Advances in Diagnostics in Pediatric Vestibular Assessment

Presenter: Soumit Dasgupta, MD

Hello and welcome to today's course, latest diagnostic and management aspects of pediatric vestibular medicine. Before I turn this over to our presenters, I would like to go through the learner outcomes for today. The learner outcomes are as follows. After this course, participants will be able to list the latest advancements in vestibular diagnostics used to assess vestibular disorders in pediatric patients. After this course, participants will be able to discuss the differences between vestibular diagnostic procedures suitable for adults and those appropriate for pediatric populations.

After this course, participants will be able to describe the utilization of cutting edge diagnostic tools such as the video head impulse test and the mastoid vibration test in pediatric vestibular assessments. And now I'm going to turn it over to our presenters. Okay, so I think that 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 a privilege to introduce the first of three lectures featuring an internationally respected expert, Professor Sami Dasgupta. Professor Dasgupta serves as consultant audio vestibular physician, neurotologist and clinical lead in pediatric audiology at Alderhey Children's NHS Foundation Trust in Liverpool. We'll sincerely thank Professor Desgupta for accepting our invitation. The title of today's lecture is advances in diagnostics in pediatric vestibular assessment. The session promises to offer invariable insight into the complexities of assessing vestibular disorders in children.

Drawing from the author's extensive personal experiences, we are also delighted to have with us doctor Salvatore Martellucci from Latina, Italy. Ciao, Salvo. A longtime friend and colleague of Professor Dasgupta and a member of the Vestibular Italian Society. As usual, we encourage you to jot down any questions in the designated space on your screen. Following the event, you will receive a survey and we kindly request your participation.

Your feedback will enable us to tailor our educational support to meet your needs effectively. I now invite doctor Martellucci and Professor Desgupta to take the floor. Enjoy the webinar.

Thank you, Anna. Thank you and greetings to all this webinar attendees. I'm really happy to introduce the lecture of Professor Shamit Dasgupta, of whom I'm honored to be a friend. And really, Professor Dasgupta needs no introduction. Introduction.

He is recognized to be one of the most relevant expert in childhood balance disorders. A real good father in childhood balance disorder. Anyway, Professor Dasgupta leads the audiovisible medicine unit of the Arteria Children's Hospital in Liverpool, one of the most important pediatric hospitals in the UK.

During his lesson, he will introduce another topic of modern neurotology, the pediatric vestibular assessment. In fact, approaching vertigo, real or supposed, in a pediatric patient, is always a challenge for the clinician. And now I leave the floor to the speaker. My friend Shamit. Thank you.

Thank you very much. Salvo. Thank you very much, Anna. And thank you very much, inventers, for this great opportunity to bring to you a topic which is, which is not terribly, you know, people are not very well aware of it. So I've been trying my best over the last few years, at least maybe five or six years, to propagate this to the rest of the world, that pediatric balance disorders are extremely important to diagnose, and not only diagnose, but also very important to figure out what's going on, because they generate very significant morbidity in the pediatric population, in children.

And remember, they can't often describe their balance symptoms or vertiginous symptoms to you, who is the physician or the surgeon. And that makes the problem far more difficult for the simple reason that vestibular history is very much important to

assess a vestibular condition. So today I'm going to talk to you about latest diagnostic, of course, but management aspects of pediatric medicine. So when originally Anna and I, we conceived this, I thought of speaking only about pediatric diagnostic, that is, the different tests that you can do. However, what I felt was that unless we are aware of the different physiological innovations, the different physiological processes, which are recent discoveries, then the whole thing lacks a little bit of insight for the simple reason these philosophy, these physiological kind of substrates or physiological attributes would determine how to diagnose a vestibular condition.

So this lecture is actually incorporating pretty much every innovation that you might find in pediatric vestibular medicine over the last ten years, not only limited to diagnostics, but to management, to new physiological discoveries of the vestibular system and the vestibular processes, the different genetic basis of vestibular diagnostics, which are very recent to the field. So this would be less than 2 hours. And as Anna said, please keep your questions coming, which I shall answer at the end, or at least try to answer. I might not have all the answers because it's still very, very new. The whole subject is very, very new, and there are only a few of us in the world.

But you know something? At the end of the day, if my today's lecture motivates even one of you, and I can already see that there are 121 delegates, thank you so much for this. If even one of you gets inspired and motivated to start this in your country, and I believe that people from all over the world have joined in, then that is a vindication, because my job is not just to tell you about what this is, but also to inspire and motivate and enthuse in you that you can start this, you can do this. Of course, you need the training. You can start this in your own.

That would be a vindication of my lecture today.

Now, my good friend, who is an absolute doin of vestibular sciences is Professor Leonard Dumanzari from Casino Salvo knows him very well. He's a good friend, and I call him Kaputituti Kapi, because he's the godfather of vestibular sciences. He's the one who was in the team who discovered the latest innovation, which is shrimps. So he told me a wonderful thing, that we are living in a golden era of vestibular medicine, because all the innovations that you see, they have seen light only in the last ten years. And it's astonishing the way we are moving forward.

However, because I am very interested and delved into the history of vestibular medicine, I came across this astounding figure, which you see here, a painting. This was painted by a french anatomist called Joseph Gichard Duvernay in Paris. He was dissecting a human temporal bone, and he dissected the human labyrinth, and he was doing it with candlelight and with magnifying glass. Microscope was not refined during that period of the Renaissance. And can you imagine what he drew?

Superior canal, lateral canal, posterior canal. The different orifices is pretty much replicated now in 2016 with a high resolution ct scan. It's exactly the same look. So the thing is, there, it needs to be discovered by human intelligence and human wit and wisdom. And now, actually, one, the main kind of advancement of vestibular medicine, or vestibular physiology and anatomy, started from the Renaissance, carried through romantic period, had a huge spurt with the father of vestibular medicine, which is Barani.

And then now, once again, in the last 1015 years, it's showing a huge spurt, mainly to do with technology. So these are the subjects that we are going to cover today. So, first of all, it's very important that if you are motivated, inspired to start a pediatric vestibular medicine service, you need the training. So how are we, who are actually doing it, addressing that very important need? So I'm going to talk to you about what

are the different aspects of pediatric vestibular medicine training, how the needs would be met.

In the future, we'll talk about anatomy, physiology, we'll talk about how to take a history, how taking a history from a child, and invariably that implies inherently from the parents, how has that changed? What are the questions? You know, those days are gone where you will see a child with a very surgical approach. You know, we all trained in ENt. Many of us have trained in Ent.

I've trained myself in Ent. It was a very surgical approach in the sense, is there a balanced problem? Therefore, that's it. Try to figure out a cause. It's not like that.

History has changed. History is now holistic, which means you are just not concentrating on the inner ear, you are concentrating on the whole child. And that is a very, very crucial thing to understand. Then, of course, we'll talk about the diagnostic assessments, that is device diagnostics, how imaging has changed, how management has changed. And finally, and this is very much my baby, because I've done a lot of work on this, and recently I've published a paper on this as well.

How do you assess vestibular compensation objectively? Now, of course you can. It says functional compensation. When a child or the parents come and tell you, I'm symptomatically better, I'm cured. But how can you demonstrate that objectively?

Because sometimes those two don't match. Both are important. You see, if a child is functionally well, but the objective test shows no improvement, then there is a chance of future decompensation. So it's very important that you measure decompensation as well. Compensation and decompensation as well.

And that has. That is slowly changing the way we are treating pediatric vestibular kids. Pediatric vestibular children. So let's have a brief look. I mean, I don't have the luxury of enough time.

So let's have a brief look as to how we are trying to address training needs in pediatric vestibular medicine. So we have initiated a joint Barani society and international vestibular Society, which I'm a member of. We have initiated a joint kind of a training curriculum, which we have discussed already in the last Barani meeting, and there would be some blue papers which would be coming out. So what are the different issues that needs addressal? In the UK, we are privileged because we have got a dedicated training program in neurotology or audio vestibular medicine, which is not ENT because our trainees come from different backgrounds.

ENT, pediatrics, neurology, any medical or surgical field for that? Not any surgical field. Any medical field. And ENT is a surgical field, and we give them dedicated training, specifically in what we call medical otology. We are not surgeons anymore.

I have been a surgeon before. Not anymore. So medical otology, which kind of is a very dedicated and focused training of five years plus one if you want to do a higher fellowship, and that is a very dedicated training which trains you in pretty much every aspect of medicine, because, you know, vestibular disorder, both in adults and medicine, strongly influence other systems as well. So as a pediatric audio vestibular physician, our trainees actually rotate through different pediatric disciplines. As you can see here, we spend a lot of time to understand how a child might behave at present.

And this medical knowledge, especially pediatric neurology and pediatric eye movements, are absolutely crucial. I'm not aware whether there is any other center in the world which can offer this dedicated training, because most trainees who do pediatric vestibular stuff, they come from a surgical background. They have done ent.

Of course, we have all done Ent again. And they would sway kids as an ENT person, they do not get dedicated training in pediatrics.

And that is a big gap in training, which we'll have to address, because if you don't have this knowledge, if you don't have this training, then you do not have enough insight to actually treat a pediatric vestibular disorder. So please, please, please consider this. And even if you don't have this built in your curriculum, then obviously you can actually physically ask for secondments or attachments to different pediatric disciplines if you want to do this in a dedicated way. And that is an absolutely crucial message that I'd like to give you, give to you today. So we need.

So, at the end of the training, at the end of all this, because I remember when I was doing pediatric vestibular training, I rotated in different pediatric disciplines. I even did acute on calls for pediatrics. You know, a child who comes with meningitis, I used to treat that child because I had then developed this holistic insight that when a child presents to you with a problem, it's not just the system that you are concerned about, it's the whole child is life. So we need a broad knowledge of pediatric medical disorders, and that is, once again, the training or the experience which we think is essential. In the UK, of course, we would encourage pediatric vestibular presentations in different conferences, not only for otology, not only for neurotology, but pediatric nature, neurology, pediatric, endocrine, developmental pediatrics, general pediatrics.

And I do this all over the world where I do not just limit myself to anything to do with the year, but very much general medical, pediatric disciplines. We are a designated fellowship center for pediatric vestibular training. And there are a few other designated centers, many of them, some of them in the US. And yes, pediatric vestibular courses are a good way to start the training. And I do a very unique course in alder here, which Anna said, I think that is quite unique.

There's one which is run by Jacob Brodsky in Harvard. In Boston, he runs one. There might be one in Toronto, Canada, run by Sharon Cushing. We need more of this. And I can tell you that I recently did a fantastic pediatric vestibular course for the first time in India, and people were so interested that they want to do it again.

So if pediatric vestibular citizens can happen all over the world, then that's what we are looking for, because that gives you a good idea about what you are going to do. In fact, Malaysia has started one. My fellow doctor, Sanyasia, she went to Malaysia and she started this. So it can be done very much it can be done, but all you need is the will, and all you need is the insight or knowledge in order to do it. So let's have a brief look into how rapidly understanding of vestibular physiology has unfolded.

Now, let me tell you that the cochlea has been researched for a very long time and still going on, and lots of things are known about the cochlea. But in spite of everything, vestibular physiology research started in the year, let me tell you, 1841, by the father of vestibular physiology, Jean Marie Flour, who dissected a pigeon for the first time, showed that the pigeon semicircular canal, when destroyed, leads to a problem imbalance. And then there were pioneers like Alexander Crum Brown, Joseph Breuer, Ernst Mach, all these guys, Fondaco, Alexander Felix or Alexander Fondisio, they set vestibular physiology on a firm footing. But 1841, and this is 90, this is 2024. So less than 200 years.

So, vestibule of physiology. Although we know a lot, we are still collecting pebbles on the seashore. There's a lot to know. So let's have a look as to what these innovations are. Now, you can understand one thing very clearly, and that is both the cochlea and the vestibular system develop from the same area.

Phylogenetically, that is from the otic placode. So obviously, why has nature kind of put these two things together? There is a reason for it. So as a result of this, what

happens is they share common properties. So you all know about cochlear inner hair cells and outer hair cells.

So these are basically type one and type two cells. Similarly, these kinds of cells have also been identified in the vestibular sensory epithelium, and that was as recent as 2014. Of course, it was known before that, but it was put on a firm footing as to what they exactly do. Just like the cochlear transducers, they encode different signals. Autolith crystal integrity is dependent on vitamin D, which we showed for the first time in 2011.

And now it's pretty much accepted. And the groundbreaking experiment, which Raymond Vandenberg, our colleague from Maastricht, has done with electric stimulation of the vestibular membrane, is that the vestibular sensory epithelium is very frequency specific. You know that the cochlea is highly tonotopic or very frequency specific. Similarly, a common property shared by the vestibular sensory epithelium is that it is also highly frequency specific. And that has got the potential to change the way you treat a vestibular condition.

For example, a high frequency hearing loss. You will give a hearing aid for a high frequency, not for a low frequency. So a high frequency vestibular loss will be addressed by vestibular high frequency rehabilitation, not for a low frequency one, I hope. That makes a lot of sense.

So the velocity of the angular. There are two types of motion, right, in the vestibular system. One is, one is an angular motion, which is the semicircular canal, and one is a translational motion, which is a gravitational sensor. It's proportional to the frequency of the movement. And the vestibular membrane is resolving all these movements in indefinite areas of the basement membrane.

And that's the way they transduce. And they modify the signal as well, just like the cochlea. And the human physiological range is between zero to 10 hz. Now, average, it's about zero to 7, is for, you know, high energy ballet dancers or people who are gymnasts. They have.

They have kind of conditioned their vestibular system for a high frequency. Let me give you an example. When I'm not moving like this, I'm not moving, but then I slowly start moving my head all the way. So as you can see, I'm increasing the velocity and frequency of my head movement. And you do this movement every day of your life.

We are very high frequency dependent animals. Cochlea high frequency is essential because of speech sounds, resolution, consonants, and the vestibular membrane. You would usually do movements like this rather than that you are trying to reach something from the top shelf of a kitchen, would you look like that? Or would you look like that? So we are high frequency, and when high frequencies are involved, that's where the patient is most symptomatic, including a child at very low frequency, 0.5 hz, that is about 30 degrees per second.

The optokinetic system, the smooth pursuit system, takes over, resolving space, resolving what the vestibular system does, and that's independent of the vestibular system, which can be utilized in your tests. And just like the cochlea, surprisingly not unsurprisingly, the sensory cells, they exhibit a resonance at a characteristic frequency, which I'm sure that you know, that the cochlea has got a resonance at a characteristic frequency which is very frequently researched, and this is voltage dependent. So, basically, at the end of the day, the net result is the vestibular sensory hair cells are tuned. Tuned means that they show a frequency tuning curve, which is very, very important, so that the incoming frequencies are resolved in definite areas of the vestibular membrane, encoded in the vestibular nerve with phase locking, just like the

cochlear nerve sent to the brain, first order neurons end in the vestibular nuclei. That's where the processing starts.

What is space? What is balance? So, I hope this is a very, very useful resume of, of how this physiology is being slowly discovered. But still, we have got a long way to go. Just to illustrate my case, let's imagine that you straighten a cochlear out.

This is a cochlear, you straighten it out and then you subject it to different tones. So look what happens to the cochlea.

So you saw how each individual tone specifically stimulates one part of the cochlear membrane. So imagine this, this kind of sheet, if you might call it this kind of sheet, as a vestibular base membrane, exactly the same thing happens.

The other very important physiological discovery, which is now gathering momentum, is genetic vestibular disorder. And one of our good friends, Antonio scams from Granada, he's got a full vestibular genetic lab where he's looking into genes for Meniere's disease. I'm sure Salvo knows about it as well. So I'm not going to detail this, I'm not going to read through this slide, because you can see quite a few genes have been identified which can influence vestibular system. And there is one important caveat which I'd like to put through.

All these genetic influences are in utero, which means when the vestibular system is developing, it's developing under the influence of genes. But the moment a child is born, it starts to develop by environmental stimulus. How motion is resolved in real life. So obviously, at any point, if the genes are mutated, then there will be a vestibular deficiency. And as you can see, quite a few hearing losses, both dominant as well as recessive, they have been identified with simultaneous vestibular losses.

My lab has actually done quite a few of these. And where we have quantified vestibular system in children, and we have found vestibular problems. So, you know, Meniere's disease can be familial, motion sickness can be familial. There's a very interesting condition called XlhR, x linked hypophosphatemic rickets, where you get endolymphatic fluid, metabolic defect, leading to endolymphatic hydrops in children. So there are loads of conditions where genetics plays a very important role.

And nowadays we do have the means to check some of these genes. That is important.

So let's come to how do we take a history? How has the philosophy changed? A child, let's say four years old, comes to you with mom or dad, whoever carer, and the complaint is that he falls when he walks. That's it. What would you do?

You will ask the child, how would you ask, do you fall? Won't understand, will not talk back to you. Ask the parents. They say yes, when he walks, he does fall. You would have stopped at that.

And then maybe send him for vestibular investigations, maybe do some scans. But that's not enough. History. History alone takes quite a long time, because just like in adults, crucial history is important. The trick is how to elicit it.

What are the questions to ask? And that philosophy has changed.

So many of them are unable to describe their symptoms. And that includes teenage boys and girls. The girls, they talk only in monosyllables. How I do you feel dizzy? A bit.

And the boys answer in grunts, so it's difficult. They might not be communicative. However, the parents are very astute observers, and sensitivity of parental observation

for a balance problem is as high as 80% to 85%. Remember, they might not be very specific, but they can. And they will notice intricate problems which otherwise you will never find unless you ask.

Right? And I'll give you a few examples.

So when you get a history which doesn't exactly confirm with a vestibular phenotype, so you think that, you know, for example, a boy, mom says that whenever my boy tries to get up from a standing position, he has to hold something and then steady himself. This might be lightheadedness coming from postural hypotension or pots, but even then, because vestibular phenotype is so vast and variable, of course, if you get a vertigo spinning, that's suggestive, but you get different kinds, you can get any sense of disorientation. So it's always important to investigate these children, at least with a screening, assessment, and history, of course, gives you a very important ideas about etiology, about the cause. Because the way you identify an etiology is by understanding the pattern of the phenotype, the pattern of the presentation, trigger, duration, episodic, continuous, so and so forth, the different presentations.

So here I introduce a word or a term called the vestibular behavior. Vestibular behavior is the observation of symptoms that a child might present if he has got a vestibular problem. And it depends on leading questions, you must know what to ask. The parent might not volunteer. You need to ask change of facial expression.

Now you tell me, as ENT surgeons or otherwise, when you are investigating a child with balance problem, do you ask this question to your parents? To your parents, because the child doesn't stand in front of a mirror, right. The parents will watch. Do you ask this? Remember, if there is a sudden bout of a dizziness, a child's facial expression will change, not only then, but also if some provocation brings on a dizzy spell, a child's facial expression will change.

One mom told me, and this came from my neurology colleagues, this child has got vague valence problems. And they did everything possible under the sun, including scans, including genetic testing. They couldn't find anything and sent this kid to me. And mom said a fantastic thing. Said when my child is in the swing, the trampoline, or when he's sliding down the slide in a park, the moment he lands, he has a vague facial expression in face and cannot pick himself up.

That is very, very vestibular. And there are millions of such questions. And that's why it's so important to interact with the children in different disciplines to kind of get a good idea as to how they can present. If you just limit yourself to an ENT history, you will not find out all these finer points. And that's why it's so important that you need to go to different pediatrics departments to see how a child presents.

They can be mistaken for epilepsy. In fact, that child was also treated for epilepsy as well. Nothing found, but treated because vacant stairs. Vacant stairs overlap fright or pallor. Clutching, bumping into things.

Do you ask your parents if they don't tell you that when your child walks, do you think that he bumps into door frames? Do you think he loses his way? Navigational problems are very much vestibular clumsiness, dropping things, fine motor skills and all these things, sudden poleaxing, falls, vestibular drop attacks, which are not very common. But if they happen under the age of four, that is a benign paroxysmal vertigo of childhood, almost like a tumor kins crisis of many years, nausea, vomiting. If the vestibular system on both sides are affected, the near bilateral vestibular, you might get delayed motor functions.

So all these different questions you need to ask, which only comes from years of experience and the wisdom and the insight that you are looking at a child from a

complete angle of his life, rather than just the inner ear. And that is the crucial message that I like to give it to you today. You need to be very comprehensive in asking pretty much everything about the vestibular system, about the child. That includes birth history, family history, school. You know, they struggle so much in their school that they are outcasts, they withdraw and they get bullied.

And not only that, they might get told of by their teachers, it's because of a vestibular problem. So you'll have to understand educationally how the child is doing, because you are going to manage the child and make him come back to the mainstream again. Of course, your symptoms, of course, neurological symptoms, development history is crucial. Motor development delay is very much a characteristic feature of bilateral vestibular hypofunction, even unilateral when it's decompensated. So pretty much everything about the child you need to ask.

So it's not just a three minute job. Right. So he is dizzy, so he falls, so he's unsteady. Fine. Normal otoscopy, normal unterberger, normal Romberg.

Full optic fixation, known stigmas. If you can do it, send for vestibular function test. If your hospital has the facility to test in a child, which very few placentas have, that's not the approach that will be appropriate. The reappropriate approach is a complete intense. Germans use the word anamnesis, or history, which is absolutely crucial.

And psychological, very important. Never miss the psychological bit. Because vestibular problems generate a significant psychological morbidity. They react to their problems. In fact, they emotionally become very vulnerable and they often end up in mental health services.

I get plenty of referrals from our mental health services with vestibular problems. No one believes them, so they end up in mental health services. And it's very important

that you do explore for this. What do you need? You need to spend at least two to three months in a child psychology unit and see how they present, how they are managed.

So now you can understand why I'm insisting that this training is so, so essential. So now, with this idea, which obviously influences the way you assess a child, let's come to the revolution, which Leonardo says as the golden era of vestibular medicine. What are the aims? The aims are to demonstrate whether there is any vestibular problem or weakness with some objective assessment, and to obtain as much frequency specific information as possible. Sometimes you understand the etiology by just looking at the tests, and also you do a full functional assessment of balance.

This is something which is very, very new. And I'm privileged to know Professor Lean Mays from Ghent in Belgium, who leads the vestibular infant screening service in Flanders, who are doing vestibular cwMPs in children as young as six months, especially those kids who have a sensorineural hearing loss. So can you imagine you get an information of one part of the vestibular system. Now, it's very important. Why CvMVP?

You might ask me? Why not remote control we hit? Why? You know, why not something else? Well, what I'll tell you is, look, gravitational sensor motions.

They are far more sensitive than angular motion sensors, because gravity is ubiquitous. That's how life began, right? It's only when you change your center of gravity movement came, so your gravitational sensors are extremely robust. As a result, when the disease process starts, they are the first to go. So cwMP makes a lot of sense.

But in the absence of cwMP, if you don't have it, even then, you can do a good screening, which I do in my clinics, day in and day out. Primitive neurological reflexes,

which we'll discuss in a bit. So, primitive neurological reflexes, at least up to 60% to 70% of these reflexes are generated or contributed by the vestibular system. And under the age of two years, if you want to have semicircular canal function, which is pretty much developed at the age of one year, not completely, the synapses we hit, which is a remote control camera, is the best tool, because the other two equipments, the other two gadgets which are in the market, the band which goes around the head, doesn't fit. So you actually need either autometrics or interacoustics.

We hit for above four and synapses may hit under four. It's very, very important that you get good information. And my colleague, our colleague, who was my actually mentor, Professor Sidwet Vasya Veena in Paris, she has done a wonderful cohort study of normative values. Following the synapses, we hit the other way. You can measure or get some ideas about whether the vestibular system is working is a full assessment of motor skills.

Yes, you do need to take a full developmental history and assess motor skills for a child when he walks through your clinic. That is completely a pediatric examination, which does not get taught to ent trainees. But you do need that because that is an indirect evidence that the vestibular system might be affected. Now, this is an interesting slide, and I'm sure we'll be sharing the. Sharing the slides with you, but this is a slide which I've prepared for you guys, and I have propagated this all over the world.

Just like the way you would select an age appropriate hearing test, this is what you would do for vestibular function tests. So birth to six months, you can do the developmental reflexes. You can do a veinge. Yes, you can. How the band won't fit, huge goggles.

What you have to do is ask the parent to hold the goggles to the kids eyes. Now, you need an absolutely brilliant distractor for it, but that's true for any pediatric audiology

test as well. You need somehow to grab the child's attention, and that is an art, by the way. It's far, far, far different from adults. They cooperate, a child will not.

It's your job to make the child cooperate, and that's where the skill lies. Six months to twelve months. So I'm not reading this, but as you can see, that you get different tests at different age groups, and you need to select the right tests from ten years to 18 years. You can do pretty much everything just like an adult.

So this is the important way this is useful for stimulus screening. This is my colleague, Sharon cushing with a baby, very, very tiny baby, as you can see. Now, these pediatric primitive reflexes, the moro, the tonic neck, head writing, parachute, dolci farmers. These are very good tests in order to assess the vestibular system, peripheral and central, and they are very, very much contributed by the vestibular system. So if you get a problem with at least two tests, you know, when the child is not showing adequate motor skills, then, yes, you have got a case, and you will do much more later on.

So let's talk about this frequency specific response. We start with zero degrees. You're completely still like that. Obviously, the test that you do here is now, ideally you should do it without optic fixation because as you know, vision might damp a subtle or latent vestibular weakness nystagmus. So if you remove the optic fixation, your vision is eliminated.

So your vestibular weakness becomes much more overt. However, if you do not have optic fixator eliminator with VnG goggles or whatever, frenzel's glasses, then you will still pick up the signs, provided that the vestibular weakness is quite significant, because in that case, vision is not enough to eliminate vestibular weakness. So this was one of our patients. As you can see, the classical example is an Alexander's nystagmus, which is a horizontal jerk nystagmus with a slow and a quick phase which

changes over a period of time, becoming 1st, second and third degree, which I'm sure you all know. I'm not going to detail that this is a zero degree lateral semicircular canal response and when it's present, it indicates an active lesion, which means it is a decompensated lesion.

It's got a high sensitivity and specificity. If you do not have anything, then always record these eye movements. Try to record these eye movements with your mobile phone and then play it back. That's a very useful way to do it. And I have said this on numerous occasions in the past and it does pay dividends.

Of course, you'll have to take the parents permission. Now, this is a very useful test, and wherever I have told them that this test can be introduced, they all have come back to me gushing for that. It's such a beautiful, and it's a no frill simple test. It's a mastoid vibration test. The official calibrated mastoid vibrator, which is in the market, is extremely expensive.

If you can afford it, well and good. If you can't, then there is a cheaper option, which I buy in the United Kingdom for nine pounds, 99 pence. And this has been proved that it is quite good, it is robust and there have been studies, international studies regarding this. So this actually delivers a calibrated response when you touch the mastoid shaker behind the ear, a calibrated response about 60 stimulation in the basement membrane, which happens, is about 0.2 hz. So it's once again low physiological stimulus.

But the important thing is it's got good correlation with caloric tests. It's not a replacement. However, in my clinic I do not do caloric tests because I have been baptized by fire. This caloric test in the pediatric population does not go down well in many. So I do not unnecessarily want to distress my kids.

I use the mastoid vibration test, which also gives me a low frequency, although a different low frequency response. And what you find is an nystagmus, which beats towards affected ear, but it's not very site specific because you are stimulating both masters when you're doing it. So here I'm touching the mastoid vibrator, and you'll see that there is an nystagmus there. That's the nystagmus there. That's the nystagmus there.

So you'll see about three or four beats, which you can obviously chart out there. And it's useful for prognosis because over a period of time, this master vibration nystagmus might disappear, which indicates good compensation. Rotatory chair tests, very expensive equipment, but a fantastic test. So what you do is you put the child, small child. If it's an older child, fine, but otherwise the small child sits on mom's knees and you rotate the chair.

Now, if you do not have that calibrated rotation, which is hooked up to a VNG computerized control, you can just use your office rotatory chair and watch the eyes. If there is a good vestibular reflex, you'll find this very classical dystigma. When you are rotating, in case of absence, in case of vestibular a reflexia, the dnystagmus will be either absent or extremely low in amplitude. Now, as I said, this is a very expensive piece of kit, but please use your ordinary office chair. But remember, best is once again done without optic fixation.

So try to eliminate vision.

Dynamic visual equity is very useful for bilateral vestibular hyper function. Very easy to do. You can use a log mart chart. You can use a Snell's chart. Nowadays, you can use computerized devices.

So you ask the child to read. Of course, if he can read. Yeah, for children who can't read, no option. I mean, you can do it still by targets, you know, different kinds of optotypes. You can still do it, but it's.

It's a little bit laborious. So you ask the child to read the lines and then shake the head.

So passive shaking of the head, and then ask the child to read again. And if the line drops by at least three, then it is a retinal slip, which indicates a bilateral vestibular hypofunction. It changes with age and vision, and once again it starts to improve the lines will improve once a child compensates. So this is mid frequency response, two to 3 hz. Next we come to another mid frequency response.

Now, remember, all these are only to look into lateral semicircular canal frequencies. You might ask what's happening to the vertical canals? How do we check the frequency there? Well, as I said, we are still on the seashore collecting pebbles. We haven't.

We do not know as yet, but I'm sure it will come by some fantastic brains. For example, in Australia. So 20 head shakes, horizontal. Always do a vertical as well, because vertical head shake is important for central vestibular integration. Horizontal post headache.

Nystagmus is vestibular asymmetry. It doesn't tell you the side, it tells you one side is weak. So here I'm shaking the head of the child, and then you see a very classical jerk, nystagmus appear. You might get caught out by the direction of the nystagmus. But please do not mention a side with a head shake test.

I don't. Some people do, because you are stimulating both the vestibule system at the same time. So it's not site specific. It just tells you which side is weaker than the other. And this also changes over a period of compensation.

In other words, it might disappear or the amplitude reduces.

Another lateral semicircular canal, which has now revolutionized everything. And this time, the vertical canals have been brought in. Previously, we had no idea about vertical canals. The head impulse test has revolutionized the entire approach to high frequency vestibular assessment. And remember, if you can't do any test, do the static response, do the head impulse, because that gives you the full idea about the lowest possible zero degrees and the highest possible, which are the most practical frequencies when you are still and when you are moving your head like that.

Head shake is like this, but this one is a more practical movement. Right? So what you do is basically, I'm sure you all know about this. I'm not going to mention this in detail. There is a fixed target.

So as you rapidly thrust or move the head to one side and ask the child or a teenager, this is a teenager, to look at the target. Then the eye will remain focused on the target because the vestibule ocular reflex moves opposite to the direction of the head movement and doesn't move your eyes. However, if there's a problem, then the vestibule ocular reflex is weak. The eye will move in the direction of the head, but there will be a quick catch up saccadede, which will bring the eye back to the target. That's called the compensatory saccadede, which is produced by the.

Generated by the brain. So this is the way you do it. So that's the fixed target there. Now, this was very early days. I'm not doing it right, by the way.

I apologize. I've touched the band. You should never touch the band. You should never, ever touch the band. But these were early days.

As I said, we were still learning. Unfortunately, I don't have a good. Another video. So this is when you do it with the video head impulse, when you are measuring it. And this is the compensatory saccadede.

You see? See, I'm thrusting or moving the head on. It's a thrust. Wait for it. There we go.

Nothing there. Left. Clear. Ketchup saccadede. Clear.

Ketchup saccadede. And this is when you do it clinically. So if you don't have the equipment to do this, then do not despair. You can do it clinically, but in clinical, you can't see a covert saccadede, which is generated when, during the head movement. What you see clinically is an overt saccadede, which occurs after the head movement.

So I'll show you this clinical one. This is a child as well, once again, taken from my venter, professor. So watch carefully. The saccadede.

There we go. Beautiful saccadede on the right and the left. So bilateral vestibule hyper function in bilateral sensory or hearing loss. In fact, this was one of the videos which Sylvette, I borrowed from Sylvet and this set me to a career in vestibular medicine because I loved it. So this is the vhit trace that you see on the left side.

It's completely normal. Beautiful. So when the eye moves with the head on the opposite side, that's called, the ratio is called the VOR gain. So you can clearly eyeball here. And of course, you can read the figures so clearly.

See the eyeball here. The eyes are moving with the head, the blue is the head, the green is the eye. However, on the right side, it is not moving. So the orange is the head, the green is the eye. They are not moving together.

There's a lag. And that lag is fulfilled or compensated by these spikes, which we call ketchup Sakhat. So this is a right sided, three semicircular canal weakness. So previously we could only check one semicircular canal, which is the lateral one. But now we are in a position to check all six canals, three on each side.

And this is the revolution that I'm speaking about. This has changed pretty much everything. And we'll also talk about this when I go to the compensation section, that it changes over a period of time. It changes with compensation. And that is absolutely crucial for us to understand.

So we will go through that in a bit.

So the functional height impulse test is another beautiful test which is divine by Stefano Ramat in Parova. I'm sure it's Perova. I think it's Perova, which is an extension of the video impulse test. Now, you know, speech audiometry is the functional part of pure tone audiometry, where it becomes more behavioral. This is a behavioral test which utilizes an objective test.

So what you are doing here is basically, it's like it acts on the principle of retinal slip, which is basically, you are measuring how much your eye can catch up with a movement. So there are different optotypes present, and the subject is asked to identify the optotypes correctly when you are moving the head. And this generates some wonderful curves, what I call the Manhattan. And look, they kind of measure the vestibular, lateral semicircular response across a range of velocities. So once again,

you get quite frequency specific, velocity specific information, and it's got a very good relation with the video impulses.

Now, no one has tried this in the pediatric population, as far as I know, and we are going to start it shortly because we have just got the machine. So this will be very interesting as to what we see. But remember, this is very much subjective, so you need the patient's cooperation in full. So I don't think it will be possible in younger kids. It would be only possible in kids who do appear tone audiometry.

So it's probably four plus, we haven't started as yet. And this is absolutely very, very new. This is a suppression head impulse test, which was once again discovered by the McDougall team in Sydney with Jan Kurthos. And my friend and colleague Leonard Dumanzari was part of that team. When they first introduced the test.

I was into wines. I didn't much believe the test because I thought VOR suppression, which means when there's a moving target, your eyes are tracking the target, you're overriding your VOR. That's a voluntary effort for the simple reason you might not want to track that object. So if it's a voluntary effort, then the VOR suppression is very much central. So why should it be a peripheral test?

It should be more central. So what are they talking about? But now, after going through eight years of the suppression heat impulse test and doing it in pediatrics, doing it in children. And Leonardo and I, we have recently published. Only two days back, it has come out in frontiers.

It's provisionally accepted in frontiers. About the first pathological shrimp cohort in the pediatric population. I am a complete convert, and I think that the shrimp not only adds to your we hit results, but also on its own, is an absolutely fantastic, almost to the point of a mind boggling test, because it gives you, I think, very important information about

the status of not only of your vestibular system, but also, crucially, how much it has compensated. And remember, in a child, it's absolutely crucial, because you need to know which stage of compensation a child is in just by noting symptoms is not enough. You'll have to make a judgment how much compensation?

Because on that will depend how much will you treat the child, rehabilitation or otherwise, how much do you have to engage the school? If a child has not compensated completely, then he'll go and talk to the school, tell them that, look, these are the different playground activities which this child will not do. And if the. If he does, if he falls, please do not tell him off. So can you see the level of engagement that you need to do with different people around the child?

It's not just the ear anymore. It's not just the vestibular system anymore. It's a child that you are talking about. And that philosophy, that attitude, that kind of ethos needs to be inculcated if you want to do a pediatric vestibular medicine. So the principle is slightly different from the hit from the hip protocol.

Sorry, hit is now called him head impulse protocol. So, as you see, the last time the target was fixed here, the target moves, you can hardly see. So that's the red light which moves. And the subject this time, my resident, who very much can double up as a teenager, who is looking at the target as the target is moving. And then what you see is because you're overriding your VOR, you get what we call an anti compensatory saccade.

So the eye moves towards the direction of the head movement. So it's obviously downward and all these spikes. And this is the gain again. And we are, and it has been said, and actually, we have shown that the shrimped VOR gain is probably a better indicator than the hemp VOR gain. Why?

Because in the hemp VOR gain, covert saccharin influence the gain. Whereas in shrimp, it's called a covert saccharinid killer. You get hardly any covert saccharin. So the VOR gain that you get the average VOR gain, that is VOR gain across a number of trials divided by the number of trials is more sensitive indicator. At least that's what the literature says.

And shame changes with compensation as well. That's so important because essentially what the original discovery said was that it is an index of compensation.

What we have found from our study, and it will be available online every. All formalities have been done. Hopefully the next few days. Please have a read. I'll send another literature.

What we have found is a very interesting observation in some of our kids. When you do a v hit, this is a real patient, by the way, completely normal. However, when you do a shim, you see. I'll show you something. You see this asymmetry, 39% on the.

I think this is the. This is the left. The gain is 0.59. On the right, it's 0.96. So there is an asymmetry of 39% between the two sides.

And the velocity, the average velocity of this left side of the saccadedes is less than that. What does that mean? That means that there could have been a previous left sided vestibular damage or assault. And you will try to find out the cause, of course. So how does compensation behave?

The first thing of compensation, cerebral compensation. Remember, a child's compensation is slightly, quite different from an adult because a child's brain is highly plastic, far more plastic and redundant than an adult. So what happens is cerebral plasticity kicks in. The VOR gain is first restored. Next, the saccadedes are still

abnormal, so you might get a situation where the VOR gain is normal, but saccadedes are abnormal, which is once again been now proof that it is a legacy of previous vestibular damage.

Now the saccadedes slowly start to disappear with more compensation because the brain adjusts to the brainstem, which is the saccharin generator. However, the Vor suppression takes a long time to go away. Vor suppression abnormalities, it lingers on and it lingers on as asymmetry and a reduction of peak circadian velocity of anti compensatory movements. This is what we have actually found in our children, and we have reported this for the first time. Now, obviously, this is still very early days, but this is what we have found in a significant number of kids.

So asymmetry and peak psychiatric velocity are important indicators of vestibular compensation. Next, I'm going to show you two tests which are not frequency specific, but they are etiology specific, which means they tell you about the etiology. This is a child who was unable to play cricket because every time he wants to hit the bat, he was very dizzy and lightheaded. And this is what I found. I asked him to hyperventilate.

Now remember, hyperventilation is not a very easy test. It's a complex and sometimes it can be a dangerous test, especially in epileptic kids. So do not do it on everybody. Only when you have got a good clinical justification, do it. So ask the child to hyperventilate 20 times or 30 times.

Slightly older child. And then watch the eyes. You can see this is a post hypoventilation anesthetic which directs. Which changes its direction with increased in something. What is it?

This is a diagnostic test of a cerebral pontine angle lesion, which can be a tumor, which can be an artery venous malformation, which can be a cross arterial Sharda type

compression of the vestibulococcal nerve by the anterior inferior cerebral artery, or in 20% cases, where the posterior inferior cerebral artery manatomical variation. Now, this kid had a cerebral pontan angle lipoma because acoustic in a middle teenager, 1415 is not terribly common unless it's part for neurofibromatosis spectrum. This kid had a lipoma, which I'll show you. I've got an Mr. Scan later.

So that's one test. The second test I'm going to show you is disequilibrium autophony. Unable to sing in the school squire because hated their own voice. And this is what I found. This is an Henewerths test where you press the tragus or you can use a valsalva or you can use a seagull.

So tragal pressure or valsalva followed by a classical torsional distigma.

I'm still pressing the triggers here. And you'll see the nystagmopsia. There we go. You can see the torsion. This was a superior semicircular canal dehiscence bilateral in a young child.

Teenager. So these. They give you the etiology writer, right. So this is fantastic. They just tell you what the problem is.

So any birth sign is a feature of third window disorders. Caloric response still useful in adults, of course, but in kids, I don't do it because I don't want to distress them unnecessarily. But they are highly sensitive and specific. Objective test. I would use it occasionally in kids when?

When I instructed by the court for legal purposes.

So you can show so what you saw so far. We looked into the semicircular canal system. Right. So we did see the different frequency ranges for the vertical canals, only

we could see the high frequency ones, but for the lateral, we had a whole range, zero to seven, low, mid zero, low, mid, high. What about the autoliths?

Well, you'll be surprised to know this is once again, a very recent thing that you can measure autolith frequency functions as well. So the physiological high frequency counterpart of the head impulse test is what we call a head heaven. So in the head impulse, you move in a rolling plane, whereas on the head, he, you move it translationally. And this is what happens. Watch for the saccadede.

Once again, fixating on a target. So watch for the saccadede. It's going to come. There we go. On the right.

And again, nothing. And on the right, beautiful saccadede. And this has got a good recorrection with ovamp in children, at least in, sorry, in adults, because in my private practice, I see adults and they've got a good correlation with ovum. But that's. I haven't published this yet.

And we have just started Owens in kids, in all the head, to gathering our own norms. It would be very interesting to see the correlation with, of head heave with the OvMVP. It may be found normally because, you know, you, you might make a prejudgment. Be very careful. Don't get caught out, because if you have got a positive head, if it must match with the symptoms.

Now here, let me just briefly tell you, and this is something which is very much undercurrent and almost invariably ignored. Can I tell you today that autolith symptoms are different from semicircular canal symptoms? That is, autolith weakness symptoms are different from semicircular canal weakness symptoms. Semicircular canal weakness symptoms is classically vertigo or spinning. But it can be anything.

Of course, there is difficult ambulation in the dark, which means when you switch the lights off the child, we lose its balance because vision can't compensate. Whereas for autoliths, the classical complaint is what we call a non vertiginous dizziness. Remember this word? Non vertiginous dizziness. What are they rocking, swaying, tilting.

I look down and the ground is rushing towards me. The positional, you will see that. You will say that positional dizziness, for example, when I'm moving my head like that, when I'm doing that, this is BPPV. Now, BPPV is extremely rare in kids, but they still have this dizziness. So positional dizziness, which is not bpPv, is autolith.

Dysfunction. And nowadays there is a different entity called isolated autolytic dysfunction, which has been discovered by a good colleague from South Korea, Matthew Sukhan, by the great giant Tashirameshu from Japan. They have proposed this isolated autolytic dysfunction. Now, we can diagnose this with all these tests and of course the vamps. So you can imagine why I keep on saying that we are living in a golden era.

We can accurately pinpoint where in the vestibular system the problem is. And isn't that an absolutely wonderful thing? So head heave is the high frequency counterpart of v hit, assessing high frequency utricular function.

Now, zero degree is nystagmus in case of lateral canal for the utricle. It's a subjective visual vertical. So that's a completely 90 degree subjective visual vertical. If you see a tilt like that, you can measure this tilt. You can have very high tech stuff.

You can use your iPhone, you can use a bucket test. What I do is simple protractor borrowed from a geometry box. If it's five to ten degrees, then that's abnormal. It can come only from a few conditions. One is a spasmodic torticollis of your neck.

Neurological condition. One is a squint, because the retinal axis needs to be aligned. In squint, the head makes a compensatory head turn. But the commonest by far is a vestibular problem. Remember, and I have found a high correlation between a subjective visual tilt, vertical tilt, and motion sickness.

Motion sickness is now autolith central mismatch. It has been proved. So autolith weakness can generate motion sickness. You have, you might have been born with it in child, might have borne with it. And a very recent addition, which nowadays we can measure, but pretty previously I just used to record the eye movements in ocular counter role.

That's once again utrecht response. So what happens is you move the head all the way and ask the child to touch on the shoulder and you see the eyes are rolling. There are two types of role. One is a static role, which is displacement from point a to point b. How far is the eye going?

Is it going from the central position all the way to the periphery? And one is dynamic. It's actually rolling from point a to b. Static, remember, is utricular dynamic. Remember, is secular.

I'll show you. Look, just watch the eyes move beautifully.

So there we go. There we go. One side, other side. So it moves like that. Like that.

And nowadays you can measure it. This is how it looks like when you are physically measuring it. And you get numbers and quantify an ocular counter rule. I think some of the latest equipment have actually brought this into the market where you can measure

an ocular counter rule, a very useful test, but on its own indicates nothing. You'll have to match it with symptoms.

You'll have to match it with subjective, visual, vertical, the head heave, and all those tests. Skew deviation. Many equipments have got it, and we do it routinely in our kids. Remember, one third of skew deviation is because of an autolith problem. It can be central because it's a part of hints.

But what I have found in kids, that, and, of course, in adults, that it is important for to measure autolith function in one third of cases, one type of skewed deviation. Wemp. Not much to say. Once again, revolution. This is a beautiful wimp colic response.

Vestibular colic response. Now, when you are looking into wimp, always, always consider the rectified amplitude, because this amplitude, which you see here is sternocleidomastoid inherent activity, plus the vamp response. The vamp response is buried in here. So the machine, your computer, will actually, software will actually measure the rectified amplitude. And always consider this, and never consider absolute amplitudes.

Always, always, always do the calculation for asymmetry. That's the asymmetry which you do the calculation and do the asymmetric calculation from rectified amplitudes. Because this machine, at least this machine which I used, does not. It does not use rectified amplitudes to measure asymmetry. It use absolute amplitudes and the inferences.

As you know, increased amplitude is a classical feature of third windows. And decreased threshold is now considered to be more important than increased amplitude. So if you get a decreased threshold, now, therein lies a problem, because in kids, it's very difficult to do thresholds in many instances, because children had to put

in a lot of effort to do the CWM test, because what I do here, the technique is I put my hand on the cheek of a child and then ask the child to press against my hand to make my sternocleidomastoid. But this is a lot of muscle activity. And sometimes when you have to do thresholds, you'll have to do more than three, four, five runs.

It's very difficult for the child to sustain the maintenance. So not in all cases would you be able to do thresholds, but you should try, at least you should try.

Ocular is the inferior oblique response. And we have just started doing it in kids in our center. And hardly any tests, hardly any series are have been published regarding pediatric ovms. But we have started, we have done about 15 now, and we are eagerly awaiting the first 30, which we aim to publish once again. This measures, of course, utricular response, cwMP measures, secular response, but quite useful for third window conditions and for autolith weakness, quite a few vestibular spinal tests.

For example, the Romberg, the Sharp and Romberg unterberger always use a foam cushion. Now, that is something which you can do in your clinic. If you don't have a foam cushion, then obviously you can use a simple pillow or a cushion, because idea is, after you ask the child to close the eyes, you are eliminating vision and you are eliminating the proprioception as well, by removing the friction. It's some kind of a static posturegraphy. I do not do dynamic postureography in all my kids, but only selected who have got a significant gait problem.

So I would do dynamic posturegraphy to assess progression following treatment, not as a diagnostic test, because dynamic posturegraphy is extremely expensive kit. We have got it now, gate laboratory, but it's an expensive kit. And also, you know, those tests where you actually put the child in a harness in different situations, six different positions might be quite scary. So I would only do it in selected cases.

Now, Meniere's disease in kids is very rare. If it is there, then it is usually secondary, and in many cases, due to an autoimmune condition. Only the other day, I picked up a meniere's disease in a child. Meniere's syndrome in a child. Sorry, Meniere's disease is idiopathic.

By definition, Meniere's syndrome is the right term, what I would call hydrops. So only the other day, I picked up a hydroxy in a child with an elevated antiocardial antibody. So if you see, or if you assess a kid with and come up with a diagnosis of Meniere syndrome, always look for the immune profile and inflammatory markers, ESR, CRP, the different antibodies, immunoglobulin profile. You never know what you will unearth. And this is the absolutely latest modern criteria suggested for obtaining a biomarker, an objective biomarker for Meniere syndrome.

The calorics do not match with the v hit. The calorics might be abnormal, we hit normal. And the other way around, you might get an henna birth sign, because in the early stages, a meniere behaves like a third window. You might get a normal VOR gain, but with saccadedes. And the very latest one is a vamp low threshold and an increased frequency tuning ratio.

So different stimuli, different intensity vamp. And you measure the vMVP response, and that comes up with a tuning curve, which might be abnormal and tone burst. Ecogee is also showing promise, but it is an invasive procedure. So these are the interesting proposals for biomarker in my lab. If I.

If there's a menias, I would. I still don't do a caloric, but I'll definitely do a vhit. I'll do a vamp, I'll do a henna, but I'll do a vamp, and I don't do a tone vertigo. Do not forget a neurological examination. Absolutely crucial.

Do not forget a musculoskeletal examination. How many of you, in your routine ent clinic seeing a child or even an adult with a balanced disorder, do you actually measure the leg from the anterosuperior iliac spine to the lateral malleolus? Can you please tell me, do you do that? I do it on all my kids because I know that falls in a child. The commonest cause is lower limb biomechanical abnormalities.

Simple things, flat feet, genuvalgum, pace planus. That is a flat feet. Different types of coxa, leg length discrepancy, hyperelastic joints, not vestibular. You remember, are not there to pick up a vestibule or weakness and focus all your energy. You are there to pick up why this kid doesn't have good balance.

And balance is not necessarily an exclusively limited to the vestibular system. No. It can come from so many different. It can come from the heart, it can come from a simple anemia, it can come from fatigue. It can come from a liver disorder.

It can come from a rheumatological disorder. So that's why, once again, I keep on saying you need this knowledge and insight of other pediatric disciplines if you have to make a correct diagnosis, the right diagnosis, and the correct diagnosis. Because, remember, in vestibular medicine, diagnosis is king. Without diagnosis, you are nowhere. I mean, you can still do empirical symptomatic relief.

A kid is dizzy, give him some anti dizzy pills, but that's not good enough because you are not treating the root cause, and that is absolutely crucial. So diagnosis is so, so, so important. Of course, you should always do a cardiovascular examination. You know, only the other day, I had a child who was presented with dizziness. So that child felt very fuzzy headed.

No one could figure out neurological. They said, well, there's nothing neurological sent to me, and vestibular system was completely normal. You know what I did? I measured

the blood pressure and everything. All I did was listen to the heart and there was a murmur and murmur heard through the osteoscope, not through what you called the EcoG.

Not ecog, echocardiogram. So I sent this kid to my cardiology colleague, who asked me one question. I thought you were a doctor for the year. And finally it found out that there was an arrhythmia, which generated the mono diagnosed from an ontology clinic. Just because I kept an open mind, just because I've trained.

I've seen my pediatric cardiology colleagues work when I was a trainee. If I did not do that training, I wouldn't have even bothered. Why. Never forget to examine the eyes. If you have got an ophthalmoscope, use the ophthalmoscope.

It's not easy in a child. Use it. But definitely look for eye movements and definitely look for convergence. Because remember, convergence problems in kids. And a beautiful paper by Jakob Brodsky there convergence problems in kids.

They do mimic a vestibular phenotype. Also, Sylvette has been telling me this for a very long time. So always watch, always observe and always diagnose a convergence problem. And of course, look, one thing which I frequently get asked. You are behaving as if you are one for all, which means that you are a complete doctor.

Are you? I say, no, I'm not a complete doctor. No, I'm not an ophthalmologist, I'm not a rheumatologist, I'm not an endocrinologist, I'm not a neurologist. But what I am, I know that if problems occur in these systems, I can pick them up for further management. So, look, if I pick up a neurological problem, if I pick up a rheumatological problem, if I pick up an orthopedic problem, I'll pick it up.

Yes, but I do not know what to do next, so I'll involve my colleagues. That brings me to a crucial point. Treating balance disorder in kids is a multidisciplinary approach, not just me.