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Beyond the Basics: Interpreting Wideband Tympanometry with Confidence

Presenter: Jackie Davie, PhD

Today's presentation is in partnership with the American Academy of Audiology. We are honored to be the continuing education partner for the Academy. This presentation is an overview of the Academy's statement on assessment of vestibular function in the pediatric population. We have a wonderful group of clinicians from across our nation here to speak with you today. I'll hand it over to Dr.

Lavender to introduce them all. Thank you so much. We are so honored to be able to present this document for you all today. We've worked really hard on it and we're very proud of what we've done and it's going to be exciting for the field to have something like this to reference. My name is Violette Lavender and I work at Cincinnati Children's Hospital Medical Center.

Hi, my name is Kristin Janke and I work at Boys Town National Research Hospital. I'm Kay Bachman. I work at Cincinnati Children's Hospital Medical Center. I'm Melissa Kane and I work at the Children's Hospital of Philadelphia. I'm Michelle Castiglione and I work at Cincinnati Children's Hospital Medical Center.

My name is Guang Wei Chou. I work at Boston Children's.

Thank you so much.

Before we begin, we have a message from our wonderful AAA President.

I'm Tish Gaffney, President of the American Academy of Audiology. The Academy is the home for audiologists. We are dedicated to achieving recognition of audiologists as the experts in hearing and balance care and the field of audiology as an independent clinical specialty that is integral integral to the healthcare team. We offer our members the latest resources for practice management and clinical evidence based practice so that they can grow professionally and improve patient care. We advocate for our members in Washington and throughout the country to ensure that the voices of audiologists are

heard and we help connect audiologists to one another through valuable networking opportunities.

If you like this webinar, then make sure you join us each year at the annual AAA Conference for Thought Leadership you won't find anywhere else. Learn more about the conference and how to join the academy@audiology.org thank you.

These are our disclosures and we do have some limitations and risks today and I'm just going to briefly show you our learner outcomes as well. We won't go over them, but here they are.

We will begin. So I want to let you all know how this how the process of this path began for all of us. It was probably back in 2000 and early 2019. Dr. Ian Windmill was our director at Cincinnati Children's and he's a Past president of AAA himself.

And he came to us, he's our director, and he said, I would love it if this vestibular team would lead a consensus document. Actually, at the time it was a guideline. I'd love it if you do a guideline for AAA on pediatric vestibular testing. And so we decided to do that. It went back to AAA and it became officially approved right in the middle of the COVID 19 shutdown.

So around March of 2020, I guess. And there was a lot of stumbling blocks in the beginning because as you all know who we were working at the time, there were some challenges with scheduling and challenges getting together. And our team tried our best to meet. As much as sometimes the patient load was intense, just trying to get everybody back after Covid. The drivers that we had at the time was that there was no formalized vestibular test battery for children at the time.

There was some really exciting normative data that was coming out in the literature and especially on the new sophisticated equipment that was coming out for V and G. Demps were recently on the scene. Rotary chair were becoming more sophisticated with. With the video goggles instead. At the time, we

didn't even have whit and we had whit.

I'm sorry, but they didn't have goggles that were maybe small enough for children. We didn't have options for them. And so we really wanted to say to the clinicians in the smaller centers, if you have a two year old on your schedule, what can you do? What are some options you can do? And here's all the tools in your toolbox.

Some of them need special equipment, some of them don't. And we wanted a centralized document that could have national distribution. So something within aaa. The team we put together, you met our team just now, but this is where we all work across the country. And we had reviewers from other centers across the country too, which was exciting to have some.

Some voices from other centers that are doing vestibular testing. And the other really important part is that in the last maybe eight years, there's been lots of pediatric focus centers popping up all over the country. The resources we used, of course, were our own clinical practice. A lot of us were figuring it out. I know in the Cincinnati children's world we could tell you lots of interesting stories of things that we came up with that we would all cringe over.

Now that we're like, I can't believe we did that back then. But we were learning. We were trying to figure out how to work with a four year old who maybe had, who was on the spectrum, or maybe a, maybe a 2 year old who was having a really tough time as a toddler that day. But clinical practice was a big part of it. The other part was textbooks.

There's not many, but there are some great textbooks out there for, for pediatric vestibular disorders conferences. There are now more and more conferences that are available for pediatric vestibular testing. For example, some of the colleagues on here, they put on an annual conference every year in the spring for pediatric vestibular disorders. There's also peer reviewed articles that have given us

some great recommendations. Obviously, Dr.

Janke here had a publication on some suggestions on how we should be testing children for different age groups. There's also some recommendations from our international colleagues at Ghent University. And of course, Sharon Cushing has some recommendations as well. So there's been recommendations from all over the world. We've had Paris as well.

But that's exciting to have lots of sources to draw from. The document started off as a practice guideline and it was switched over to a clinical consensus document. This was a nice change because it really, we felt, highlighted more of a option for clinicians to read it and look at it from the clinician perspective. We really wanted it to be accessible and something that clinicians could pick up and easily digest and use. We didn't want it to be a cookbook.

We didn't want to say you have to do this with every child. We wanted to show these are just tools that you have and these are some options for altering or modifying your test battery for children. We also wanted to give appropriate normative data sources that that was the most current and up to date. I'm sure we will be amending that from time to time as more normative data or equipment change. And then of course, there was challenges with the focus areas too.

We wanted to make sure that we were providing information on the specific end organ structures that were involved. For example, was it the canals? Was it the otoliths? We wanted to look at subjective and objective data. We wanted to look at the functional impact.

How is this impacting children's lives? And of course, we wanted to look at the age and developmental level because not all children test exactly the same. Maybe for adults we could do more of a standardized test pattern, but for children, because every child is different, their functional or developmental level is different, we need to make adjustments. I also want to point out, and I think this

is on your test, that around 50% of children or less probably have a vestibular disorder. If they have hearing loss.

And with that comes certain challenges. So this was a key driver for us. We wanted to make sure that especially the children with hearing loss had options to get tested and get therapy because they may pose risks for developmental delays, developmental milestone, gross motor milestone delays, maybe academic challenges because of their VOR deficit. So we're going to go into all the tests today, kind of a little by little to show some of the highlights for the pediatric modifications and normative data so that we can accurately tell you all these are some ideas of how to test kids. And this is just a real nice chart we made in the document.

You can pull this out at any time and you can screenshot this if you want, but it will be published. But eventually it will show you that if you have a birth to two, for example, you'll look at the first column. These are some bedside tests that we have available questionnaires. Here are some canal tests that we can use. There's the otolith tests as well.

And of course these are your V and G tests that are available for 0 to 2. So I will go ahead and turn this over.

So I'm going to talk about bedside testing and bedside test. Bedside examination is a clinical term that was used in currently in the medical practice. And the concept of these type of examination is nothing new. You can trace back to the ancient time. And these type of examination are more or less standardized in the last century.

So nowadays many practices heavily rely on technology like MRI or Connecticut scan. So the bedside testing we think is still as valuable tool and they can use for diagnostic reason or screening too. So for pediatric balance of vestibular disorder. So we primarily use these tools to get a sense their basic

vestibular balance function. So these tests can be used on the bedside, of course, inpatient hospital care, in emergency room, outpatient clinic, in the pediatrician's office.

Of course we can use in the audiology practice. Whoever doing these tests have to have a basic knowledge and skills. It's not like without training you can do it. So for any kind of vestibular condition, the cardinal sign is of a nystagmus. So nystagmus is an involuntary rhythmic eye movement.

So you usually have a fast phase, slow phase and but not all abnormal eye movement is nystagmus or not all nystagmus is vestibular origin. So people have to be aware of that. So normally the direction of the nystagmus is named for the fast phase. So some of the nystagmus, like a torsional nystagmus is very hard for people to see with naked eye. So you might need a Frenzel goggles to do that.

Common type of nystagmus. So we'll start with a spontaneous nystagmus. So spontaneous nystagmus usually signifies there's uncompensated peripheral vestibular loss and in most cases it's horizontal. Occasionally if you see a vertical nystagmus that's uncommon. If you see that that usually indicates of central involvement.

And for people doing these type of things, you might need a little attractive toys for the young kid to get going. And evoke nystagmus. We have gaze evoke sound or pressure evoke or post headshake nystagmus. So let's talk about VOR assessment. So VOR is present since birth.

That means you can do this type of evaluation even for infants. So these will get you idea about the function of the semicircular canal. And these tests include head impulse or head thrust test which is reliable tool for unilateral loss. And post rotatory nystagmus. When you spin a kid for 30 seconds you should see it.

If you don't see it, that's a problem. The next one is the dynamic visual equilibrium test which is very useful for bedside testing. A lot of people use this screen for autotoxicity. So normally the visual activity change would not change more than two lines with head motion. Okay.

About vestibulospinal reflex. This reflex helps people to stabilize their body and maintain posture. So as we all know, at a certain time a kid can do certain things. So for example, typically developed children can start walking at 12 months. Definitely can walk independently before 15 months.

If you see a kid cannot walk at 18 months, that's definitely there's a vestibular loss. Romberg test, tandem gait or tandem walk.

For balance testing we primarily for screening purpose. And so the test we use often is modified clinical test of sensory integration balance. And so the kid can sit or stand on the hard or soft surface with eyes open and close excessive sway indicating a poor balance. And there's a single leg stand test. And so normally kids can definitely do for 10 seconds.

So these are the numbers that will be on the statement. And so if they cannot do it less than four or five seconds there's highly likely there's an issue.

So we occasionally we do need this cervicogenic screening, especially people involved in a pain in the neck or head injury. So be careful when you do these tests and listen to what the kids say in terms of complaint. So we talk about the value of these tests for the people without expensive equipment. You can use these to triage and to screen patients for more diagnostic testing. And they can do very quickly.

And like I said, you don't need very expensive equipment. You may need to buy some toys and they are quick and they can find out right away. So there are limitations and we're talking about variable sensitivity specificity in terms of what condition. So overall, I think this is very useful before the lab

testing. Now I'm going to Turn over to Dr.

Janke for Vemp testing. Wonderful. Thank you so much, Huang Wei. So we are going to Talk now about VEMPs, and most of you are likely familiar with VEMPs, but just a quick review. There are two types of VEMPs that we use in clinic practice, one being the cervical vemp, which is related to the vestibulocolic reflex and represents an uncrossed ipsilateral response, which we think tells us a little bit about the reflex pathway extending from the saccule down the inferior vestibular nerve to the ipsilateral sternocleidomastoid and causes a release of contraction.

And so what we're primarily concerned about with the cervical BEMP is just amplitude, which is shown in the above picture. And then below what you see is a standard montage in a child where the active electrode is placed on the belly of the sternocleidomastoid muscle, typically at the level of the chin, with the reference electrode on the sternum and the ground electrode placed on the forehead. The second type of VEMP response is the ocular vemp, which is related to the vestibulo Ocular reflex represents a cross and contralateral response and we think is reflective of the utricle and separate vestibular nerve, which then travels to the contralateral inferior oblique muscle. And similarly to this event, we're primarily concerned about amplitude, which is shown in the top picture. Then in the bottom picture we have a representative.

We call this the belly tendon electrode montage, where the active electrodes are placed medial laterally underneath the eye to get information from the inferior oblique muscle with the reference electrode placed on the medial canthus. And then the ground electrode can be on the sternum or can be on the forehead. In terms of age, for cervical vemp, we can start assessing the CVEMP in newborns, but I would say most typically we're doing this assessment starting in children at 6 months. And this is driven by a couple of factors. One, that we see better responses in full term versus preterm infants.

And so this kind of goes away if you're checking them at six months and then children are just smaller and the newborns are a little bit harder to handle. The C bump is currently being used to screen for vestibular loss in children who fail their newborn hearing screening. With regard to size, we're seeing some differences in latencies where latencies are shorter in infants and children compared to adults. And that's just simply due to the SEM neck length. And so if you have a shorter scm, those latencies are going to come in early, earlier.

With regards to ocular vemp, we typically don't start recording this response until age 3 to 4 and that's due to one maturation of that reflex pathway is just not completed until that age and second is compliance. So for ocular vemp, individuals have to sustain up gaze and that can be really hard for infants and toddlers, but less difficult for children who are about age 3 to 4. With regard to OVAT parameters in terms of latencies and amplitudes, the research to date is showing that there are really no differences between children and adults. One of the biggest issues with CFMP is just the overall lack of standardization. So there isn't uniformity across sites and research studies with regard to type of stimuli, the electrode placement and then test settings like filter settings or stimulus duration.

Fortunately, most studies are using either a 500Hz tone burst or a click stimuli, which is helpful. And regardless of our test settings, we are seeing roughly 100% response rates in normal control ears, which demonstrates their feasibility, suggesting that if you get an absent response, there's a high likelihood that there's some degree of pathology there and that that's not just due to normal variability. For an overview of normative data, you can see this in the manuscript in Table 4.

One of the biggest hurdles with doing cervical vemp in children is just getting a good contraction and sustained contraction of that sternocleidomastoid muscle. So for children who are three years and older, we have found it easier to have children lace to pine and then prop themselves up on their elbows or forearms and then turn their head away from the ear that's receiving sound stimulation. For

toddlers, they can sit on a parent's lap and the parent can hold the child's head in the desired direction. Or we can have them do what's shown in the bottom picture, which is have the child relax on a triangle shaped pillow and then kind of sit up or have someone assist their head in terms of turning in the direction that you need. For infants, we will Oftentimes use this triangle shaped pillow, but rest the infant higher on the pillow than what you see the older child doing.

And if you have the head almost hanging off of the pillow, the child will automatically try to lift the head and we get great SCM contraction that way. Or you can do what's shown in the middle picture, which is just to have the child stand on the on the parent's lap and then turn. In any instance, regardless of child's age, we typically recommend EMG monitoring just to recommend that we're getting adequate SCM contraction. And then we are always reinforcing with toys or a short video. So we have a closet full of toys and I usually have my phone on hand.

I'm ready to pull up Disney plus. To keep children engaged in testing for ocular vamp, we have the children lie down or be seated. And the difficult thing here is that they have to maintain up gaze, which again is hard for infants and toddlers. And so we typically will start this in age 3 to 4 and we will get children to maintain standard updates by putting a sticker on the ceiling at 30 degrees, or again by holding a phone video that children can watch. Or sometimes I'll stand at the head of the bed over them and have them look up at me while I have numbers on my hand and having them tell me how many fingers I'm holding up.

And that seems to work out pretty well too. If children do not want to sustain upward gaze, you can have them lie quietly with their eyes closed. The eyes will automatically roll up just a little bit in the socket with eyes closed. And so you can get OVAP amplitudes that way. However, I will say that not everyone elicits ovamps in that condition.

And so if you do not get a response, it's difficult to rule out just normal variability versus pathology. In terms of considerations, we typically recommend checking tympanometry prior to VAP just to rule out a middle ear disorder. If a middle ear disorder or patent tube is present, we use bone conduction sound and we're also checking for overall stimulus levels. So VEMPs are usually elicited with 125dB SPL stimulus. And so if ear canal volumes are less than 0.8, we run a risk of presenting a louder stimulus.

So we recommend turning the sound down. Vemps overall have been found to be reliable and again we recommend EMG for amplitude normalization. Some other considerations are that we recommend bone conduction testing again with conductive hearing loss and following cochlear implantation because that Cochlear implant does introduce a little bit of a conductive hearing loss that doesn't matter for the children in terms of hearing, but does for VEMP testing. We've already discussed that children are being screened with VEMPS for sensorineural hearing loss. And then lastly, we do get interesting characteristic VEMP findings in children with large vestibular syndrome.

And with that I will turn it over to Kay to talk about.

All right, thanks. So I'm going to talk about video head impulse testing.

So your VHIT was, is really based on the head impulse test or the HIIT bedside test that was developed back in 1988. And this is a measure of the vestibulo ocular reflex of the semicircular canals. And with vhit we know that we can add the vertical canals as well for assessment. Now the HIT bedside screening test, you know, it's not the most sensitive test. And so let's just quick reminder, sensitivity is being able to correctly identify dysfunction when there is actually dysfunction.

And specificity is identifying normal function when there actually is normal function. And so that bedside screening is not very sensitive as far as, you know, identifying somebody with vestibular dysfunction in their canal. As a matter of fact, you know, the human eye can see the corrective saccade and about, if

there's a dysfunction of about 42 and a half percent or greater in that canal. So if they, if there is a large dysfunction, the HIIT bedside test will be fine. But VHIT is gonna give us a lot more sensitivity and specificity.

As a matter of fact, in the 90s, two groups were working on increasing the sensitivity and specificity of the HIT test. And what they did was they, they mounted a video camera on some, like a high speed video camera on some goggles that had triaxial gyroscopes in them. The first group was the Germans and they developed the IC cam. And group two is from Australia and they developed the ICS impulse VHIT system. And through their research they validated that VHIT actually has a sensitivity and specificity of 1.0.

So can't get better than that. Now getting the most accurate data is the goal and there are some challenges to overcome when you're doing VHIT on children. So first of all, the goggles have to fit very tightly to the patient's head because you don't want any slippage of the goggles that will just be moving the camera and then you'll get erroneous data. If the child has long hair, you can put their hair in a low ponytail so that the band does not slip down their head. Also, we do use packaging in the hearing aid boxes.

So, like the foam that comes in those hearing aid packages, we can put that in between the band and the head to add bulk to the head, but also to add some friction on the. You know, children, they have very thin and slippery hair. So that can help. Another challenge is that we really need to make sure that the whole pupil is visible to the camera. So you can see these round white drawings here.

These are the pupil through an infrared camera. And this is very well known in the ophthalmology literature, not so much in the audiology literature, but in ophthalmology, they already know that children have very large pupil diameters. And the pupil diameter of a child will increase all the way up to 13 to 15 years of age before it starts to slowly decrease with time until they're in their early 40s. So on the right is

an example. This top one is a picture of a person who's 47 years old versus a child who's 10 years old.

And these two pictures were taken within minutes of each other and in the same room. Lighting. So it had nothing to do with the lighting of the room constricting or dilating that pupil. So you can see how much bigger the pupil is in the child. So it's very important that we just need to lift the loose skin above the eyelid up so that we can open the child's eye a little better and secure it with that tight goggle.

You can also pull down just a little bit on the cheek below the eye to make the eye nice and big.

Calibration. It's completely fine to use default calibration, particularly in your younger children.

Calibration is a little bit like the VNG test. So if you feel like your.

Your child can do that, go ahead and have them do it. But default is just fine as far as the subject position. So we have our kids sitting one meter from the focal point, which is on the wall. This is a nice little strip of Velcro. And we just have stickers that also have Velcro on them.

You can just, you know, Velcro a sticker at eye level right in front of the child. The child can sit independently here, as shown there. We do also suggest for children that are under 10, we did a little study in our lab that showed that children under 10 do really well just looking at a video on a phone. And it does not cause extraneous eye movements that would be considered, you know, catch up Saccades or anything abnormal. You can also have a child sit independently, crisscross applesauce on the chair, which gives them a little bit, keeps them a little more secure on the chair.

Or they can sit on a parent's lap. No problem there either. You just have to reach around the parent's head to do the impulses. This is an example of.

I don't know if I can play this video but okay, example of I'm doing a head impulse test on 11 year old girl.

You can see that I'm monitoring the impulses as well as her pupil and I'm coaching her to keep her focus right on that sticker on the wall. So that's what's needed when you're doing the testing. And lastly I want to talk about real quick is the interpretation. So this is what you will see once you've done your impulses. This is an example of a lateral impulse.

Okay, so here's the right lateral and the left lateral canal impulses results. So let's just look real quick. If we take a quick look at the right lateral tracings, you can see the green. That's the eye movement. It should be right over the red head movement.

Okay, those are the same. And the first thing you're going to look at is this chart here which shows gain. Okay, so here's the velocity of your impulse and here's the gain measurements. Everything in this white area here is the normative data that was collected for adults. And we know that from our child normative data study that children have the same gain as adults in the lateral canal condition.

So on the right we have a nice white there and we have good gain results here on the left you can see that the green doesn't really match the head impulse. So the head is the blue, the green are the eyes, which means that the eyes moved with the head. And so we see we have low gain, we're in the gray area here. And when the eyes move with the head, it requires the patient to make a corrective saccade. Corrective saccades can either be covert, meaning that they're occurring during the head movement, or overt, meaning that they have occurred after the head movement.

So what you're going to see is you start with your gain measurements. We have low gain and then we have catch up saccades or corrective saccades. You can have covert saccades or overt or maybe both, I'm not really sure.

The most important thing to note here is that lateral canal normative data is the same as adults and children, but the anterior canal and posterior canal gain is going to be lower in children. So down here at 0.6 to 1.2 would be your normative data for children. That's it for me. So I'm going to go ahead and turn it over to Michelle.

Thank you. I'm going to cover vng and so I'm going to go through the subtests of engineering as well as focusing on modifications and how it's applicable to children. And so just keep in mind that all components of V and G testing can typically be completed eight months or, sorry, eight years and older.

So we have a couple different recording options. We have the adult, which are the see through goggles, but we also have pediatric goggles that look like a scuba mask. We can record components of them also in rotary chair using the in room camera or also via electrodes.

So high frequency head shake. We typically start at 10 months and older. You can attempt it on a younger child. We always say, kind of try it and see what you can get. But for this we're looking for asymmetrical vestibular system function.

So what we do is we tell the child that we are going to be silly and shake our head. We typically try for 15 seconds, but with our younger ones who don't want to be in the dark, don't want us touching their head, moving their head. We say that we're going to say no, no, no, 10 times. There's no normative data specific for children. What we're looking for is three consecutive beats that would be considered pathological.

And then be aware that if you see a latent onset and or persistent nystagmus, that that would indicate central involvement.

Skull vibration induced nystagmus test can be done at any age. What we do is we apply vibration to the mastoid. You're going to. And we're looking for the presence of nystagmus once that vibration is applied. So you're going to record for five seconds without stimulation and then you're going to record for at least 10 seconds with stimulation.

And so we tell the child we're going to be silly and we're going to tickle our ear before we do that. We do let them, you know, hold the vibration tool, feel it, play with it. We kind of touch it to their ear a little bit before we place it completely. So we tell them we're going to be silly, tickle our ears and we're going to sing a song. And when we are done, we're Going to sing a new song and do the same thing to the other ear.

And so with that we're looking for the presence of nystagmus that is greater than 10 beats and greater than 2 degrees per second, or if there's already an existing nystagmus that it enhances by at least 50% to be considered abnormal. Positional testing, we typically start about four years and older and what we're looking for is to see if certain physicians elicit nystagmus. This would be non localizing and there's no normative data established for children. So we use what most clinics use in that if nystagmus is persistent, it's greater than 4 to 6 degrees per second and is present in more than 50% of the positions, then that's considered significant. And for this we might sing songs with the child.

We'll play guessing games, asking them what animal says woof woof. If they're a little older, we might say, like what animals do you find on a farm? Just looking for age appropriate tasking topics. And so it's our collective experience that when all peripheral tests are normal, nystagmus without fixation can be a peripheral or a central finding.

Dix Hallpike is not a test that we do on every patient. We consider doing these on patients who complain of positional vertigo as BPPV is not common in children, as with adults, you want to avoid on patients who have cervical or vascular issues and you want to assess their ability to rotate their head

before testing.

Ocular motor testing is probably most accurate on children 8 to 9 years of age or older. There's limited normative data in pediatrics, but artifact has been noted on children under seven and it's thought to be due to attention. Smooth pursuits will have lower gain and varied asymmetry. OPK will show differences in asymmetry and saccade testing will show longer latencies. You can do this on infants and toddlers as a bedside exam and essentially you're getting, you're looking for kind of like a grossly overall accuracy in their eye movements.

So you can use their a finger puppet, a light up stick, a sticker, their toy. If they bring a favorite toy and you're just going to see if they can track it back, back and forth smoothly. For saccades, you're going to put a puppet on each hand and just pop each finger up and move it around and then you're just looking to see can they make that quick, pretty accurate eye movement to the target. You can also do it on 4 to 8 year olds using the pediatric goggles.

Keep in mind that sometimes the eye that has the camera in it, depending on the target range, it may fall out of range. So the child may lose the target momentarily and then it could also look like they're not paying attention. Skip if the patient's attention is limited or if your time is limited. And if you have the ability to change your target from the red dot to a cartoon like Mr. Potato Hat, a flower pot, sunshine, do that just to keep it fun for the child.

And you could always shorten the recording time by again just getting a quick look to see can the child do this task? Calorics we typically start at 8 and older, but they can be tolerated as young as five. And this is the one that we're going to do as we know for vestibular weakness or look at site of involvement. So some just things to be aware of is consider using the monothermal warm caloric screening.

For that to be applicable, the nystagmus has to be greater than 8 degrees per second and the asymmetry ratio has to be less than 15%. If you have those if they that meets the requirements, you can skip doing cool calorics. You want to be aware of middle ear pathology or PE tubes and know and using air if you have a tube or a perforation. And then also be aware that you that you if you have two different ears. So an ear with a tube and a normal ear, you can no longer compare the ears.

You want to just make sure the ears turn on and off and that's essentially what you could look for. And again, the tasking will be the same for children or same as for positionals. And I'm going to turn it over to Melissa for pediatric chair. Thanks so much. All right, time to talk about pediatric rotational chair together.

So I've certainly included a lot of slides, more than we frankly have time for. So please know a lot of these slides are here for your reference while we wait for the statement to go to publication. So for the purposes of the statement, we covered SHA testing step velocity and VOR suppression with guidance for age ranges. For all of Those starting with SHA, the age recommendations is 10 months and above to account for the maturational concerns with young infants below that age. And there will also be some language for guidance if there's a need to test below that age.

I'm sure of course you guys are all thinking, but what about normative data for shot testing? It's certainly the number one question I'm sure, we all get when we're lecturing or presenting, so there is normative data available for children 5 years and above. But overall it is the emphatic recommendation of everybody that contributed to this statement that if you are engaging and practicing in this work with working pediatrics to collect and establish your own individual norms for your center, we acknowledge that this is an area that needs further attention and development and research. But this statement reflects where we are at currently with research and data data. When performing shot, it's recommended to test three frequencies minimally and that should include a high, mid and low

frequency.

If all of those check out within the range of normal that you've determined for your center, you should feel confident that you can move on to the next test in your battery. If anything is outside your established norms, it is encouraged to repeat for consistency because kids are kids and then also test adjacent frequencies as well. And of course, if you're doing SHA testing, don't forget to do tympanometry beforehand to rule out any impacts from active middle ear dysfunction on that day. It's not uncommon to find high gain values when testing children, but at the same time understand that your gain is going to be affected by all the same factors as if you were testing an adult. Other pediatric considerations with SHA is to order your testing of frequencies for patient comfort, which is likely going to increase your success rate in compliance and getting all of those frequencies you'd like to obtain.

Of course one of the big challenges is completing testing and those that have motion intolerance, anxiety, general nervousness with doctor's appointment. Certainly working with children that have any range of neurodiversity as well. But again, applying some pediatric focused modifications in these instances is again going to really increase your success rate. For step velocity, the same age ranges and considerations are in play as in shock. Current research supports that the established normative data can be applied to children at this time and that 100 degrees per second is an appropriate speed for pediatric assessment.

The consensus statement will also include some high level interpretation guidance when it comes to the gain values, time constants and time constant symmetry. VOR suppression is an excellent tool, but one that you need to save when you're testing school aged children and a little bit older or a child at a developmental level that's going to understand the instructions really clearly and also have the focus and attention to actually stare at that target in the goggles for the duration of that test. This is another area that warrants further research and assessment. So again please establish your normative data for

Your individual center. Okay, so VOR suppression.

The guidance is to perform testing at two frequencies, again, one high, one low, but that your lower frequency should not be below 0.044 Hz. So let's spend the remainder of our time together getting more into those dedicated pediatric considerations. When it comes to rotational chair, we do say please complete calibration whenever possible. However, ensure that the calibration that you're getting is high quality. And when it's not, or if you're testing an infant or a super young toddler, proceed with default calibration.

Do also adapt your seating to keep your child secure and safe for their weight. Chairs can be adapted with a car seat seat, a booster seat, or when they're finally at a size and weight that they can fit in the standard chair. A. Okay, again, do everything that you can to keep them safe and secure and to minimize the body movements. Keep them from shaking around.

So in other words, keep them buckled up for safety. Pay attention to that head placement. Ensure the horizontal canal is in the proper plane while minimizing head movement. Overall, of course, take a couple minutes or two. Ensure those goggles placement is really good.

Make sure you have a strong pupil lock. If you're using electrodes, make sure they're not slipping and sliding all over the place. If you're using the infrared camera, ensure that that height is really at the proper spot, even if there's a little bit of head movement from the child while you're testing. And of course, make sure that as soon as you, you know, put them in the vision denied that they're not immediately going to close their eyes or, you know, take the goggles off on you. So once you get your patient properly seated, head secured, recording method and a good thing, again, we want to make sure that all that hard work and prep doesn't immediately, you know, come undone because of busy hands.

So we a good thing to have on hand is a bunch of small toys for hands, fidget toys, just something to keep their hands busy. Also calling the family ahead of time, encouraging them to bring their favorite toys or comfort items for home. Something to make that testing environment a little bit more familiar. Also, keep in mind that being in the dark can be really scary, especially for our children with bilateral hypofunctions or children with cochlear implants that really rely more heavily on visual information. But at that same time, we really need that dark environment.

So we need to eliminate any light emitting objects. Particularly I'm calling out parents and caregivers or even clinician colleagues that have smart watches that will light up in the middle of testing, we got to take them off ahead of time. All right, so when it comes to recording methods we have, we have a range. It's going to depend on the patient size, their age, their compliance of the day and the hour that you're seeing them in the clinic. So starting with those ENG collection for infants.

Since we don't have baby sized goggles yet, we acknowledge it can be a challenge to get them on. But modifying by the electrode type you're using, when you're attaching the leads and how and having an extra set of hands for distraction is going to increase your success rate. The infrared camera is also a lovely option when electrodes simply aren't happening that day or when goggles are not being tolerated. However, please know this camera does not track the eye and only provides a recording for subjective observation of the vor.

Monocular goggles generally start fitting around two years of age, but getting them on and kitting and keeping them on can be a challenge because again, toddlers are going to toddler on you. And also we understand they're really big on the face, it covers the nose. The, the material of the goggles aren't the most comfortable when you put the strap around the hair. And then also of course, that strap needs to go exactly where a lot of processors, you know, attach. So if the feel of the strap is the problem, doing handheld can be really helpful and then utilizing a colleague or whatnot to help keep them on is really

great.

Finally, we've got our binocular goggles, which are large and in charge because they were made for adult faces. Depending on the size and the head of the face, they generally fit well around 10 years of age. If you're using them on younger, more narrow faces, you're likely going to get gapping along the eye sockets which are going to compromise your vision. Denied. So again, you want to make sure that you're using modifications ensuring no lighting is leaking in.

And if you're going to work with kids, treat yourself, get some inocular goggles. It's really going to help you there. Take home. Message here is choose the recording method that best suits the patient for their stage of development and their mood of the moment when you're seeing them. And what is going to give you the best quality of data that you can provide sound interpretation on for tasking.

I know this was mentioned with Michelle. When it comes to vng, I'm not going to visit it again. Do whatever you can do to keep your younger patients awake, alert, happy, cognitively engaged, and not crying or squinting their eyes too much.

Testing in the dark for many children can be hard, even a hard stop for some. So you know you can allow some visual access in between cycles, in between frequencies to increase their overall comfort and likelihood for them to continue on with testing. You can do that by either opening the door, opening the goggle cover, or keeping a light emitting toy on hand and turning that on in the vision denied testing environment. And finally, I've listed some recommended supplies that I spoke on throughout that serves as a reference when you're ready to start making pediatric rotational chair part of your practice. And I'm going to hand things back over to Violette.

Thank you so much. So I'm going to very quickly talk about some questionnaires that are available to you. I'm mostly just going to show them to you and then we will move on to questions. I want to make

sure we have time.

So this is the age group that I've divided up. So based on the normative data that's out there, the standardization of the assessments, in the birth to five group, you can use the ages and stages Gross motor. This is a screener that a lot of preschools use to look at gross motor milestones, but there's multiple sections. There's also a language section, there's fine motor, there's personal social, so you can search more. We often just do the gross motor portion of it just to look to make sure they're meeting their gross motor milestones.

In 5 to 12 year olds we can do the Dizziness Handicap Inventory for children. This is actually, I said for children, but it's actually the parent caregiver one. And it's nice because if the child actually has vertigo, like true vertigo, it'll ask questions about how much this impacts their Life. In the 6 to 17 year old group, we can do the PBID and this will look at children who have dizziness that's induced by visual. So think of standing at a street corner and watching all the cars going by.

That's triggering, especially in our migraine population, that might be triggering for them. The same group who wrote the PDID also validated the PBSQ. This one is also for the same group, it's 6 to 17 year olds and this one is specific to vestibular symptoms as well. So. So if you're looking for more motor function, that's in the lower ages and if you're looking for more dizziness, that goes in the higher ages.

This is just what the questionnaire looks like for the gross motor, for the I'm sorry, for the ages and stages. So you can see all the different sections and the parents very easily. In six questions, mark yes sometimes or not yet. And this gets scored for each section. You just add it up, 10 points for a yes, five points for a sometimes and a zero for a not yet.

And then if they're in the section to the right on your screen, that's the clear section, meaning they're meeting their milestones appropriately. The middle section, where the bar is and that's still white is

telling us that they're at risk and you should keep monitoring. And the dark section tells us that they might need referrals out. So especially if we get somebody in the gross motor section and they may score on this gross motor one like a 5 or a 10, we might be thinking, okay, well, you have hearing loss, you have some gross motor delays. We need to think about a vestibular assessment.

So like I had told you, there is a dizziness handicap inventory that the parent, caregiver, patient, caregiver would, would give. It's 21 items. It's yes or nos, and it quantifies the subjective dizziness handicap. So very similar to the adult version from the Vanderbilt group. Here are some sample questions that you might see there.

The PBSQ again is 11 questions. And this is going to quantify the subjective vestibular symptoms or severity. And you're going to place a number value. For example, is it most of the time, sometimes, almost never, never, or I don't know. And you're just going to be listing all the symptoms you have and how much it affects you.

And similarly, the PVID is quantifying the presence and severity of the visually induced dizziness. And this is what that questionnaire looks like. So you can see they're going to be asking how often in the past month have you felt the follow following riding in the car, for example, does that make you dizzy walking down a supermarket aisle standing in the middle of a wide open space? This one's super helpful in our teenage group, especially because we get a lot of children who are migraineurs or maybe even they have some anxiety as well. So they may score high on this specific questionnaire.

But all these are validated. So it's just another tool to have if you just, especially if you're doing a hearing aid check, for example, and you just want to get an idea of how much this impacts the child, child that might be helpful to give them. So the Takeaways from our talk today would be that you might find that the table we presented at the beginning might be a useful desk side companion. And again, we just want to remind everyone we are not advocating that you need to do all these tests or that you need

to go out and buy \$150,000 rotary chair. They're not required for everything.

There's a lot of tests you can still get on children that still give you a lot of information about the impact of the dizziness or the impact of the vestib disorder on these children. And we hope the document points to resources and provides you normative data. And we hope that as you read the document or that you've heard today in our talk that you've learned some tips and tricks that you can possibly use in your future testing. And we're expecting that this is going to be published very soon in J. AAA and we hope that we can continue to amend it as new tests come available and as new normative data.

Normative data is available. And of course, we did not not address the vestibular rehabilitation or treatment options. A lot of people have asked us about that and that was not covered in this document. So thank you from all of our centers. I think we have time for some questions and answers and I'd like to invite all of our panelists to go ahead and turn on your cameras again.

And the first question I will post to Michelle, it's a VND question. It is from. It is in the caloric testing, is the normative data the same for both air and water irrigation, the normative data. So you might, you might find some variety in that. What we recommend, because again, it's based on your center, it's based on your equipment, it's based on the temperatures that you're using, if you vary those at all from the standard that you want to establish your own normative data to determine what would.

What would be, what you would expect to see. We do find that in children the caloric responses tend to be a little more robust. So what you might think is hyperactive and what would be considered hyperactive in adults is not in children. So the big takeaway is establish your own norms to determine air versus water if you have the option for both, because they can vary. Okay, the next question we have is, is, and anybody can answer this one down.

Beating nystagmus is common in what pathology? I think that was on our test and we did not cover that specifically. Would anybody from the audience like to, to chime in for that? Is that Is that an option?

Christy, can we, can we have a poll?

Can we ask the audience down beating the Stanley Split? I know that is on the test. Anybody want to get guess? I think. All right, Kristen, you're up.

Do you want to answer that one? Sure. Yes, I can take this. So down beating spontaneous nystagmus is typically a central nervous system sign. So automatically when you see this, you would be sort of ruling out any peripheral vestibular disorder and start thinking down the central vestibular pathway.

Typically we think about like posterior fossa tumors generating downbeat nystagmus, something like a Chiari malformation. But that's sort of how we start thinking about down beating nystagmus. Hopefully that answered the question. Thank you. And we would love to take any more questions, if you all have any.

I think like one question that I get frequently and I will just post to the panel is for individuals who just want to get started. Are there any tips or tricks that anybody wants to offer to individuals who are looking to get a pediatric vestibular program started? I'll start. I do get this question often and my most common response is find yourself a physical therapist or somebody who is interested in vestibular rehab first because it's not super helpful if you are able to diagnose these children and have nowhere to send them. Because our PT parts are an equal, equal part to this journey.

Or not just PTS. Sometimes OTs also handle this vestibular portion as well, but they are an equal part to this journey. So it's, it's very important to get your rehab piece set up. So I feel like that's step one before we even identify the equipment or the budget. It's almost like, do we have partners in this?

Do we have professionals like ents and neurologists who want to help us with this because they're going to be the source of your referrals. Do we have the buy in from our department? So that would be my first level. Thoughts? Does anybody else have something?

Yeah, I have a couple things to add. I echo everything that Violette says. I also think too, like, we always want to help. We're a caring profession. So everyone's like, I'm going to do it.

I'm going to jump in and I'm going to do everything. And I would say, hold up on that. Like, pick the population you want to target first. Like, if you want to do get into this and be like, I'm going to start with the CI population first or I'm going to start with, with, you know, CCMV or if I'm going to start with, you know, another, like the charge population and get really comfortable with your testing with that and expand from there also. Again, we always get questions like, what do I do?

I don't have equipment yet. There's plenty of things that, you know, we talked and touched upon today that you can start doing now. Single leg stance and a modified cat sip. Learning how to do a, you know, a head thrust using those questionnaires. You know, even if you're not got all the fancy equipment, all the goggles, the chair and everything, you can start identifying children early and establishing that network of who you're going to refer out either as the vestibular PT or a center like ours that can do more diagnostic testing, you know, build your network, build your home, build your family with us.

And you're going to find so much support from us too because again, like, we want to help and support everybody that wants to start engaging in this work. That's awesome. We, we do have another question before we finish. These are all great points. Thank you.

Melissa, I'm going to jump in and say we have the question that says what is name of the annual pediatric vestibular meeting? Melissa, do you want to jump back in? Because I know your center is part of that or your physician is. Right. Yeah.

So there is a traveling meeting and it's sometimes every other year versus every year. Exactly. It depends. A lot of times it's attached to a pediatric ENT meeting that is usually formally organized by Dr. Sharon Cushing, Jake Brodsky at Boston, and then Rob O'Reilly here at Charles Chop.

Usually it has a very generic course name like Pediatric Vestibular Testing course. And it can be sometimes hard to find when it's happening, but I know it's happening at the end of April attached to ASPO and Montreal. I do believe at Chop, we're going to try and have something in the fall of 2026. And I believe Colorado Children's is aiming to host that quarter course in spring of 2027. So just keep an eye out, you know, email us, you know, ask us, like, do you know any meetings sometimes can be posted if they're getting ASHER or AAA accreditation as far as like open and upcoming conferences that way.

Wonderful. Do we have any? Go ahead. I was going to do a quick plug that they are coming up with an international Pediatric Vestibular Network network that's being sort of headed up by the group at Ghent University. And so please be on the lookout for that group to start.

And so there will be some, I think, online forums for individuals who want more information. And there is a website that's in the works. And if you need more information on that, please feel free to reach out to me.

Okay. Thank you so much, everyone, for attending today.