole.  
Can I just go ahead and go through them.

>> Sure, you bet.

>> Yeah.

I have noticed a large air bone gap on 4,000-hertz, can you explain, please?

Thank you for the question.

Usually sometimes it's to do with calibration.  
The bone oscillators are very fragile and sensitive piece of equipment.

And so oftentimes getting it to vibrate loudly enough can cause some difficulties at 4,000-hertz.

I have seen that as well.

And so it doesn't necessarily mean there is a conductive issue. Sometimes it's a calibration issue.

Cora asks: Any tips for using the audiogram to explain hearing loss to families who don't notice the hearing loss at home.

Cora, I would say if you have access to knowing what the SII is, that can be a much easier way to explain to families.

If the child has a mild hearing loss, they may have an SII of 75 unaided and so telling them that they only hear 75% of what you are saying may be a better way to influence change and implement more strategies to keep hearing aids on.

I know it can be hard to tell families who say, well, we can -- we see our baby turning to sounds.

We know they can hear.

The second thing I would say to that is, talk about clarity of speech and hearing versus listening.

Yes, they can hear you, but do they understand you?

And it's too hard to tell with young babies whether or not they actually understood you.

And so you want to enforce audibility with hearing devices as best as possible.

Mary asks: How would you simply briefly explain an audiogram to a parent of a newborn.

when I do this, usually we take quite a bit of time to make sure that they understand the audiogram, but also really talking about their needs where they are in this process because it is a bit of news to receive that your child has hearing loss.

And so usually I try to break it down across multiple visits.

The audiogram is a tool.

It's a graph and I do want families to be empowered by knowing what the audiogram is, but at that beginning stage of diagnosing a newborn, usually we want to focus a little bit more on the coping side of things and making sure that the family is prepared for that process.

So usually I would just tell them, you know, if it was moderate to severe, I would show them the graph.

It's a moderate to severe sensorineural hearing loss and I would go into how are you feeling?

What would you like to move forward?

What are your goals?

And then we would review the audiogram at all future visits beyond that.

Jaime asks, do you follow a specific set of data for SII for all children that have an audiogram and then follow your recommendations of assistive technology based on service II data.

Yes.

There is a normative table for SII based on the Pure Tone average of the audiogram.

It's not perfect but it gives us an idea of what is the best outcome for that child because not all children with significant losses will get an SII that is 100%.

They may get close to 75 or 80, but they never get that full 100 and so for them especially assistive technology would be a recommendation to help improve their access to -- at school.

Patty says: Is there a way the audiogram symbols in the downloadable documents?

yes.

There is in one of the first few slides it has the Xs, Os, the carrots and the brackets.

You should be able to see that there Candice asks, when did you

say a speech reputation test can be used.  
As early as the child is able to.

So usually for infants we are using questionnaires, but I would say as young as a two-year-old can participate in a speech reputation task and that -- repetition task and that would understand functionally how that child is doing if that child is able to repeat ten words in our test set.

All fantastic questions.  
I went through them quickly because I wanted to answer.

I still have a few minutes so if there are any other questions or if I didn't answer your question to the depth that you liked, feel free to chat -- type it in the chat.

>> I don't know if you see Kathleen says, if the audiogram notes share sound feel testing she is --

>> Yup

>> Mile hearing level with the cochlear implant, does this mean child is comprehending and gaining clarity of spoken language words?

>> I could --

[End of captioning]