Assessing Vestibular Function and Compensation in Children Post-Treatment

Presenter: Soumit Dasgupta, MD

Good morning and welcome to today's class. Assessment of vestibular Function in Children, including Compensation after management. Before I turn this over to our presenter, I do need to run through a few housekeeping items. These are the learning outcomes associated with today's class. And you'll find these in your handout if you'd like to read through them at a later time.

And these are the risks and benefits associated with today's class. This is also available in your handout and if you'd like to read through them, please do so from the handout at a later time. And now I'm going to turn it over to Inventus and our presenter for today.

Okay, I think we can start. So greetings everyone. We extend a warm welcome to each one of you and express our gratitude for joining us today. Inventis is privileged to introduce the second of three lectures featuring an internationally respected expert, Professor Sami Dasgupta. Professor Dasgupta serves as a consultant audio vestibular physician, neurotologist and clinical lead in Pediatric audiology at Elderly Children's NHS Foundation Trust in Liverpool.

We sincerely thank Professor Dasgupta for accepting our invitation. The title of today's lecture is Assessment of Vestibular Function in Children, Including Compensation after Management. This session will focus on the assessment of vestibular function in children, highlighting the challenges and techniques required to ensure an accurate diagnosis and effective management from neonates to adolescents. Professor Dasgupta will share his expertise on compensation mechanism, clinical assessment and modern diagnostic tools such as vng, vhit, VEMP and chimp. We are also delighted to have with us Dr.

Andrea Castellucci from Oregon Emilia Hospital, a longtime friend, I would say, and a colleague of Professor Dasgupta and and a member of the Vestibular Italian Society. We encourage you to jot down any questions in the designated space on your screen and following the event you will receive a survey that I kindly request your participation. Your feedback will enable us to tailor our educational support to

meet your needs effectively. By now. I strongly invite Dr.

Castellucci to take the floor. Enjoy the webinar and see you later. Thank you. Wana, thank you very much for your kind introduction and thank you for inviting me here in this international courses. And thank you for reminding me here to introduce a great friend of mine, Professor Shamit Dasgupta.

And actually he doesn't need to be introduced as all of us know him and I think we should be grateful for his lectures. All of us know his skills in otio vestibular medicine, in particular in the field of the Diagnosis and management of odio vestibular disorders in children. It's a kind of field that it's not very familiar. A lot of clinicians are not familiar with dealing with children. So I think he is one of the few person, the few physician skilled in this particular field and he always organize in interesting courses about diagnosis and management of a civic disorders in children in Liverpool.

So yes, I really would love to go there and learn so many things and I really would like to thank him to be here and I really would like to thank him for the things that he will teach us and for the things that we learn tonight in these lectures. So okay, I'm very honored to be a friend that we are friends and I will leave the podium to show me. Thank you Shomit for being here.

Thank you very much Anna and thank you very much Andrea. Indeed, Andrea has been a very, very close friend and whenever we meet, especially in Paris, we had super time. And thanks to Inventis for arranging these webinars which are very, very important as a platform of learning spread across the whole spectrum of neurotology. So many of you have heard me before. I am primarily a pediatric vestibular specialist and today, as Andrea said, I'm going to talk about assessment of vestibular function, especially how to measure objectively and subjectively vestibular function after rehabilitation of any kind, in fact any treatment.

So that is a topic which is not very well known. And even in the adult side, objective quantification of vestibular compensation is slowly emerging.

So let's talk briefly about the vestibular response. And I have told you this before, that just like the cochlea, the vestibular sensory epithelium is quite tonotopic, that is frequency specific. Therefore, one region of the vestibular sensory epithelium in the canals or in the utricular sacral system will actually resolve and analyze a definite frequency of vestibular movement. And this knowledge was first discovered when our good friend Raymond Wendenberg was working on the vestibular implant system. Vestibular implant system in Holland.

But it has now been pretty much established that because phylogenetically the cochlear and the vestibular system originate from the same oticular code, they would share similar properties. It's taken much earlier for the cochlea to emerge as a tonotopic organ and it's taken much later for the vestibular organ to do the same, simply because the vestibular system, to me at least, is more complex than the cochlear response. Now these tests, therefore nowadays we have tests which can measure quite a few of these frequencies, not all frequencies, but quite a few of these frequencies. And they can give us individual information about the vestibular response, for example, whether the high, the middle or the lower the ultra row frequencies are affected. And how do they, why do they matter?

They matter because based on this, you can tailor your vestibular rehabilitation and new concept in the field of neurotology. For example, in a cochlear hearing loss, if someone has a low frequency hearing loss, there's no point in amplifying the low frequency because that would be counterproductive. A similar kind of philosophy is now slowly starting to emerge with vestibular responses. So first let me just give you a brief idea as to what we are dealing with here. You know, a child is a completely different, let's say animal to an adult.

We are all animals, we are all living animals, we. So the children are completely different in their physiology, in their get up, for the simple reason that their systems are all developing. In an adult, the systems are all developed. So that's why you do not get a similar kind of response from a child. And that's a crucial thing.

In other words, for those of you who primarily deal with adults, it will be inappropriate just to extrapolate adult norms to the pediatric person. In other words, just kind of using your adult knowledge and your adult physical characteristics to a child. That is not the right thing to do. And that's why you need some training in pediatrics. And as you all know, who have got children or who, of course all of you have seen children, that testing a child is definitely an art and it's not exactly science.

It requires a lot of improvisation, it requires a lot of activities. You have to go down to the level of the child. And we are talking about some very difficult children who are challenged children, children with cerebral palsy, children with autism who will not cooperate with you. But it's your job to get the best meaningful result out of them. And you'll be surprised to know you can do it in 100% of children.

You can check the vestibular system. In some kids, for example, when you're checking the hearing loss, you might not be able to get any behavioral audiometry. You'll have to either give them a sedation or melatonin or even a general anesthetic to get a hearing threshold. But as far as the vestibular system is concerned, you will eventually get some information regardless of how the child behaves in the clinic. Just as an audiologist, sometimes a second tester, who we also call a distractor, might be required.

And just like audiology, again, just like cochlear tests are selected according to the development age of the child. And it's very important to know, therefore, how the child's vestibular system develops. And this is a point which I have made before, that these are not established in children. Many papers who have published comparing adult norms to children, for example, the VEMP amplitude, the rectified web

aptitude, what is normal for an adult at the age of 22 is not the same for a child at the age of six years. These are important considerations.

The best way to do is to have your own norms in your laboratory first and then compare those norms with the children that you get. And this is what we said yesterday, that vestibular phenotypes or presentations and etiology are markedly different. And we are not just interested to figure out whether the vestibular system is weak. But very importantly, why is a child decompensating? Now, an adult will decompensate quite quickly, but a child, because of the resilience and the cerebral plasticity, will decompensate only if something else is going on.

And as medical people, as audiovisor physicians, need to figure out why is the child decompensating, which will be a medical or a psychological or mental cause. And we also definitely assess neurological function, which is central vestibular integration. We do call ourselves neurotologists for a reason, because you'll have to know neurology like the back of your hand. So I'm, I'm also showing you this to make another very important point, that a child with a balance problem or a dizziness or any kind of disorientation note, I'm not using the word vertigo because children of the entire age range, all the way up to 16, will not be able to describe a spitting sensation. Some of them do.

So the term pediatric vertigo in my, in my dictionary should be completely taken out. It should not be used because vertigo is a symptom, a specific kind of a symptom which children cannot almost in many instances describe. So neurological function assessment is very important. And you'll have to know the neurology like the back of your hand, really, you need to know your neuroanatomy and neurophysiology. So a child presenting to you with disorientation or balance problems, or walking, falling and tripping frequently, bumping into door frames, navigational issues, you know, they might be neurological, very much so.

Therefore you have to have this neurological hat at the back always. And it's not just doing some vestibular function tests and saying vestibular system is normal. That's not just good enough. And this is a message which I'm trying. Not only me, but a few of our colleagues internationally have been trying to reach across the globe that the more important or the more apt term to describe what's happening in children is pediatric balance rather than dizziness.

Note. Balance can come from vestibular and extra vestibular causes. You'll have to know these extra vestibular causes. For example, it can come from the heart. So just vestibular function test on its own.

Saying vestibular function is intact, therefore no cause for balance problems found, is probably not the right thing to say. And we'll have to make a diagnosis because diagnosis is very imminent, especially with the tests that we have, because that will lead us to guide our management plan. Is it rehabilitation? Is it just wait and watch? Is it treatment of whatever is causing decompensation?

A child with bilateral vestibular hyperfunction symptomatic is extremely anxious and stressed out. You need to treat the stress and anxiety first because remember, in children, even bilateral vestibular hyper function can be adequately compensated, leading the child to relatively symptomless life. BPPV is rare, but of course you can do particle repositioning. And very importantly, if there is neurological cause or any other cause, you need to figure out whether the vestibular system is actually linked to it or the vestibular system is intact. Because that will also lead you to devising the correct, correct management plan, especially in comorbid multifactorial conditions.

This is a quick resume of what we do in the clinics. As you can see, it's not just vestibular examination. You see, that's only a part of the whole system examination. We do musculoskeletal check. We do motor development, of course, history.

We do see cardiovascular, neurological. We do a full general medical examination. We do a few questionnaires regarding the disorientation of the balanced pediatric scales. And then we come to the inner ear. And of course you'll have to do a full ocular.

So this is not easy and it takes a lot of time. It's not just slapping some VNG goggles on a child's eye, if the child is old enough, slapping some VNG goggles and looking at the eyes and do calorics and do a V hit and then say, that's it, Nothing else? No, it's It's a full, complete algorithm and there is no shortcut. When I see my children with balance problems, I go through this entire rigmarole, entire algorithm. Otherwise, you know, in many instances I will miss the diagnosis.

So very quickly. Presentation history, the one which you see in yellow are very typical. Not absolutely specific, but they are sensitive enough. They are typical for a vestibular disorder in a child. So if a child can manage to tell you that, you know, I'm dizzy, that that's very good, you are lucky.

But many of them will not. You'll have to depend on the parents, the carers. And they note vestibular behavior, which are quite sensitive as well as specific, about 80% spec and sense. How would you glean this information? This information gleaning is, is, is an art, you know, I showed you Sherlock Holmes video last time, the art of deductive reasoning.

So you'll have to ask parents leading questions. How does a child do in the playground? Would you ask this to an adult? The adult will volunteer. Sorry, when I'm trying to hit my golf club, I'm suddenly feeling dizzy.

This was the first presentation of acoustic neurotomy, by the way. A child won't do that, but the parent will note when the child is trying to kick a ball, he gets a very dazed expression in his face and suddenly falls to the floor. He can't kick the ball for about, for about a few seconds. He stays like that on the floor and then picks himself up and tries to do it again. The mother will note it.

The child will never tell you. So in Alder hey, I've developed a full set of these questions, about 60 to 70 of them. But obviously the list is not exhaustive. You'll have to, you know, kind of imagine things as you go along, but as a broad rule of thumb, obvious dizziness, bumping into things. As I said last time, navigation is very important for vestibular function.

Vestibular function is very important for navigation. Sudden poleaxing faults, often misdiagnosed or wrongly diagnosed as epileptic fits. They are not. They can be very classical of vestibular migraine, especially under the age of four, which I would still use the term benign paroxysmal veo of childhood. Periodic episodes of nausea and vomiting with migraine.

Delayed motor function, difficulties in playground activities, dancing, swimming. Swimming, then also dancing. For example, ballet. A child who is loves ballet suddenly stops twirling round. Why?

No one gives. No one thinks why. But they might have vestibular problems. In fact, it's not something which you would not expect in a child with a vestibular problem. Difficult to track challenging visual stimulation places.

For example, super stores difficulties in reading because of the problem in vestibul ocular reflex and difficulty when the room becomes dark because your visual senses are eliminated. And if you are vestibular weak then you will have some kind of imbalance. The white ones are the more general ones. But one thing you will see very clearly here, and that is they do overlap with children who present with autism, ADHD and all other neurodivergent conditions. So what is vestibular and what is not?

Am I implying that all my pediatric community, pediatric colleagues who deal with neuro disability send all their kids to me with these problems? No, definitely not. So I've made a checklist for them so that they undergo a tick box exercise. In other words, from the symptoms alone, they can screen the

patients or children who need to come to me. And at the moment it's working quite well.

So I'm going to quickly, quickly go through this. This is just a few key points in history which do share some properties with adults. But remember this history might be coming from the carers. So the type of the dizziness, the duration, whether there is any loss of consciousness. Now remember, loss of consciousness if happens is not a vestibular problem.

What is the trigger, whether it is provoked by any movement. For example, one important movement is my child suddenly stands up from a sitting position and he feels very light headed, dizzy, fuzzy headed, muzzy and sits back again on the chair. This is more suggestive of an orthostatic hypotension than vestibular. But does that mean that you wouldn't do the vestibular functions? No history gives you a clue, but confirmation comes from the tests.

Remember, movement disorder, ataxia, paucity of movements is usually neurological. But you do sometimes have a vestibular ataxic gait which is usually broad based. But remember in vestibular lesions, classical peripheral vestibular lesions, not central, the ataxia is not exactly an ataxia because it's not broken. So when you ask a child to walk in front of you, and if he doesn't want to walk, then you'll have to show something so that he can walk or run with you. Now I run with my children many times at this age, which I do not enjoy but, but observation is crucial.

So the movements that a child does for a vestibular hyperfunction is a broad based one. It can be slow, but it's not broken up. Broken up or ataxis is Not a feature of a peripheral vestibular problem. You can get a headache, of course, in case of migraine. And you do get challenging, you get kind of visual vertigo kind of stuff where you get feel very disorientated in challenging visual environments, which are frequently ignored by everybody.

And they think it's an eye problem. The first port of call when the complaint comes, my child doesn't want to go to the stores because of the bright lights, doesn't want to move their skeleton because can't look down. They say that go and have your eyes checked. I say everything is fine, pristine, there's no problem with you. So it's very cryptogenic.

And I'll come to cryptogenic a little bit later. So nine different presentations. So episodic, the red ones, they indicate the most common diagnosis. So episodic spells, vestibular migraine, vestibular neuralgia. The difference is the duration of the spells.

For example, for vestibular migraine, it's usually not in seconds, it's in minutes, up to hours, up to days. In vestibular neuralgia, however, or paroxysmia, it's very quick. Paroxysmia by definition means about 10 to 15 seconds. Then you can have Meniere's disease, which is very uncommon in kids, the idiopathic variety. But you can have secondary end lymphatic hydrops and vestibular paroxysmia is in second.

Sorry, vestibular neuritis. VN is vestibular neuritis, which does resemble an adult, but the recovery is far more quick. Then you get a sustained which is bilateral vestibular hypo function. 3 PD. 3 PD is not very common in children because of their cerebral plasticity, but it can still happen.

You can get positional dizziness for autolith involvement as well as bppv, which is usually secondary. Now autolith movement, isolated autolith disorder can generate a positional dizziness when you move your head. Lie down like that, but without a nystagmus. Therefore it's not a bppv. It's a positional mistake.

It's a positional dizziness because of otolith dysfunction where the crystals are intact. You can get visual ortigo oculopsia. You all know you can get a hearing loss. Central symptoms, headache. So it's a whole wide spectrum which you need to ask your.

And sometimes it takes easily half an hour to 40 minutes. Remember after that you'll have to do your tests. So five major peripheral vestibular phenotypes in children. Acute vestibular event which can be infection or it can be vascular. Vascular is usually not because of, you know, the.

The old age vascular causes, for example embolism and stuff. It can still be embolic. If there is a condition which can cause embolism, e.g. atrial flutter fibrillation, or it can be following an otic infection. Then you get a presentation where a child presents with intermittent decompensating episodes which is precipitated by a mental or physical stress, a paroxysmal irritation of the vestibular system, as we mentioned, like for example vestibular migraine, BPPV, secondary immunoleptic hydrops, etc.

Amalda DeBarque syndrome. I have seen MTDS like syndrome in slightly older kids. But once again the brain is very adept in a child to accustomed to the three axis situation when the child is at sea. So it's not as common as you would get in adults. It's not common in adults anyway.

But it's not as common as in adults. And of course you get a bilateral vestibular failure which is characterized by oscillosia and imbalance. We have said that and this is a point which I'm revisiting. It's absolutely crucial vestibular behavior. You need to take the carers on board.

Even if the history suggests the peripheral that the peripheral vestibular system is free, for example, an autistic child who bumps into door frames. You should still do at least one screening, balance assessment. And what is the most useful screening test which I have found in children and that is high frequency information. Because human beings as animals are very dependent on high frequency information. Movements like this, not movements like this.

We don't do this every. If you do this every day when you are responding or conversing with your colleagues or whoever, or when you're trying to look into something, then you will be duffed this

movement. So if you want to do one useful screening, but this is a problem again because you know V is very well developed from six months to two years. But sometimes you might, you might get an abnormal behit even in a normal child because that's part of a development. So when to do this ideal screening roughly at from the age of about four years onwards.

Below that your screening would be pretty much a VNG if you want to look into middle frequency information. So the history is just to get an idea as to what's going on. The etiology mainly, but whether how much the vestibular system is weak, the that comes later and it's A huge exercise of taking other history, birth, family year development, other medical illness, head injury, ototoxic, muscular, skeletal, Gluten sensitivity is very important because cerebellar gluten sensitive, cerebellar ataxia can present with a vestibular phenotype. I've diagnosed quite a few in kids. Very simple to treat.

Take the Gl off. So once again, I'm trying to tell you that your knowledge needs to be very holistic, not just limited to vestibular function, because you're looking at the whole child, not just trying to figure out how much the, by how much the vestibular system is weak, past history of sepsis. So as I said, I use the word cryptogenic. Now, what is cryptogenic mean? Cryptozoology is a subject which is not recognized, I think in universities, but there are some mad people like myself who are extremely passionate about it.

Cryptozoology is about finding evidence or traces of mythical monsters. What are these mythical monsters? You get the Loch Ness monster, Inverness, you get the Mokele Mobembe in the Democratic Republic of Congo, round about those parts. You get the Bigfoot in America, you get the yeti in the Himalayas and all these things. And the only cryptozoological animal who has been found with physical evidence is the Tasmanian tiger.

When we found, but not me, V but when people like me, they found the skeletal remains of a Tasmanian tiger, then cryptozoology, the science was vindicated. So who knows whether there is a

Loch Ness. So this is actually the Loch Ness. So imagine a sea of symptoms or a lake of symptoms where something is lurking which will indicate a vestibular problem. So have a look at this video and I'll tell, and I'll show and, and I'll tell you why I'm so showing you this.

And there is the Loch Ness there. Now this is, of course, we haven't proved this is the Loch Ness. So once I actually spent a whole night in a place called Ramnath Rocket in Inverness, near Inverness, and tried to find out whether I could see the monster, but I couldn't. But we do not give up trying. So remember vestibular phenotype, vestibular presentation in a child, not as much in adults, is cryptogenic.

In a whole sea of symptoms, it is there somewhere. And it's your job to figure out what it is. And decompensation, as we said, can happen with a number of factors in the physical or mental domain.

So it is difficult engagement. So it must be very playful, the assessment. I mean, it seems to be Quick. You'll have to win over the child by removing all apprehension. They would keep their eyes moving at all times.

So unstable gaze. Unless you have got your eyes fixed, how would you make a judgment? How would you make. How would you make your measurements? But it can be done, provided you've got a second tester or some way so that the child is completely fixated on the target or object.

Long eyelashes is a problem because it's very nice when you slap the goggle sound and the eyelashes are beautiful looming and big. And the mothers, especially the mothers, they gush out, look at those eyelashes. And I tell them, yes, beautiful eyelashes of your child. But you know what? They will mess up with my camera.

So you'll have to pull the eyes up. Circumference of head. The band might not feed all heads. In fact, some equipment the bands do not fit under the age of four, but you do have a remote camera, remote camera system as well, which you can measure. And if you don't have anything, you just use your mobile phone.

As simple as that.

Sometimes we are again in vertical canals. It's difficult to interpret because there's a lot of cervical contamination, especially under the age of four. And it needs a lot of practice changes. Chances of artifacts are more because they continuously keep moving their eyes. So you need to filter out your right correct responses.

And you know, there might be so many neurological lesions present with generate their own eye movements. So filtering out peripheral vestibular eye movements requires a lot of skill and practice. It's almost like, you know, you do have an ABR peer review system. So all these traces need to be peer reviewed. My colleague and I, who's also a experienced pediatric neurotologist, we often sit together and we try to make a judgment as to is this a right movement or is this an artifact?

And just the trace on its own doesn't indicate anything. The trace, what you get has to match up with the history with the vestibular behavior, with the overall presentation. So in other words, you are just not concentrating on the vestibular quantification. But pretty much holistically the whole child in the same way as hearing test is not the end of the whole thing. It's the whole child which is important.

So this is a useful ed memoir. Birth to six months. As I said last, as I said before, you can still check the vestibular system. And these are the different tests that you need. So as you can see, from the age 10 to 18 years, you are pretty much doing whatever you can do in adults.

But before that, it is a system of evolution that the different tests that you select. So the most important equipment you'll have would be your hands, eyes and brain. That's most most important. You can use children's psychometric questionnaires, but sometimes subjectively, what the parents tell you is enough. You do not have to go through a formal statistically validated psychometric questionnaire.

You do need the VEMP equipment because wimps. Lately I've picked up loads and loads of isolated utriculocecular dysfunction with completely normal semicircular canal dysfunction. And these kids are as symptomatic, they are presenting with decompensated vestibular lesions. Foam cushion is very important. If you don't have a foam cushion, you can use just a pillow.

And this is when you are doing your vestibular spinal, the cat battery by eliminating friction. But at the end of the day, if you don't have anything, use your mobile and play it back. So under the age of one year, I often get asked by many people all over the world, how on earth can you actually check vestibular system in a child under one year? Now remember, there are some primitive neurological reflexes which you show here, which, which are shown here. These primitive reflexes, 80%, 8 0% of them, are contributed by the vestibular system.

This is very, very important to appreciate. So under the age of one year, a child who requires vestibular information, especially a child with a hearing loss, you can actually assess the vor simple tests, but you should be very well versed by it. And then of course, from the age of six months, we do have objective tests as well. For example, CVMs from the age of six months. We hit from the age of eight months with the remote camera.

You can do the VNG with just asking the parents to hold the, to hold the, hold the VND goggles on the eyes and then watch the movements and neurological assessment will tell you what's going on. So children on the age of one year, very importantly, you can do vestibular assessment. In fact, vestibular infant screening in children with hearing loss is already very much underway. And there's some

wonderful papers by my colleague Lin Mice and a team in Ghent, and we are starting a similar program hopefully from the beginning of April, because now we have started CWAMs beyond the age of six months and the remote mounted camera beyond the age of 8 months. I'll show you a video.

I'm going to show this test to you individually. But these are the different angular semicircular canal Function tests which measure different frequency responses of the vestibular epithelium. Not all of them, but most of them. So let's go to the one by one gaze tests. This is what we call a spontaneous nystagmus, the classical Alexander's nystagmus.

As you can see in this video, this is a classical Alexander's nystagmus. And it depends, it does not change its direction. When you put the case on the lateral directions and this is lateral semicircular canal at static frequency, I.e. 0° Hz. However, nystagmus can be of various types.

As you know, it's a different central eye movement, which I did last year. So you need to pick up, you need to accurately, you know, accurately understand which nystagmus is vestibular and which nystimax is peripheral. For convenience, we would describe vestibular nystagmus as an Alexander's nystagmus. So this is an Alexander nystimus. Quick and slow phase gaze is the gaze does not change the direction of the nystagmus.

However, this one is a gaze evoke nystagmus. I'll just fast forward it because that's also on gaze. But there was nothing in spontaneous. And the nystagmus changes its direction on the direction of the gaze. So clearly this one is not a peripheral Alexander's system.

And look what will happen when the gaze comes back central. There will be a rebound.

This wasn't there when you first started examining. So you can make out which is peripheral and central and highly specific and sensitive. Mastoid vibration test. Very, very beautiful test, Very easy to

do. And I use a kit which is only nine pounds, maybe 12 Euros, which has been validated by a few of our colleagues in Italy.

So you touch the mastoid vibrator behind the mastoid process and watch the eyes. It's not side specific because it's vibrating the whole skull. But asymmetry is very important. So if you see any stagmus but not mention the site, but it is an asymmetric response. So these are my ST vibration test.

You see, after touching the vibration, we are very clearly seeing a right sided nystagmus. I can't say whether it's right or left sided lesion, that will come with other tests. But remember, it's got a very high relationship or a very high correlation with the calorics. So this is a low frequency vestibular response with this device that I'm using. So I do not use calorics in my kids.

I would use this one and this is low frequency information. Then comes the chair. I do not use a formal chair. I just put the child on the chair, on mom's lap or otherwise. And watch the V, what we call an office chair test because rotatory chair, the classical rotary chair is a gold standard for bilateral vestibular hyperfunction and we do not get many bilateral vestibular hyper function.

But once again this is a low frequency test. Oh, by the way, the ones that you see at the top, the names, these are the guys who discovered those tests. So the head check test is middle frequency response. Once again you are stimulating both vestibular systems so side cannot be mentioned. However, post head check you see this beautiful nystagmus and this is middle frequency.

It's not very sensitive or specific so it has to be combined with other. And moreover head shakes can be post head shape. Nystigmus can be central as well. The classical vestibular post headshake nystagmus is horizontal with a slow and quick phase, might come after a few seconds of latent period and will tire out at the end. A central post head shake is continuous.

It can happen with vertical movements as well. So this is mid frequency. So so far you have got static, you have got low and you have got mid. The DVA once again is a very good test for bilateral vestibular hyperfunction. But for unilateral hyperfunction the evidence is debatable.

But you can do it. It's very easy to do. Use a snails or a logmart chart, calibrate the distance and then shake the head and ask the child first to read the line static visual equity and then shake the head. If the child drops three lines there's a problem with the VOR retinal slip and that's a problem. So once again this does not measure which side it would stimulate both vestibular systems.

But it's useful for prognosis which we will come after some time. And nowadays this can be done with a computerized thing with a software built in software. This is one of my colleagues, Dr. Bhandari who's doing it and but I, I do, I don't use the computer and I hardly use it unless there is good evidence of bilateral vestibular function. So this is once again middle frequency and then comes the revolution which has rocked the entire vestibular world.

So this is a fantastic test provided it's done properly. It's not just thrusts and watching the seconds, it's not just thrust and looking at the trace, it need to. It needs to be read in the proper context, in the proper test. And this context needs to be medically backed up. Not just the test, but whatever is going on with the child vestibular system.

So the remote camera, this is the one which you have recently procured. As you can see, the child sits on mom's lap, the examiner stands at the back and then similar kind of thrusts as you would do in any child. You see me on the opposite side, distracting and you see the screen there. So you can very eminently do this. And this can be done from the age of six months on, which is a fantastic piece of kit.

And then you get the normal vhit in adults or older children, which is same. Now, please excuse my video on this one because here I'm doing a cardinal error and that is I was holding the band, Never hold

the band. Now this was my old one, this was one of my audiologists. So please excuse me, I do not have a recent video, but you should not touch the band. And of course this is the video counterparty will very clearly see the saccade.

And this has rocked the whole world for the simple reason. It measures all six canals beautifully. And you do get such good idea about high frequency. The cardinal response you require for vestibular information, objective vestibular information would be the head impulse test. And you get that information.

But once again, it's not just a matter of doing it, but to read it. So, typical example, I'm not going to spend too much time because I've got loads of COVID You can see the sage and the lor gain. These are all real. And then comes in another revolution where I was not convinced. Initially I thought it was a complete rubbish test, but now I'm the biggest convert converted to me by Professor Leonard Danari.

This is a suppression head impulse test where the target, this is the right technique, not holding the band touching the band, so. So the target is actually moving. That's the target, which you can see. And when you see these anti compensatory saccades, fantastic way to assess vestibular compensation, which we will cover later on. And we have just published on shimp in children, the only study of shimp in children with pathology.

So please have a read of that paper. And this indicates not only peripheral compensation, but also in some instances it does indicate a central lesion as well.

So these are the anti compensatory saccades. As you can see, that's the video head impulse test followed by the shimp. The problem with shimp is it only measures lateral semicircular canal. It can't measure anything else. The functional head impulse test, which has been patented by Ramad and as well as after that research extensively by Marco, is a recently introduced test which is an elaboration of

the.

It's a combination of the dynamic visual equity and the video head impulse test. It's yet to be tried in children. Some centers are doing it, I know, and I've got the kit, but I haven't started it formally. But this also gives you a very useful idea about vestibular hyperfunction. But very importantly it gives you a frequency range across which you can map or chart and these will change with compensation.

Caloric testing. Well, still extremely good test, but I do not recommend that in children. Try to avoid it. If you don't have anything else, you can still try on all the children, but otherwise try to avoid it. And there are some old timers who are absolute doins in our field who will not agree with me.

So in that case we would have a constructive debate. But it's very uncomfortable for children. This is a test which doesn't. This is a test which does not involve frequency information. This is a test which requires or which tells you about the likely etiology.

So hyperventilation. Be very careful you do not use it in epileptic children. Number one, children who might actually have a respiratory trouble, for example, do not do them. So ask the child to breathe rapidly for 20 seconds, show him how to do it. Obviously you can't do it in very young kids, but when they can wait for a few seconds for a latent period and then watch the eyes and then comes a beautiful nystagmus which is like Alexander's nystagmus, a jerk nystagmus, horizontal, slow and quick phase.

Now that is an indication of a cerebelo pontine angle lesion. And the nystagmus changes its direction. Initially it's an irritant nystagmus if the tumor is located intracanala. When the tumor spills out and starts to lose its myelin, then goes beyond the internal canal and it becomes the direction changes. And this sometimes can predate an Mr.

Scan. In fact it has happened to me. I have seen a change in hyperventilation nystagmus before the typical interval two year scan. I wrote to my neurosurgery colleague that look, it's probably increased, so you might have to do the scan now. And that's indicated.

So this eye sign predates and Mr. Finding it is uncomfortable. So be very Careful, you don't have to do it in all cases. Hennbuts. Very beautiful sign for third windows and very easy to do.

Press on the triggers, ideally valsalva but children might not be able to do valsalva. So press on the tragus and watch the eyes. This is a sign of a third window, usually any canal dehiscence, lateral, superior, posterior. So it's got, it's. It's not done often so that's why studies are lacking.

So you will find a typical torsional nystagmus and I think Andrea, I have shared this video with you in one of your lectures. This was posterior semicircular canal dehiscence with a positive hennabert and there you see the beautiful intorting so towards the canthus moving eye movements tors.

So we have covered translation semicircular canal function frequencies. For example we have got, we have got information about zero degrees, we have got information about low, we have got information about mid and we have got high frequency. What about nutriglocir system? So there are quite a few tests as well which you can do, not just the wemp and that is something which is very important to appreciate. WEMP is not the only test.

Previously there was another test called off vertical axis rotation which was hugely cumbersome. It's not a clinical test but now there are clinical tests. So high frequency utric, utricular, secular utricular function analogous to the video head impulse test lateral canal is the head heave. So what you do is rather than the thrust, you move the head sideways translational and you see a catch up Sardia. There we are again, There we are.

None. There we are. So this is not a head thrust by the way, this is a head heaven. So it's got a good correlation with OVamp which in my clinical experience I haven't published it. Hopefully if I get someone to write it up I'll publish but and it's operator dependent.

So this is a very useful information for a head heave test and this has actually won cases in courts of law. Subjective, visual, vertical, you can all do. There's an ultra modern computerized test, there's a bucket test, there is an iPhone application bucket test, plenty of things. Simplest way to do it is this. Use a protractor from a geometry box, get your own norms first and then measure the thrust on one side.

In my lab it's more than 10 degrees which is significant. Now it depends on individual ages as well because the vertical gets slowly vertical as the child grows under the Age of four, it's not a very good test. But after the age of four this is a very useful test for utriculostatic response. Very, very important, right, because this gives you static response utricular function. The next one is a mid frequency test which is an ocular counter rolling.

Move the head all the way to the shoulder on each side and watch the eyes roll. There are two types of role. One is a static count, static ocular counter roll. One is a dynamic ocular counter roll static. Both these counter rolls by the way nowadays are available in latest software by the manufacturers.

This has come, I think last year, correct me if I'm wrong. So look at this ocular counter Rome, this is normal. Look, look at the ways the eyes are rolling. So they are being displaced from point A to point B and whilst doing that they are moving a torsional movement. Static counter roll is the displacement from A to B and dynamic counter roll is the actual physical movement.

Static counter roll is utricular, dynamic counter role is secular. That was the normal situation. Now look at this abnormal situation here you get some dynamic counter role but you hardly get in displacement on the right side. So right sided utricular deficiency, very likely, possibly also secular. But once again

just this test on its own doesn't tell you much.

It has to be combined with other tests. Skew deviation, of course, it's a neurological examination. Very importantly you have all done it. But remember, 1/3 of SKUs, this one, one side goes up, hyperopia, one side central is coming from the autolith system. So we always would do a skew which will give us new information not only of the neurological system, but the type of skew will tell us about autolith dysfunction as well.

And of course the wemp, this lecture is not about wemp, but CWMP measures circular response once again low to mid frequency as well as OVIMP measures utricular response. Now once again vemp traces need to be read in the proper context. It's very, very important. And lately what we have started doing in adults is VEMP tuning in endolymphatic hydrops, which is a. Which to me it does give you some extra information about Meniere's disease.

But adults mainly, I don't do a VEMP tuning in children and I've got two fantastic auditors who do the tests and they get up such beautiful traces. And we always, always, always peer review, we talk to each other. What is what. Three audiologists actually, not two. We always take a collective decision as to is this abnormal does it match with the clinical picture?

Does it not? Is it to be discarded? Is it an artifact? So remember, this discussion is very important, not just one person looking at the trace and writing a report that should not be done, at least in these instances.

Different vemp traces, as you can see, beautifully normal, hugely asymmetrical, absent wimp on either sides, huge amplitudes with low thresholds. Classical of third windows. So next we come to the vestibular spinal test battery, the cat sib, which is a modified test, of course. You use the foam cushion. And you of course ask the child to close the eyes, take the optic fixation and then watch what happens.

Does he sway on one side, etc. And you can do it with a number of other tests, like the Romberg, the Unterberger, the tandem gate, the retropulsion, etc. And then you watch the eyes like a hawk as to whether there are any central eye movements. Very, very, very important. Is there anything neurological rather than vestibular?

And it's absolutely crucial, not the end of story. We would do a full musculoskeletal cardiovascular. I still listen to the heart with stethoscopes, and if there is an irregular beat with a child presenting with lightheadedness, it's likely not vestibular, but I have to prove it. Full development assessment, of course, hearing assessment, of course. Imaging, posturography, I do not do in all instances.

We have got a great, great lab. I would send selected patients, but I do not do it in all because they are mainly for rehabilitation, they are not for diagnosis, not as much for diagnosis. And of course, try to figure out an etiology. Full gross motor assessment. This is a useful chart which you can hang in your clinic wall.

This gives you a rough, average space, average idea about what happens when and if there is a deviation, then of course, you know there is a case for a vestibular hyperfunction and a fine motor assessment. As pediatric people, as pediatric specialists, we have to know this like anything, like our names, probably. Different neurological tests, different muscular skeleton. Now, remember, a child coming to you with imbalance, falling and tripping from the age of, let's say one year to the age of four or five. That can be entirely normal, right?

What is a toddler? A toddler is a toddler who toddles when he walks, right? Now, falls and trips frequently. We all do. Is that pathological?

No, it's not pathological. It's a part of development. And very importantly, because it's a part of development, it can come from the lower Limbs. So lower limb abnormalities, for example, flat feet, tallipis coxa vera genu hip knee, leg length discrepancy, very common. I still physically measure the leg lengths from the antero superior iliac spine all the way up to the lateral malleolus.

And if there is a significant discrepancy, that explains the faults. These are all part of my whole clinical examination. So I see a child who frequently falls and trips, and I find that he's got flat feet and a different leg on each side lengthwise. I have got a very strong feeling this is definitely or very, very clearly this is coming from the lower limbs, which explains why he's falling and tripping. Does that mean that I'm not just going to do any vestibular quantification?

No, as I said, I'll have to prove that this is not vestibular. And that's where all these different examinations come. That's where all the different knowledge comes. So it's not an easy thing to do. It's very, very, very complex.

And it needs such a huge holistic knowledge of the whole child that we train extremely hard for it. And I do appreciate that not everybody would be able to train in such a great detail. But as long as you have an open mind and know where exactly to rever. For example, you have not trained as much in pediatrics as you have in adults, but you see a child who is obviously, you know, kind of having a flat foot and there is a balance problem. You do the vestibular function test normal, and then you send the person to a pediatrician.

So having an open mind is very, very important. Elasticity of joints, you know, you might get frequent inversion of ankles because the joints are very lax. We call this hypermobility syndrome. Hypermobility is one of the commonest causes of falls and trips in children. One of the commonest.

It's not vestibular. So that's why we call ourselves pediatric balance specialists. We don't call ourselves pediatric vestibular specialists. Cardiovascular ophthalmological with an ophthalmoscope. Very important.

Convergence is very important because that can mimic a vestibular phenotype. And this is the vestibular gram that we have produced, which have been inspired by Ulmar and Shea in 2005 from France. And this is a very, very beautiful kind of a graph as well as gives you a full picture of a vestibular assessment history, developmental reflexes, the vestibular quantification test battery, the Hennibert hyperventilation, FH Shimp, the posterography and the entire gamut of neurological examination, cardiological examination and ophthalmological examination. So this is our vestibular algorithm, which you can see is extremely comprehensive. So next we come to assessment of vestibular compensation.

What is compensation? Compensation essentially is the cerebral response to make up or to mitigate problem or a symptom which is being originating in the vestibular system. In fact, the central nervous system will try to mitigate any problem anywhere in the body. That's what the brain does.

So the first way to assess compensation after treatment, and that includes any treatment, by the way, which is rehabilitation with exercises, with medicines for vestibular migraine or lymphatic hy drops, post surgery, post radiation, post autotoxicity. First is subjective, which is often. You would be surprised. It can be very robust because parents are always right on the ball. You know, if you are interviewing an adult, sometimes it's difficult to find out or figure out whether what is what is the right history.

But a child does not make up one, very rarely. And two, because parents, their children, their flesh and blood, they are very quick to figure out what's wrong with their kids. I mean, I'm a parent myself. I'll know immediately where my son or daughter is behaving slightly out of the ordinary, and I'll try to figure it out what's going on. So subjective interview is by far I, in my opinion, it's the most important bit.

Now I might be challenged. It's not objective. You do not have any scores. Scores are very important objectives. But still, at the end of the day, guys, we are human beings.

We would like to tell other people what's going on with us. And why wouldn't you believe me? So interview about symptoms. You can use a visual analog scale from the parents and from the kids when they're old enough school, you'll have to very importantly engage the school. I talk to schools every now and then to find out what's happening to the child when he's trying to play.

I had a report from a school headmistress. Oh, he withdraws himself because we have got a huge maze and he doesn't want to play in the maze. You know, we love to play in mazes. You know, we would like to find our way out and stuff like that. I had a child who withdrew psychological because he was unable to go to laser quests.

You know, you go inside a dark kind of a room, all the kids have got lasers in their hands. My son used to love them. And you shoot at each other and score a point. He was afraid because he lost his balance in darkness. That is vestibular.

Similar maze, visual vertigo. That is vestibular. So, school and educational report vor, you know, reading problems. And of course you do have formal scores. I use eventability inventory from the age of five years onwards.

And of course you get pediatric balance courses. But nowadays, of course, the more important thrust would be on the objective testing. And there you can see, all these different tests give you an objective idea whether the child is compensating. And that is what is absolutely, in my opinion, this is one of the very, very radical and revolutionary ideas which are slowly emerging. Of course, this was known for some time, but how it can be harnessed to do good to a child is now coming to the fore.

Right, let's get to them one by one. However, one thing I must be very clear at this point, subjective perceptions, right? So you have a child with an obvious symptom, vestibular phenotype. You do a full vestibular assessment. You have diagnosed, let's say, unilateral vestibular hyperfunction due to any reason, you have treated the child adequately, you have rehabilitated, and then you do your vestibular function tests and you see there's a clear improvement in objective measurements.

However, the child and the parents tell you nothing has worked. My child is exactly the same. No, I know there is no improvement. Why is that happening? And this does happen, why does it happen?

It happens because of other comorbid physical and more importantly, mental factors. A child who comes to you after one and one and a half years, going through different medical disciplines with no diagnosis. You give him a diagnosis, you start to treat him. The brain might take some time to acclimatize to this, all this treatment. So the brain will do its job and your physical measurements will be restored.

But the cognition, the psyche, the emotional, the limbic system, that takes some time to recover. So do not lose hope or disappear. Eventually the child will go. And many of these kids who do not improve with objective signs of vestibular compensation will have to be referred for some kind of psychological or cognitive behavioral therapy. In fact, I do have someone in here who works in Manchester, Dr.

Petitrena, who is a genius in this field because she's the one who picks up all these kids from me and treats them with fantastic results. She will be coming to Budapest in the, in a roundtable which I'm conducting, so we'll hear from her. What she does is absolutely phenomenal. I've never seen Anyone do this? Not only that, the success that she achieves is absolutely phenomenal, but she works in the ground, she goes out with kids to actually look into their behavior.

She interacts with them. That's the way to do it. And in some instances, of course, on the opposite side, there might be no objective recovery, but the child is symptomatically, completely better. No problem that I have seen happening with kids have with cochlear implantation. So children no vestibular function, cochlear implantation of no objective compensation.

So we hit chimp, everything the same. But the child's balance improves like that. It improves exponentially. And I've asked this numerous times, and finally I heard from a few colleagues in Jerusalem in a conference that, you know, this kind of central compensation of balance is independent of the peripheral system. So because the cochlear implant delivers the sound which has been deprived in the very crucial area of the.

Of the, you know, it's. It's the main cortical area for vestibular processing, which is very next to the cochlear processing center in the angular gyrus, in the temporal lobe, the PIVs or the peri insular vestibular cortex PIVC. So it gets a sound and the sound stimulates the vestibular system centrally. And that's why the child does not recover from the peripheral point of view. But the child recovers brilliantly from a simple point of view.

So it can happen in both ways. But generally, kids with good vestibular, good objective evidence of vestibular compensation usually do very well symptomatically. Also. Why, how do you have to do your objective monitoring? Objective monitoring is essential because you will understand how effective your treatment is becoming, right?

And it's very important to understand this because remember, just treating vestibular system is not enough. You'll have to treat other problems comorbid. For example, you have to treat the psychological side, you have to treat the medical side. All these things you have to treat together. So objective monitoring is essential not only to figure out that the vestibular system is improving from the physical point of view, but also whether the decompensating factors are severe or intense enough to actually

dampen that compensation.

Once again, I'll tell you it's a bit complex. Objective monitoring is essential a to understand how much your rehabilitation or any treatment is working. For example, vor gain in our series in vestibular migraine, they are on an average more than 1.3. But with effective migraine treatment, they drop right down. Does that Mean the child is completely free of symptoms might not be the case.

So objective monitoring is essential because number one, to assess what your treatment is doing and two, to actually also assess how much the decompensating or comorbid factors are playing up. Because if that is the case, symptomatically they are not much better. So in that case you'll have to focus specifically on treating the factors for decompensation that can be physical, that can be mental.

So these are the different objective measurements. Recovery of Alexander's disagamus grade 3 2, 1. The visual vertical tilt might recover. Calorics have been reported to have recovered in some instances in adults. I have got no experience with kids, so I've put it in red.

We don't know. I have seen mastoid vibration, nystagmus recover. I have seen rotatory again nystagmus or phase recover. I have seen head shake nystagmus disappear. I have seen improvement in dynamic visual equity.

Not three lines, they could just drop one line or vamp. Whether they improve with compensation is once again a little bit controversial. So that's what I have put in red. In my experience, some vamps that I have done have shown signs of recovery, at least in the amplitude bit. Rectified amplitude in cvemp.

No OVIM I haven't seen. I haven't done any post rehabilitation OVIM study as yet. So the rest are all eminently possible. However, I come back to my favorite test, the video head impulse test.

So the vestibular ocular reflex gain is of course a very good measure to evaluate vestibular dysfunction. So the VOR gain is a good indicator of vestibular compensation. The saccades are also extremely important. Velocity, amplitude, latency, clustering. So what happens with saccade evolution with rehabilitation or compensation is initially the saccades are dispersed and they slowly get together.

Together together we call them clustering and finally OTS become coverts. That is happening and that we have seen. And nowadays there is a new score called a PR score which some centers are using for adults. But there is no evidence in pediatrics we would be doing it at some point, but not as yet. The this bit is so important.

Normal VOR gain with catch up seconds. I have seen many reports where it says the VO organ is normal. There are a few saccadic saccade like movements which are likely to be artifacts with a clear history of vestibular dysfunction. This is very important. So what happens after a vestibular assault of damage?

There will be low VOR gain, there will Be saccades clear, no doubt. With that, as the child starts to compensate, the brain takes over. The brain is active. The first thing for the brain would be to restore the VOR again, which it does brilliantly. However, the saccade generating places in the brain stem, they are slightly late to catch up with this.

As a result they keep on producing saccades, which is not a pathological saccade because the VOR gain has recovered, but it indicates that there was a problem before. So remember, normal VOR gain with ketchup saccades is an indicator of active dynamic vestibular compensation. And this has been first proposed by our colleague Nicola Fernandez, which was then replicated and then replicated again recently. So there is good reasonable evidence for this. So please do not ignore normal VR gain with ketchup saccades as artifacts or as if nothing has happened.

Of course you can get it in the norm, maybe, maybe you can get it in the normal population. I do not know which is now coming into the fore, that saccades can be present in the normal population. But once again, let me keep you emphasizing to you one important point. Just on its own, a VOR gain, normal gain with ketchup saccades indicates nothing. This child will have to present to you with a vestibular phenotype, vestibular features, maybe other tests.

So it's once again the whole holistic picture which we are interested about.

So this one is. Let me give you a few examples. Get this down a little bit. Yeah, so this was a left vestibular, left. Left vestibular nerve hyperasia presenting with imbalance where hardly any symptom, but still unable to go on slides and swings and so on, so forth.

And very clearly see a beautiful sacard on pretty much all the canals, but you see a good restoration of the VOR gain. So this was a bilateral incomplete cochlear partition with right sided vestibular dysplasia. Only the right side was hugely weak with plenty of catch up saccades and low VOR gain. After rehabilitation, this child recovered brilliantly with his balance. But look, the V heat hasn't changed.

Well, I wouldn't say it hasn't changed. Saccades have become coverts in the right posterior where they were very dispersed over here. So some change, but not a great deal of change. Saccades persisting and, but very, very beautiful. Symptomatic, symptomatic kind of improvement.

These are the dates, of course. Bilateral enlarged vestibular aqueduct, asymptomatic without any treatment. You just see a Few saccades on the left lateral bit out here that there are no sards here gone. So this was a good recovery. Following there was no kind of treatment here, we just kept an eye on him and natural cerebral plasticity did this.

Acute vestibular neuritis. And this was because of a rheumatoid arthritis which we finally discovered. So it was an autoimmune neuritis, not your classical viral neuritis as you find in adults. So as you see significant this weakness on the right low gain, plenty of saccades. And then after some time, this was 2017, this was 16, 2017, you have already seen the beautiful saccade clustering over here.

And finally this was in 2020, you hardly see saccades. And he, if I do do a vestibular V hit again now, then the saccades would be at the most covert, if not completely disappeared. Of course this kid has good rehabilitation and still has balance problems because his rheumatoid, her rheumatoid arthritis is playing up on and off. It's well under control. But there is a comorbid physical decompensating factor which is getting controlled by our rheumatology colleagues.

So good recovery but not complete recovery. This was a posterior fossa space occurring lesion which bled and at a complete right sided vestibular failure. This was the acute phase. So you obviously get some SARS on the other side as well. And over a period of time you see the SARD morphology that the SARD are changing with the, with much more clustered.

The V organ hasn't recovered much on the right posterior canal, but most of the other canals you see the SARD clustering. So once again the VOR gain has not recovered well. However, the child became asymptomatic with rehabilitation and with surgery. So once again I make my point. Objective compensation gives you two ideas whether your rehabilitation is working properly and if not does what does it tell you with about the comorbid decompensation factors T different dates, unilateral cmv.

You see right lateral anterior sparing, right lateral, plenty of saccades, beautiful clustering, beautiful clustering. A good recovery of VOR gain rehabilitation. We had some intense vestibular rehabilitation with customized vestibular physical exercises and you see the result which is usually the norm rather than the exceptions that I mentioned about. Let's come to my favorite other test, suppression head impulse test. And this is all from my original paper, our original paper.

So it's considered to indicate vestibular ocular reflex recovery and the first time that we actually found. So as you can see that this was an acute bilateral autoimmune disorder. This was the vhit and this was the shimp at the same time as the vhit. So the, so what are we looking for in shimp? The peak psychotic velocity.

We look at the asymmetry between the two sides and we look at the VOR gain, which is probably a more robust indicator than a V heat gain because it doesn't have any coverts. So as you can see, the psv, the one in the yellow is low by our norms, was abnormal on one side. Asymmetry was similarly abnormal. Normal asymmetry is up to 18% and VOR 0.33 and 0.69, grossly abnormal. So this was initial presentation and then what we did was we treated the kid with steroids and with vestibular rehabilitation and pretty much everything else.

And as you can see, not much improvement in the peak psychotic velocity. But the asymmetry has dropped beautifully and the VOR gain has dropped beautifully. So this is a very important one because here you see the three parameters for shimp changes after compensation would be the peak psychedic velocity, would be the VOR gain and would be the asymmetry between the two sides of the VOR gain. And all three of them do not need to be present for telling you whether there's good compensation. At least two need to be present.

Because remember, the brain is a brilliant organ, but it doesn't do everything at the same time. Some things take time to do it. So if I repeat this now, this was when. This was when January 2023 is in you for a follow up. Actually if I repeat this now, what will happen is the, the peak psychic velocity would have improved beautifully.

That's the point. So this was Kogan syndrome. So this kid was sent to us after by the infectious disease team thought had a very exotic infection after a trip abroad and he eventually transport, he developed

iritis and developed acute cochlear vestibulitis with the hearing loss and came to me and this is what we found. This was the initial bit. October 2, 2023, the V Heat was pretty normal.

There's not much of a problem there. Right. But we found grossly abnormal shims with the peak psychedic velocity. So after some time, November 2023, still no pro change in the VHIT. But out here, what do we find?

PSV hasn't recovered, but asymmetry hasn't, has climbed up, but the VOR gain has hugely climbed up. So some compensation is going on. Some symptomatic relief is going on, but not completely. So our rehabilitation has started and we will be checking this kit soon. And what will happen is there will be a significant improvement in the peak circadic velocity.

The asymmetry will drop down and the VOR will gain even further. So that is why we would do all these different tests.

So this was the posterior force isol again, which we said before, as you can see, these were pretty much abnormal and there was a significant improvement. So, yes, we have got loads of problems with this. So remember, for vhit, the important parameters of compensation are VOR gain and saccades. Both might improve or just the VOR gain improve. For the shimp, it's the peak circadic velocity, the asymmetry of the VOR gain between the two sides and the voor gain itself.

These are the three main parameters. And remember, the normal values are not adult volumes. You need to have your own laboratory methods. So these are all different. I don't.

We'll be running out of time, but once again you can see the different changes. This was a left, this was a likely usher. And we have, we, we, we. He actually underwent a huge rehabilitation which gave us very good results and you can see the results here. So it's pretty much improving in all respects, but

rehabilitation is still continuing.

Head injury. So once again, it's very, very clear as to what's going on. So once we are, we are still, we are again looking into the peak circadic velocity, the asymmetry and the VOR gain. Look at this. VOR gain, 0.27, 0.32.

This was decompensated. There's hardly any improvement. Maybe on one side, this was decompensated and the kid is still having rehabilitation. And the decompensation is because it serves a head injury and is whole with a significant traumatic brain injury. So the brain is unable to compensate properly.

That's why you get a picture like this.

So at the end, diagnosing balance disorders is very challenging. It needs a lot of patience, art, skill, knowledge and an approach to the whole child rather than just the inner ear.

It does demand a high skill set, but it is eminently feasible and possible. You have to see kids day in and day out and they are different from those in adults. And compensation can be measured both subjectively, objectively, to give you very useful information. So this knowledge is just, still, I would say, just beyond its infancy. It's evolving at a rapid rate and this is how the vestibular system history, if you look into the history we frequently publish about vestibular system.

History, medicine, physiology. You'll see that this is a story which has been going on for the last two millennia. You would be surprised to know that after Hippocrates in bc, there was a Greek physician called Arche Guinness who described a syndrome in a human being with tinnitus, dizziness and hearing loss at the same time. Rings a bell. In the 15th century, in the dark Middle ages in Europe, Abu Rashis from Baghdad in the, in the.

Iraq, in the, in the Iraqi caliphate, replicated a similar symptom in 1861. Finally, one man, Prosper Menier, died, quantified it and said, this is a Meniere's disease coming from the inner ear. So look at this picture, 1695, you see the inner ear, the vestibular labyrinth, drawn by a French artist called Duvani Joseph Guichard Duvane.

He drew this on a human ear, dry temporal bone with candlelight and magnifying glass. And 2012, my University of Manchester did the highest possible resolution CT of the inner ear labyrinth. And can you see the similarity? This is incredible. This is the way we are evolving.

And I'm so lucky and fortunate to be surrounded by wonderful colleagues who are actually as passionate about pediatric vestibular medicine that I am. And I hope that this lectures will actually motivate and enthuse you to do the same. Thank you very much.

Thank you. Thank you. Thank you. Shumit, can you hear me? Yeah, I can.

So thank you very much. It was brilliant. It was a brilliant lecture and I think that all of us learned a lot from all that you said tonight. And I personally appreciate a lot the last part about vestibular compensation. It's, it's great.

I, I had the chance to, to read your, your paper with Professor Manzari about shimp. Yeah, it's, it's great. It's great. And I personally appreciate a lot what you said about the presence of normal beer gain with correctly saccade. It means that there's something going wrong.

Maybe there was something going wrong before. And yes, it's compensation that is going on. So it's, it's wonderful. And I totally agree with you that a lot of patients, a lot of physicians say that maybe they are artifacts, but they are not. Definitely not.

So I think video head impulse tests never tell us lies about what's going on in the, in the semicircular kind of that we are testing. So thank you. You are one of the acknowledged, and you are one of the acknowledged masters of video editing. Pulses. And I've learned a lot from you.

No, no, no, come on, come on. We learned so many, so many things from you. So I'm going to three questions. Yeah, yeah, sure. For you.

Yeah. Okay. We have a question from, from Andrew McGrath. He says for the vibration test is. Is that a match massage gun or something similar?

Well, for a mastoid vibration test you need a calibrated. Calibrated instrument. Right. And the one which is recommended for the mastoid vibration or which is now, you know, kind of. It's very much into the market, especially from the French team.

That's a very expensive gadget. So the team in Italy actually figured out a device which is also replicated by Timothy Hen. If you go To Timothy Hens designers.com balance website, you'll see this, this is a shower messager and the company I think is called Thule or something. And I am not getting any commission from them if I tell this name. No conflict of interest.

But it's a fantastic device. Unfortunately I don't have it here, but I'll write to Anna who can then tell you as to where you get it. It's a very cheap device and it can be used instead of the calibrated device, which is. Which can be quite expensive.

Yes, thanks. I. I personally use the. The one from Inventus that is calibrated. Yes, but yes, I personally appreciate also.

Yes, yeah, Marco, Marco, Marco. And Daniele has got a very good paper on this device. So. Yes, he told me that to use it. So yeah, I'm very happy with it.

And it's only €12. Come on. Yes, you're right, it's very cheap. Okay, we have another question from Yana Kubisova. Normal deer gain with ketchup saccades.

Is that something we can see in vestibular migraine as well? That's a very good question. So vestibular migraine, if you see a child when the spell is actually active, which you hardly get, because why would you bring an ill child with dizziness and photophobia to the clinic? But if you happen to see one, then you can get any kind of vhit results. You can get Sakad's lov organ, you'll get a vestibular hypofunction.

But the vast majority, 99.9% children that I see, they come during the interal period, which is the quent period. They're not having a spell. In that case, you should not see any saccades, but you'll see a high vor gain because SARD is Peripheral vestibular hyperfunction. And remember Bharani's fourth criteria of vestibular migraine. You'll have to exclude other conditions.

Now of course, if there is a coexistent vestibular problem, then you can have it. But pure vasceral migraine on its own during the interictal stage or during the interspell stage, you can get a high VOR gain, but you should not get any catch up seconds. Great. Another question. What about medical treatment of vestibular migraine in children?

Well, that is for the next lecture I'm doing one and a half hours. So very briefly, lifestyle change, cognitive counseling, engagement with school and medical management with drugs, seven different combinations. Drug 1, 2, 3, 4, 5, 6, 7. Somewhere down the line they will have to have to improve. So that is our protocol, the Alderheit protocol, which works brilliantly and we have published on this actually.

So yes, it's a very intense treatment which I'm going to cover in detail in the next seminar. Great, great. So we, we're really curious about it. So a lot of congratulations. Safa Dawba says lecture as usual.

Thank you so much. I thank you. So another question from Sandra Ville. I have always wondered about normal year gain, but the occurrence of ketchup saccades, this happens at clinics so often. So it finally understood what this happened was eye opening.

Okay, thank you so much. This is another interesting comments, another comment, another question. Comment from Fatmar Raghab. Rehabilitation therapy in children, does it follow same rules as adults? Well, yeah, the basic principles are same, maybe habituation, substitution, adaptation, but we try to tailor it to the frequency specific information that we get.

So in other words, someone who has got a normal mastoid vibration test and no Alexander's distigmus, but a significant vestibular vhit result, then yes, we would concentrate on high frequency physical exercises rather than lower, rather than once. So yeah, it does follow. It does follow the general principles. But the exercises you choose or would implement may be different. You know, I don't know because I do not deal with adult rehabilitation at all.

I leave it to very, very competent audiology colleagues or vestibular physiotherapists. Okay. And the same participant asked for how long and when to. When to do assessment after vestibular rehabilitation therapy in pediatrics. Sorry, come again?

Yes. Vestibular rehabilitation therapy in pediatrics. For how long and when to do? Okay, in how long? Right, okay.

Yeah. So vestibular rehabilitation, initially you'll have to do it for at least three months. So the way we do it is we would give them some handouts, some home exercises to do if they are tolerant. These

home exercises are very, very beautifully explicatory. If they are tolerant, then you would take an update in three months and repeat the vestibular function test in six months.

But in the meantime you'll take regular subjective updates. But many times they actually do not perform the physical tests themselves or they do not want to do it or whatever. Then you'll have to bring them to clinics and show them how to do it. So that would be, you know, at least a minimum of three months, maybe once a week, and then go from there. Okay, so here we have our conversation from Ashmi Banu Mandan.

It was really clear, very understanding lecture. Thank you very much. So we thank, we thank all this audience. And another question from Nurul Isa. Modern school vibration gives nice segment test of mast vibration.

Is its sensitive? Is it is sensitivity high in pediatric assessment? Well, there has been no sensitivity or specificity study as yet. So on its own I can't give you an answer, but my series I can tell you, look, mastoid vibration is low frequency information which is very important for the children. So under the age of four, in my opinion, mastoid vibration would be a very useful test, very easy to do.

But after the age of four, it slowly starts to disappear. So maybe the sense and spec are not very high beyond the age of four, but under the age of four, it's a very useful test. And as I said, it's got a very high correlation with calorics. Yes, I totally agree, even if I'm not sure why. There are a lot of physicians that say that it is a hype.

Okay. Right, Andrea? I mean, I didn't want to bring up this topic deliberately because I don't want to go against, let's say, very top expert views on this. What I will say, Andrea, this is a debate that I'm having with you. So when you hold the mastoid vibrator over there, either your device or my device.

Yes, There is a very hard bony skull, right. The mastoid process. So by the time these vibrations reach the lateral semicircular canal, it does not stimulate the lateral semicircular canal at 100 hertz, it can't. So by the time it reaches the lateral semicircular canal cupola, the vibration strength or the vibration intensity drops down to 0.02 Hz. I'll tell you why, Andrea, because it said in some circles that the Massar vibration test checks very high frequency 100 Hz response of vestibular basement membrane.

The normal physiological range of vestibular atal semicircular clearance is 0 degrees to 7 Hz. 0 Hz to 7 Hz. How can you possibly stimulate a vestibular organ with 100 Hz which is 12 times the normal physiological range? And. And if.

If you do that, then the person will lose balance and fall. You see, I moving my head like this. If I do it like that, I'm going to fall. So how can you do this? So my logic is.

And Marco. And you know, they have said that, Danielle, it is a low frequency sensory stimulation. But I didn't say anything because in some circles it's written. It's a very high frequency test. So debates are fine, but I don't want to contradict anyone.

With due respect to everybody, that is my. Yes, it was just some. I totally agree with you, but really, it's maybe just a misinterpretation of the test. Probably. Probably, huh?

So another question from Simon Marin. If you have a positive test to vibration and then you test in lateral gaze and it reverses, would this be a good indication of central disorder? That's a very good question. I've never seen that happen and I haven't read about this. But in answer.

Remember last time when I said. In my last lecture I said that anything which is. Doesn't follow the peripheral rule is central. So it might jolly well be. But I've never seen this happen.

I'll be frank. It might be. Yes. We'll test. Another question.

Vestibular epilepsy. Is it common in children? Well, yes. It's not infrequent, but it's a diagnosis. Once again, by exclusion.

We have edited Jacob Brodsky, Josephine and myself. We have edited a frontiers research topic on pediatric vestibular. There's a fantastic article which we have selected. It's about vestibular epilepsy. Please have a look.

Vestibular epilepsy. Go to Frontiers. And then the research topic is called pediatric vestibular disorder. And out there, I think the second or third paper is Vestibular epilepsy tells you everything about vestibular epilepsy. It's a fantastic paper.

Yes. It's not common, but yes, I've seen it. Okay, thanks. And then we have other.

Yes. Hi, Joanna, it's very nice to have you here. And Aliman Yamin, thank you very much for informative lecture and. Okay, so a lot of nice words from you. Show me.

Thank you very much. Thank you very much for being here, really.

Oh, thank you. Oh, there's few other questions. Oh, just one I can see. Oh yes, you're right. Any comments on bcw?

Yes, yes. Sorry, yes, what? It depends on what kind of comments do you expect? Because BCWS is pretty standard if there's a middle ear infection, which we do in our, you know, in our lab. So.

Well, what I would say is BCVMs are good tests, of course, they're quite good, but the norms and parameters are once again completely different. And usually we would have a run on both ears at the same time because it's stimulating both sides. So no special comments. It's pretty much the same as in adults. And yes, your honor, you do a lot of rotary step test, as does Silver, as does Professor Veja, who is of course my mentor.

But I don't do it for the simple reason I do not think that it gives me any extra information. Look, it's a low frequency test. I've already got my low frequency response. But yes, I would do an office chair test, of course I would. Plus, as I said, in kids bilateral vestibular hyp function is not that common.

If there's a bilateral vestibular hypertrophy, then of course there's a definite case of doing it.

I think you have got my answer. You don't work with the rotary chair. Exactly. You've got my answer. We have another question.

At what age does the value of rotatory visual fixation test results occur, iPhone join the values seen in adults? I would say roughly from the age of 8 onwards. Roughly. But no, I don't have any data. Yes, Iona, it's a great tool.

But look, once again, I would beg a little bit to differ here. Why do you have to do a test which does not need to be done? Well, if you didn't have any low frequency information, then fine, of course I would do it. But here I've got low frequency information, so why would I do a test which I do not need to do? But then it's not true that I don't do it at all.

I do an office chair test. I of course physically measure the VOR when I spin the kids round. But not the very expensive rotatory chair that I think you mean. Yes, it's physiological, but remember, once again, it's a gold standard for bilateral unilateral. The evidence is a little bit controversial.

In other words, I just won't do a test just because the test is there. I'll select my tests carefully. Majority of them I would do so that I get a full frequency Specific information. I think that's the most clear answer that I can give. Okay, then we have another very hard question.

What is the standard test to detect secondary endolymphatic hydrops in patients with otosclerosis before surgery? This is not very. Well, I'm not very clear. Secondary endolymphatic hydrops. So that, does that mean that you imply that otosclerosis is associated with secondary endolymphatic hydrops?

Yes, I think so. I think so. That's the. Yes, probably. Yes.

There are some patients with autosclerosis who do have in the same year and lymphatic hydros and probably atosophorosis as play an important role in the development of hydrops. And, and the other thing is also, I think sometimes some semicircular canal dehiscences, they, they also present with similar enolep hydrops. I think in the first or second stage. Yes. Well, it's not easy to kind of detect endolymphatic hydrops anyway.

Right. It's a disorder. Was still very much largely by exclusion. But what we would do is, in order to have a definite idea is a discrepancy. Now, this is one of the few instances where probably I'll do a caloric.

So a caloric and vhit discrepancy. That's, that's what we do sometimes. Or as I said, a vemp tuning, which I do not have much data for children, but adults. Yes, there, there is good data. So, yeah, I mean, if you can manage to, you know, kind of specifically delineate the vestibular phenotype that there is an endoliphatic hydrops, then you can do these tests.

But that doesn't prove anything because the test can be negative. Yeah, I think, and I think this person also means probably some kind of a risk of a perilymph gasha when you are doing the surgery for

otosclerosis because of raised indy fluid volume. Right. Yes, that is another risk, I think. Yes.

If I, if I was his surgeon, I would never operate. Sclerosis and endothelial. So someone, so someone, Andrea coming to us with paracusis villisi with a clear conductive gap with a clear like say Carhartt's notch, yet the person feels dizzy, has got significant tinnitus and you know, all the rest of it, oral fullness. So definite clinical picture of an elephant hydrops then. Yes.

Surgeon will think twice or thrice before doing anything. Yeah, sure, sure. And then we have Another question from Dr. Excellent talk. I'm A pediatric infectious disease physician interested in congenital cytomegal, various virus associated with vestibular hypofunction.

Any experience with vestibular rehabilitation in affected children? Oh, yes, as I showed you a slide, that they do respond to vestibular rehabilitation. But not just vestibular rehabilitation. You have to also concomitantly treat the, the cmv. In other words, if it's a non syndromic CMV just with cochlear vestibular involvement, then vestibular rehabilitation will work brilliantly.

But if it's a congenital cmv, which is syndromic, which has got other organic problems, then you'll have to treat those other organs to make the best possible result. Because if you don't do that, then vestibular decompensation will be maintained. So with your rehabilitation you'll find improvement in all the different parameters, but the child will not improve.

Perfect. Great. Okay. Yes, there are a few comments from Joanna Voda about. I am not going to respond because it does look like that there's a little bit of argument going on here.

Well, is not low in audiometric terms. No, it's not low. But in vestibular terms it is low. Yes. Up to 2 is low.

Up to 2 is low. Let me very clearly tell you. Up to 2 is low. 2 to 4 is mid. 4 to 6 is just high.

Mid and beyond 6 is high. We do not have any tests between 4 and 6 as yet, but it will come. But definitely up to 1 kilohertz. It's low. But that's my opinion.

You might. Of course we can say it's mid. Low. Mid. Low frequency.

I mean, up to 2 kilohertz. I would rec. I would, I would consider it as low, but anyway, that's my opinion. And people can of course differ. No problem.

Yes, exactly. So, Shumit, I think we are at the end of this talk and so we really would like to thank you once more for your excellent lecture. I think Anna will, will be now. Yes. And I'm, I'm here again, so thank you all for attending and what a fantastic session.

Professor, your insight and expertise, in my opinion, are truly invaluable and we deeply appreciate your contribution to our academia project. So thank you very much and thank you, Andrea. Thank you, Andre as well. Of course. Thank you.

Thank you. Oh, there's one more question. I'll quickly. Oh my God, the last one. Would you like to.

Yeah, what are. This is a very interesting one. Prevalence of audio vestibular problem in pediatrics with neurodivergent issue based on a. Oh, that's a very, very good question. I'll have to answer this.

Okay, so peripheral vestibular loss in neurodivergent children with autism, adhd, provided they are not syndromic. So let's say for example there is a definite chromosomal abnormality which is known to affect the cochlear vestibular system and autism at the same time. I'm not talking about these cases, I'm talking about virgin exclusive, adhd, asd, etc etc Peripheral vestibular problem is hardly known but

there can be loads of central vestibular integration problems. Nowadays, our autistic kids and ADHD we do a full central vestibular quantification and peripheral and you wouldn't believe this, but I am picking up eye signs to suggest to me that there might be central or vestibular problems. And there's been a fantastic paper once again in the same research topic or I don't remember.

Maybe Andrea knows probably in audiology research whether I have just reviewed the paper. Actually yeah, I think it's an audiology research where they have looked into vestibular problems in peripheral ur divergent issue. Just type in Google what you have read and I don't remember where it came from but I reviewed it and it was a brilliant paper so it's been accepted. Now I'll have to answer this and Anna, this is a very good question. So in other words, what I'm telling you or asking you or requesting you guys is you know, asd, adhd, all these kids who come through your doors, they would require vestibular assessment in some instances.

Please do not just just do not discard their balance problems as you know, because they are autistic. No, they can be central vestibular, not peripheral central vestibular lesions.

Thank you. So professor, let me say again that your insights and expertise are invaluable. Thank you so much Anna for giving me the chance. Honored. But I'd also like to take this opportunity to remind you that third webinar in Professor Dasgupta's series will take place on April 17, titled Vestibular Migraine in Children, the Commonest Cause of Dizziness.

Additionally, our next Academia webinar is scheduled for March 25 and will be hosted by Dr. Vishal Pavar from Dubai who will talk about the fundamentals of Video Head impulse test. Lesson 1 Principles and the mechanisms. So stay tuned for more updates by visiting the Academia section on our website and following us on our social media channel. Thank you all.

Once again, thank you so much, Professor Dasgupta, and see you at the next session. Thank you.

Bye, guys. Bye.