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A Recipe for Success in the Vestibular Clinic –
Clinical Decision Analysis for Vestibular Testing
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- It is my pleasure today to introduce our presenter for the course A Recipe for Success in the Vestibular Clinic, Clinical Decision Analysis for Vestibular Testing. We are so happy to welcome Dr. Julie Honaker to share her knowledge and expertise with us today. Dr. Honaker is the Section Head of Audiology, Head and Neck Institute and the Director of the Vestibular and Balance Disorders Program at the Cleveland Clinic. As a clinical researcher, she strives to advance the care of patients with balance disorders, but more importantly, she mentors students to become independent and critical thinkers and consumers and producers of research. Her significant contributions to the field are enhancing the clinical training and research preparedness of students in audiology. You can read more about Dr. Honaker on our website. Thank you all for joining us today. We really appreciate it. Without further ado, Julie, I'm gonna turn the mic over to you.

- Thank you so much and welcome everybody. It is great that you have joined me today to talk about a topic that's near and dear to my heart, which is kind of those decisions that have to go into vestibular testing. What tests, when, how do we make these decisions? And I'm gonna give you a little bit about my thought process behind this and, hopefully, answer any questions along the way. So feel free to put those in the Q and A. All right, just some disclosures just to go over. Again, I am an employee of the Cleveland Clinic and some of the basis behind this presentation has to do with the book that I published for Pleural Publishing on the "Diagnostic Vestibular Pocket Guide".

So we'll go over at that in more detail in just a moment. Okay, as we think about today's learning outcomes, I wanna go ahead and I wanna bring up the first polling question for all of you. And with this polling question I wanna better understand what is the length of time for your vestibular balance appointments? Is it one hour, two hours, three hours or four hours? So I'll give you all an opportunity just to answer that. Okay, so the results are in and it looks like about 45% of you indicated two hours for your

appointment lengths. Some, 27% only have one hour. About 23% have three hours and a very few of you, only one of you, indicated four hours.

And I would say I'm right there with the majority. So I have two hours that I am able to evaluate my patients when they come to the clinic. That's not a lot of time, even though in the realm of audiology testing, it's a huge chunk of time. So we have to be very strategic in what we're doing with our patients. So we have to have a plan before they even walk in the door of what we're doing so that we can make our appointments as efficient as possible for our sake in trying to determine what the cause is for a patient's symptoms and also for the patient's sake, just to maximize their time considering that they had to travel to our clinic, considering that they had to take time off of work, perhaps, or bring family members in.

We just have to be very strategic in our thinking and that's really what we have to do in this mind frame of vestibular testing. We have to really think about what are those clinical decisions that we're making that's gonna help us make that determination of a cause of the disorder or potential management options for our patients. So hopefully, at the end of this talk you'll have a better appreciation for all of that. Okay well, I don't know if you're anything like me, but I feel like sometimes dizziness, balance problems, vertigo is the abyss. There are so many different causes that a patient can have that they may present with very similar symptoms. And as a vestibular audiologist, we have to sift through all of the patient's symptoms, all of their past medical records and try to make this determination and kind of categorize what could be the problem for our patients.

Just looking at kind of just a snapshot of some common reasons for patients to present with some symptoms of dizziness, vertigo, imbalance, it could be something neurologic. So it could be something that's related to, you know probably one of the top reasons I see patients in my clinic is due to migraines. Is it something related to

that that's causing their dizziness or vertigo? Maybe they've had a recent TIA and that's why they're experiencing dizziness or lightheadedness. You know there could be, aside from maybe central abnormalities, there could be sensory abnormalities that could be causing this, such as visual deficits. Potentially they have inner ear disorders, which is the focus of today's talk. Maybe it's something just related to their medication; the type of medication, a recent change in their dosage, side effects from their medication.

There's a plethora of reasons with that. Even thinking about cardiovascular causes; high blood pressure, heart disease, heart failure could be a source for patients to have imbalance concerns. The list goes on and on with all different disorders that can lead to patients presenting symptoms that, perhaps, they went to their primary care physician or, perhaps, they made their way into our clinics as the first step that we have to really sift through to try to make a determination of why are they presenting with these symptoms and what can we do, ultimately, to help our patients manage their symptoms. So that presents us with a clinical dilemma. So we have, again, a plethora of causes for patients to have symptoms of dizziness, vertigo, imbalance and there's multiple paths that these patients can go, often without a clear clinical practice guideline for us.

So we're kind of left at the demise of what are the patients presenting with and then what should we do to try to get to the root cause, the culprit for their symptoms? In the realm of vestibular and balance disorders, we do have some guidelines and we do have even criteria as far as diagnoses that we can go to refer to. Probably, the one guideline that's the most specific that was just recently updated in 2017 is really the "Clinical Practice Guideline for Benign Paroxysmal Positional Vertigo". This is a great resource. I highly recommend if you have not looked at it, certainly, to do so. It's lengthy, but it's pretty much putting together the minds of physical therapists, physicians, audiologists and really coming up with clear cut guidelines for patients who

present with symptoms that are suggested of BPPV and what we should be doing as clinicians to help these patients for best practice approach to identifying and then managing their symptoms.

So certainly, please look at that. Within this guideline, it basically states that if a patient is presenting with symptoms that align with BPPV, if our testing is positive suggesting that the individual has the characteristic nystagmus findings that align with BPPV, then really no further vestibular testing is needed and this patient would be a fast pass for treatment. If in the case that the patients are not recovering from their treatment, potentially they have really protracted recovery or really recurrent BPPV, this is where we might come into play with actual vestibular testing. So within this guideline itself, it's an important guideline based on a very common, probably the most common reason we may see patients coming to our clinic, source for their vertigo or dizziness complaints.

But we don't really get into the realm of testing these individuals until their BPPV has not resolved or they still have symptoms that we need to further address or it's intractable BPPV. So when does testing come into play? Our objective measures, if we think about this, they're commonly performed to evaluate dizziness and imbalance concerns, but there's quite a bit of disparity and who may be performing them, how often they're doing it, where they have testing available. This is really varied by geographic regions. Specialties who may refer for it or who have this at the tip of their disposal to be able to perform objective testing. So it really is varied across sites and across geography. And because of this, our testing can be either over-utilized in some populations or in some sites and regions or underutilized where we just don't have it at our disposal and we're not able to utilize this.

So for this, patients could be over-referred or under-referred to have this objective measures. There was a really good study by Erin Piker and Associates that came out in

2016 and it looked at data across 12 different sites that was primarily academic universities, hospital settings, ENT practices. And what they did was they pooled all of the data from these patients from these 12 sites and these were individuals who were diagnosed with some sort of dizziness or vestibular disorder. Of those individuals, close to 2,500 had at least one vestibular test. And of those particular vestibular tests that were performed, the most common was caloric testing. If we think about the bread and butter for vestibular testing, it probably is our electronystagmography or videonystagmography and part of that particular test protocol is caloric irrigations.

So it stands to reason, that's probably the most common test that was performed. Within this study 31 sites or individual, excuse me, 31% had rotational chair testing. And a fewer proportion, only 13%, had functional measures, such as dynamic computerized posturography. This particular study was interesting because they really found that, again, this kind of highlighted that objective vestibular measures they varied by site. Academic institutions were more likely to perform these measures than what is more common in community-based practices. So when we get into the idea of vestibular testing and you know who might be qualified for this, thinking about that kind of what was highlighted from that last slide of being overly referring versus underly testing for our patients, it's kind of a fine balance.

And I always like to preface for my students, and even for myself when I'm in the clinic, that every decision I make as far as the protocol I put together or the objective measures that I'm performing, I have to be sure that I'm justifying why I'm doing this for the patient. And I have to ensure that performing this measure in some way is of medical necessity or, at least in our case, to help us identify what could be the cause for their symptoms of dizziness, vertigo, imbalance and then to help us with that management planning for our patient. So I always have to keep this at the forefront and really justify what I'm doing. If we break that down a little bit more into this justification for medical necessity, I just wanna draw attention to this quote from the Centers for

Medicare and Medicaid Services, which states that "Services which are not reasonable and necessary for the diagnosis or treatment of an illness or injury or to improve the functioning of a malformed body member are not covered."

So I think that's a really a key point. You know if we have vestibular testing at our disposal and we are blessed enough to have a fully functional vestibular clinic with all these objective measures, we still have to be very strategic in what we're performing for our patients and to ensure that the testing that we're doing is really necessary, it's reasonable to help us identify what could be the cause, why the patient is having functional decline or dysfunction in general and maybe to help us identify what the culprit is for their symptoms. So when we think about vestibular testing and how to add this into the mix, our diagnoses should be guided by what our patients are presenting with, potentially, office examination or bedside testing.

And objective testing then should be performed if it's clinically indicated to help us kind of crosscheck or better identify what could be going on with our patients. So we kind of have to have a good ballpark of what's happening in the beginning based on the patient's symptoms and perhaps office testing, like bedside testing, to then make some real determinations of what we should be doing for our objective testing. And our objective testing has to have some plan in place for us to know how we're gonna answer those particular questions. So with this in mind and with it in mind of thinking about when should we be including vestibular testing and what testing we're gonna include, it is a fine balance.

We have to think about the monetary costs that are involved with vestibular tests. I mean they are quite costly. The equipment alone can be costly. Sometimes our testing doesn't have the best outcome for our patients as far as them, perhaps, feeling nausea or even feeling some of their symptoms of vertigo with some of our testing, such as rotational chair or calorics. It can even have an impact on the family. You know I have

for my notes, my instructions for patients, that they should have a loved one come with them to the appointment. So that means that their family member or significant other or friend would have to take off work and have to make arrangements to come with them to the appointment if they're able.

And we have to balance all of that, the monetary costs, the patient experience and even the impact on the patient and the family, with how these tests are gonna help us refine our diagnosis, improve the patient management outcomes by, hopefully, helping to identify maybe a source for their symptoms and where they are functioning right now. So we really have to balance all of this when we think about what we're doing and how we're adding these tests into the mix. And that really comes down to this idea of this kind of vestibular testing decision making. Kind of the critical thinking that has to go into our planning for when we see our patients in the clinic. We have to determine what testing to perform and to do that we really have to think about the following.

And that's kind of this three-part prong where we have to be very mindful in our pre-planning for our patients and we have to start developing clinical questions every time we are at kind of patient-facing or we're getting ready to see our patients. We have to very much think about what is the clinical hypothesis I need to answer for this particular patient and then what tests or what would I need to do at the time of the appointment to help me answer that? So it's very much this planning part. We have to then determine if we have this kind of clinical question in mind for our patient, we have to determine if we need to answer the question with testing.

Is this something that makes sense? Would it be worth their time to come in for an evaluation? And if yes, then we need to really start thinking about, okay, what are those tests that we need to perform, that's kind of that medical necessity again, that's gonna help answer those particular questions. So this idea of vestibular testing and clinical decision making it's something that I do with all of the students I work with. And at the

Cleveland Clinic, it's actually part of our report. We actually develop a clinical question and then we kind of think about based on that clinical question, what tests we would want to perform to help us answer that. Knowing that anytime you're with a patient, those clinical hypotheses can change based on gathering more information.

But at least it's a starting point for us to really begin that planning process so that we go in with a game plan. Because, again, I only have two hours that I can spend with my patients and the majority of you do as well. So we have to use every bit of time we have as strategically as we can for our sake and, more importantly, for our patient's sake. Okay, so how can we do this? And let's break this down a little bit. So the first thing we need to do is we have to formulate our clinical questions. And this formulation process, it really has to be specific to help us gear our evaluation toward possible answers.

And it has to be answers that's within our domain and within our scope, as well. So we're trying to identify most often if the patients have some sort of vestibular disorder and how that disorder is impacting their system physiologically and functionally. So most of our questions that we will present with for our patients are really developed during our case history portion. Often the pre-planning portion when we do our chart review that really helps to simplify the process when we're patient-facing. And many clinics send out questionnaires. We do as well. We use our electronic, kind of our MyChart system, where patients get a questionnaire ahead of time. We use that information, in addition to medical record review, to help us start to develop those clinical hypotheses and questions that we need to answer during the appointment.

So let's break this down a little bit of an example of how we can formulate a clinical question. So in this example, we have a patient who presents with movement provoked symptoms of dizziness and unsteadiness for one month prior to evaluation. We noticed on the medical record review that the patient has negative associated symptoms. So

no auditory symptoms, visual symptoms or no neurological complaints. Based on this and the fact that the patient just has kind of these movement provoked symptoms, I might start to wonder does the patient in some way have benign paroxysmal positional vertigo? Is that suspected? Another question that I might come up with based on this symptom presentation is there any evidence of uncompensated vestibular system hypo or hyperfunction?

So you can kind of see how these questions could then help guide the type of evaluation that I'd wanna perform or, at least, a starting point for my evaluation so that I can try to determine what could be the cause, in addition to asking the patient more questions. So key things that I like to review as part of kind of the medical chart review or to really hone in on in the case history that helps me in developing all these questions, I wanna understand from the patient in their own words a description of their symptoms. What are they describing? And then when they get to that kind of root description of either dizziness, postural instability, vertigo, lightheadedness, I wanna understand really, truly the duration and the frequency of these symptoms 'cause that already starts to categorize to me different types of disorders that the patient could present with.

I always wanna understand the initial onset of symptoms because by the time the patients land in my clinic, it might be months to years after they had their initial onset. But that important information is critical for me to understand what could be the initial cause and now the patient's left with these secondary symptoms or tertiary symptoms, what have you. I always wanna try to, if I'm able to, look and think about clinical correlation. So is there anything like any imaging results that would help me kind of guide the direction I wanna do with my evaluation or the direction I wanna go? I always wanna understand any associated symptoms, any auditory complaints, neurological complaints, 'cause that can start to help me categorize more peripheral versus central issues in nature and the direction I might wanna take for my testing.

Other visual concerns. Any history of falls for our patients. Any type of comorbidity that could be the culprit for their symptoms of dizziness or imbalance. And we went through quite a few of those at the beginning of this presentation that I have to be mindful of that could be kind of exasperating a person's symptoms or could be the underlying cause for their symptoms. I always wanna understand any family relation to their symptoms. Anyone else in the family and then their social history. How is this impacting the patient's everyday activities? How is it impacting their ability to, are they restricting any activities because of this? If they have passed vestibular assessment, I wanna know the results. 'Cause we're always looking at our patients at one point of time, so I wanna understand how they were then to what I need to be looking at now.

Understand any past treatment such as physical therapy, medications and did it work? What was the outcome for this? And then anything else that I think would be pertinent to help me formulate that particular clinical question, I wanna keep that in mind. Once I have all of this information, this is kind of just the pre-planning part, and it doesn't mean I'm spending weeks on end like a book report, putting this all together. It's just something that I'm sifting through as I'm going through the medical record before I see my patient or as I'm looking over the patient questionnaire if they're given that ahead of time. But once I get all this information, I then can start kind of the initial point of trying to develop those key questions that I wanna focus in on when the patient comes in the clinic.

Or perhaps I'm gathering this information while the patient is in front of me, I then wanna take a moment just to kind of synthesize all this information and then really hone in on what am I trying to address and how are we gonna get to the most efficient route to answer what could be the cause for the patient. So let's go through a few of these. So we already kinda talked about BPPV. If a patient is presenting with symptom that's kinda described as this vertigo that's triggered with position changes only lasting

seconds to minutes, I then am gonna have questions in mind of is there anything on my testing or my evaluation that would be an objective sign that would kind of crosscheck to say, yes indeed, this person has BPPV.

And then if they have BPPV, I would then wanna think about what is the most appropriate treatment approach for this particular patient based on what I've identified. And I would likely start the appointment just with that. And that's what the clinical practice guideline outlines, if the patient has symptoms that are suggestive of this, this is my starting point that I need to try to determine if it is indeed BPPV. If somebody's presenting with more symptoms of unsteadiness when walking or standing. Maybe increased symptoms in the darkness. Maybe when we have them on a surface that's uneven or compliant, if they start to notice that they have real problems with visual stability when their head's in motion but they feel really well when they don't move their head or body, I might start to wonder, okay, maybe this person has a vestibular impairment.

Maybe they have VOR dysfunction. Maybe that's why they're having problems when we remove certain sensory systems that are taking over to help with their balance. I might start to formulate questions of is there maybe bilaterally impaired VOR? And that might be the starting point for my evaluation. An other question I could try to think about or maybe I would need more information from the patient is are there any central signs to account for these symptoms? That could also be very similar, especially, if they're having symptoms of oscillopsia. So you can kind of see how you can walk through this game of having this initial information and then developing those questions that we have to answer as far as the appointment.

All right, a patient presents with spontaneous episodes of vertigo or imbalance maybe lasting hours to days and maybe, now by the time they make it in the clinic, they just have some residual kind of head or body triggered symptoms. Based on that symptom,

kind of characteristics alone, I might start to wonder 'cause there's symptoms of vertigo, maybe there's a vestibular asymmetry and I might try to sift out from the patient which side is involved. So my questions might be really pertinent to are there any signs of unilateral peripheral system involvement? If yes, to what extent? What particular organs might be involved or particular divisions of the nerves? And then what is the status of compensation for this patient?

And then finally, if patients are maybe presenting with slow onset of imbalance, maybe even sudden onset of symptoms but they have a lot of neurologic symptoms that are associated with that, maybe they do have oscillopsia and maybe they're even endorsing some head or body provoked symptoms but they also have neurologic complaints. I might start to really wonder are there any abnormal oculomotor system signs or dysfunction? Is there anything that would tell me that there is a central vestibular impairment? Is there anything that's impaired vestibular function that could account for these symptoms that might be in addition to something central going on? So just these questions alone would kind of lead us down a path of needing more information.

And by needing more information, we can then take patient symptoms and we can start thinking about what we might wanna do as far as our maybe direct office exam or bedside exam to gather a little bit more and really to refine if we need to start doing objective testing to help us answer more questions. So we'll break this down even further. All right so for direct kind of office examination, some things to keep in mind as far as signs that would kind of align with the symptoms patients would present with based on some of those categories. For unilateral peripheral vestibular dysfunction, I might expect to see or think about in my mind that I would expect to see with testing direction-fixed nystagmus.

So maybe it's gonna have a horizontal and a bit of a torsional component to it throughout testing. Nystagmus is always gonna beat to the more active neural side, so that might start to tell me which side could be involved based on the pattern of the nystagmus. I would expect if it's something peripheral that is going to be enhanced when we remove visual fixation and then it's gonna follow Alexander's law. So the briskness of the nystagmus is gonna increase when the patient gazes in the direction of the fast-phase. I might, if I see the patient in the acute-phase, I might expect to see other clinical signs, such as more otolith dysfunction where they have a bit of a head tilt or a skewed deviation with their eyes and we can even see signs of ocular counterrolling toward that ear involved.

I might expect to see not only some things with them moving their eyes in different directions, but if we actually move the patient's head and there's an asymmetry, we might expect to see some nystagmus that is provoked after those head movements. So we might see post-headshake nystagmus that's direction fixed or even nystagmus that's brought on when we use a little vibration behind the ear. So all these things are kind of signs that I would expect to see or that I would think about what testing would I need to help me kind of see these particular patterns if that's my particular clinical question that I'm concerned about. I might expect also impaired postural control when the person's really relying on the vestibular system and even abnormal gait when they have to really provoke the vestibular system such as with head movements.

And in this case if it's truly just a peripheral vestibular dysfunction, I would expect to see normal oculomotor performance. For bilateral vestibular impairment, if that was my clinical question, I'm gonna already think about what I would expect to see on testing and this is I wouldn't expect, if it's truly bilateral, any nystagmus. I might start to see some functional decline for our patients such as abnormal performance on testing such as dynamic visual acuity when they have to rely on kind of visual acuity input to be able to see things clearly when their head's in motion. I wouldn't really expect any

nystagmus post-headshake or even mastoid vibration, so that might not be something I'd wanna include as far as my clinical exam.

But I would see, or expect to see, if it truly was bilateral reduced vestibular responses. So I'd wanna do some testing that would help me confirm that and maybe help correlate why the patient is experiencing symptoms of oscillopsia. I might, again, see more functional decline when they're really having to rely on those vestibular inputs to help them with their balance. And certainly, abnormal gait performance with head movements to both sides would be something that I'd be looking for. But I wouldn't expect, hopefully, if it was truly a peripheral cause, them to have any neurologic signs, any a oculomotor dysfunction. And then finally, if I had a strong suspicion of central disorders as part of my clinical hypothesis, I might be looking for more signs during my testing such as direction changing nystagmus, kind of pure vertical nystagmus or torsional nystagmus.

Might start to see or think about other oculomotor deficits such as saccadic intrusions. Kind of weird movements of the eyes when we're asking a person just to look straight ahead. I might see even pure vertical nystagmus that would be induced with just natural horizontal head movements, which wouldn't really be true to a peripheral cause. I might see perfectly normal peripheral vestibular responses. But the patient may have acute dysfunction on other parts of the testing, such as oculomotor testing or even their gait and postural control performance. So kinda based on this, so we've categorized some questions that would help us kind of delineate what could be going on with the patient. We then can start thinking about what testing would we expect if the patient is fitting that particular hypothesis.

And that can really help us hone in on what particular test we'd want to perform to help us really, truly correlate and identify if that is, indeed, the cause for the patient. So that kind of takes us to the next part is we need to determine if we need to answer the

question with testing? So if we don't know the particular disorder, we don't have a clear cut understanding of the management pathway for our patient, we then have to determine if testing is really gonna help us answer and what answers can we obtain with our particular vestibular testing? Our vestibular testing I think is great, in the sense that it can aid us in determining the physiology response.

It can let us know how the right ear vestibular organs are responding compared to the left ear. And based on that we can start to identify side of lesion and maybe even side of lesion with respect to the peripheral vestibular system. We can get a good idea of how a patient is able to utilize vestibular cues to help them with their posture, help them see clearly when their head's in motion. So it can sometimes let us know a little bit about the status of functional ability to use the system. And we can get a good impression of status of compensation. So if somebody has a vestibular pathology, how is that person progressing through the compensation process?

And even our testing if we have somebody, let's say, with a bilateral vestibular loss, if we add a number of tests into our test battery we can get an appreciation for the extent of the lesion and even residual function for our patients. Our vestibular testing can also help us just confirm that, that we suspect with our history if we need that confirmation. If we are just kind of on the cusp of I'm thinking there's something going on, on the right, I need to confirm that there's an asymmetry, this is where testing can come in. And based on this, it then can help us drive the appropriate care path for our patients for their management. Whether that is medical management or therapeutic management, having this information can help us make that next step determination of what would be best, most appropriate, for our patient and that really aids with our decision process during the treatment.

So once we get into the idea of, okay, maybe we need testing to help us answer particular clinical questions, we have to be very strategic, again, in what tests we're

gonna add in. And for a decision for best practice, what tests when? Sometimes a single test is appropriate. Sometimes that is enough. It might have a very high yield for sensitivity or specificity that's gonna help us identify that a person has a particular disorder or they have impairment of one part of their system. But oftentimes, with our testing we have to think about things in a protocol standpoint. And where we have multiple tests to help us identify what impairments, what part of the system is involved and to what extent is it involved.

And that's where we have two tests that can help us, if we're strategic, improve diagnostic accuracy. But we have to be mindful of the tests that we're adding into this. We want tests that are gonna help us with our overall hit rate, helping us with improved sensitivity to identify those with the particular kind of dysfunction that we're thinking about with our clinical hypothesis or to help us really rule out that it's not this particular issue. So we want it to have also high specificity in those cases and that gets us into this concept of clinical decision analysis where we add tests in a particular protocol to help us do just that, to come and render a decision point for treatment or for identification of a particular disorder.

And there's a couple ways that we can go about this. The first is that we can do something known as a parallel protocol. In this case, we might have a particular test that has multiple subtests within it. So let's look at the example of vHIT. With video head impulse testing. If you're familiar with that and I'll talk about it in a little bit more detail in a moment, that particular test looks at all six semicircular canal function. We can tease out all six semicircular canals and all of those tests looking at horizontal canal function and vertical canal function can be kind of our two tests within one protocol. If any one of those particular kind of subtests in that protocol are positive, that might tell us that the patient has vestibular dysfunction and we need to go on for treatment or maybe that helps us with our determination of the real cause for their symptoms.

Another way we can do this is maybe by adding tests in what's called a series. And there's two different ways that we can look at this with series protocols. So we can have series negative protocols or series positive protocols. And the idea is that we're using a starting test and then based on the results of that starting test, we add another test into the protocol. And sometimes we do that other test in the protocol as confirmation or sometimes we need it to make a real determination whether or not treatment is necessary or not. So to kind of break down series protocols into the two ways, we have a series negative protocol. This series negative protocol basically states that based on the results of the first test, so let's say here let me get, if my little pointer will work.

Okay, so based on the the results of the first test, if this first test is positive in a series negative protocol, we don't have to do any further testing. We can go on. We've identified what's going on with the patient. We can go on for treatment. But if the first test is negative based on a series negative protocol, we need to add in another test that also has to be negative in order for us to say the patient does not have that particular condition. So we'd need to add another test. If it's negative, then we can say for sure they don't have it. The other way to look at this is called a series positive protocol.

This states if our first test in the series is negative, we don't have to do any further testing. But if the first test is positive, we need another test to confirm what could be happening with the patient. And then if that test is positive, we can go on to treatment. So if you think about things in vestibular world, we kind of, sometimes we might add another test into our particular protocol in hopes of maybe we can better identify what's going on. So if our first test is negative but they have symptoms that's suggestive of semicircular canal dysfunction, we might add in another test to

semicircular canal dysfunction in the series. And if that test is positive, we then would go on and treat.

So there's ways that we can look at this in the vestibular world as far as this clinical decision analysis thought process. And that really brings us to, if we're gonna identify what test to perform, we have to think about all that could be at our disposal. So I'm just gonna focus in on kind of the cream-of-the-crop for testing. There are subtests here that we won't have time to dive into, but I'll just kind of hit the high points for these particular tests and ways that you can incorporate them into these kind of protocol decision points. So the top here, we can see we have vestibulo-ocular reflex or semicircular canal function tests where you can do caloric irrigations, rotational chair testing and even video head impulse testing to get a good snapshot of how the semicircular canals are working.

We also have otolith tests such as our vestibular-evoked myogenic potentials. There's even now ocular counter roll testing that you can do that can look at otolith responses. And then finally, we have functional tests. I've mentioned to some extent dynamic visual acuity and then you can do functional testing, such as posturography. I actually don't have posturography at the Cleveland Clinic but we do bedside modified clinical tests the sensory integration on balance or just kind of bedside testing to get a good idea of a person's functional ability to be able to stand upright quietly or even we'll do some gait testing. So lots of tests that we have at our disposal and we have to be strategic in which ones we might wanna include.

So if we're trying to think about to identify the tests needed to answer questions, I think we have to dive in just very briefly about anatomy and physiology. And for this for our semicircular canals, we really wanna focus in on thinking about their primary purpose which is to convert kind of angular movements of our head into an electrical code. Our otolith organs really are designed to convert linear information into an electrical code

and for this patients might present with different symptoms. Perhaps more spinning vertigo symptoms, if it's a semicircular canal dysfunction. Maybe a little more imbalance or rocking or tilting sensation if it's an otolith dysfunction. For division of labor for just thinking about the vestibular nerve itself, the vestibular nerve is broken down into, it innervates the horizontal canal, anterior canal and part of the utricle, a large part of the utricle.

So for that we can start putting our tests into kind of this category of what tests would help us to identify a superior nerve dysfunction. And for that we can hone in on tests looking at the horizontal canal, such as calorics; anterior canal, such as vHIT testing and even VEMP testing looking at the utricle. And the same can be true for the inferior nerve where we have testing that can look at posterior canal function and saccular function, whether it's vHIT or VEMPs. So a primary thing that we do with our testing is really looking at vestibulo-ocular reflex where we're trying to in some way activate the VOR response which is from end organ to effects our muscles of the eyes.

And we're looking to ensure that a patient is able to maintain stable gaze on a particular target of interest. So a lot of our testing we're able to tap into this and, probably, the cleanest way that we're able to do this is with looking at the medial or looking at the horizontal canal VOR response. For testing kind of across the frequency range, we have a gain of a response and then we have frequencies that we can test for our semicircular canal function. The vestibular system is really good for semicircular canals at testing in about two to five hertz. But testing that we have whether it's calorics, rotational chair or even video head impulse testing, it's kind of snippets across the frequency range where calorics are very low frequency.

vHIT is more mid-frequency, more accustomed to where we perform natural head movements. For kind of diving into particular tests such as, probably, the bread and butter tests that we have for vestibular testing, which is our videonystagmography or

electronystagmography. This is kind of a parallel protocol where we have many different tests within one major test battery that we perform. And if any of these tests are positive, that would mean the person would need to go on for some sort of management in some way or we've identified potentially a problem. With all these tests we can do in any particular order including even starting with our positional testing, if necessary. For our VNG or ENG testing, probably the most important kind of component to this is caloric irrigations which lets us know a little bit about side of lesion for dysfunction.

It lets us know a little bit about whether or not a person has unilateral impairment versus potentially bilateral impairment. But this is really isolated just to very low frequency response. We can branch it out a little bit further into rotational chair testing which looks at mid-frequency range. It's really limited just to horizontal canal function, again, in the superior nerve. But it does help us kind of extend our abilities to look at function and status of the system. There's kind of two primary ways that we can look at rotational chair. There's a test known as step velocity which really examines system time constant. So we're kind of having the person go from nothing to a constant rotation and then we're looking at the time it takes for nystagmus that we've elicited by exciting a vestibular system to decline over time.

And there's particular patterns of performance where we'd expect to see for a peripheral dysfunction, a shortened time constant and then for more central problems we might see more of a prolonged time constant. Probably the most common rotational chair protocol that you would see in practice would be more Sinusoidal Harmonic Accelerations. And this is really looking at kind of almost like an audiogram for your vestibular system. It's looking at the system response across different frequency range. We can look at the gain of the VOR. So how strong that response is. Timing of the eye movements to chair movements, which is called phase and even

symmetry of the response where we can get a good appreciation for whether or not the system is compensated.

So some ways that we can look at this in a protocol. Let's say, a person on rotational chair testing has very low gain responses across this entire frequency range during SHA testing. So they have low gain, what's represented right here, across all the frequencies. We're not even able to measure symmetry or phase because there's no real nystagmus that we're provoking during our testing. We can then crosscheck with our calorics and this can tell us that we, indeed, have bilateral dysfunction. There's some instances where we can do caloric testing and, perhaps, that was our first test that we performed and we see that we have a right ear asymmetry. So we have very low response for the right ear.

We can then add in rotational chair testing to get an overall kind of composition of the system. And in this case, this particular patient has an uncompensated right hypofunction based on their symmetry scores. Kind of the same type of example, if we did our VNG testing as a first pass and we see that the person has a right weakness here based on calorics or excuse me, a left weakness based on calorics, we can then add in rotational chair to get an idea of the status of compensation. And in this case, symmetry is perfectly normal. We have gain within the normal values for VOR and phase is normal, too. So adding these two tests together in a protocol can help us get an appreciation for side of lesion, as well as, status of compensation.

Moving on, just a couple other tests and then we're gonna get into some cases. So this one here, our video head impulse I've talked about a little bit already. It does look at the higher frequency range, which is the more natural range for head movements. We have a little camera and some goggles that we use to test our patients and this is more of a high frequency response of all six semicircular canals. So we're looking at both inferior and superior divisions of the nerve. With this we can look and expect patterns of

performance where we have a normal VOR response which is an equal and opposite eye movement to head movements. When there's VOR dysfunction, though, we can start to see some abnormal patterns where the VOR response it's not able to keep the eye steady and patients have to make a bit of a corrective eye movement called a corrective saccade.

It can be after head movements or even during head movements called covert saccades and this really starts to show a decline in the gain of the VOR and that can show us an abnormality of one or all six of the canals that we're testing. And finally, we have tests that we can include that can look at the other part of this system which is otolith function. And for this, we can do testing such as vestibular evoked myogenic potentials and this is a myogenic response that's picked up through muscles from the neck sternocleidomastoid or the inferior oblique muscles. And based on this we can look at saccular function or inferior nerve and even utricular function. This particular test we're able to kind of tap into otolith function based on using a loud stimulus or even a vibratory response to activate these organs.

And with this test it's important we have an evoked potential response that we expect to pick up for these patients. And in some cases, such as those who may have a third window effect such as superior semicircular canal dysfunction or dehiscence, excuse me, we might see an elevated or an increased response because we have another source for sound to stimulate the otolith organs. So we see this really large response. So with this, we have all these tests at our disposal. We can start to add in our, kind of based on our symptoms that a patient may be presenting with, what type of testing we may want to start to include. So these are just some examples here.

Maybe unsteadiness when walking or standing, increased symptoms in the dark, symptoms of oscillopsia, I might be more inclined to check for bilateral vestibular dysfunction and we'll break this down in just a moment a little more. If they have more

spontaneous episodes of vertigo lasting hours then getting into that resolved head-body provoked symptoms, I might be suspecting something unilateral and I'm gonna wanna know which side is involved. So I might add some of these tests into my test battery. If they have more of this kind of false sensation of motion, rocking or tilting sensation or just imbalance, I might be inclined to think that there's an otolith dysfunction. Or maybe even if they have brief symptoms of dizziness that is kind of brought on with loud sounds or pressure, I might think there's a third window effect and so on.

We can even do testing to check for status of Meniere's and even some testing that we can look at for central dysfunction. So lots of things that we have at our disposal that's really specific to the questions that we need to answer. So let's get into this and I think just based on time, we might just do maybe one or two polling questions. So perhaps, not for this first one. For this particular case we have a patient who has disequilibrium and unsteadiness, maybe some brief spins when they're laying down, getting out of bed. A previous history of BPPV. Nothing else going on, but they're kind of presenting with the same presentation pattern. Based on this, I might start to wonder for my clinical question, does the patient have BPPV?

And if we're gonna formulate our clinical question here, we might wanna know are there any objective evidence of BPPV? If not, is there anything else peripheral that could be the source for this? So based on the patient's symptoms alone we need to determine if we need to answer these questions with testing. And I would say, yes, in some way we need to evaluate the patient, determine what could be the cause. Based on that, we might wanna start with BPPV screening because that's our best practice to go onto that first. And that would be more Dix-Hallpike positional tests that would really align with trying to get to the root cause, which could be BPPV. If we think it's BPPV, we should really be looking for are there signs a brief nystagmus that's characteristic of

these particular eye movements that would tell us which canal would be involved for our patient.

So we're really gonna be looking for those signs to help us kind of cross-check what could be going on. For Case Two, if we have somebody who has spontaneous onset of severe vertigo with nausea and vomiting lasting just for days, but now things start to improve with time and they're no longer experiencing symptoms when their head's perfectly still, the only time they feel symptoms is when they start to move their body. Everything else is completely unremarkable. No neurologic or auditory symptoms. MRI was normal. I might start to wonder at this time for my clinical hypothesis am I dealing with something that's a unilateral vestibular dysfunction? Something such as they had vestibular neuritis in the beginning, but now we're left with something else that could be going on.

And in this case I might be curious, if it is unilateral, to what extent, which side's involved and what extent and what's the status of compensation for the patient? Testing would be necessary to help us answer those particular questions. And for this, we would really wanna hone in on tests that would look at side of lesion or the status of vestibular loss and even status of compensation. So a way that we might be able to do that and really help us define if somebody has unilateral hypofunction, and this is just kind of reiterating some of those signs we talked about before, we might wanna think about testing that's really gonna start to think about, okay, if we have involvement of the system, which side?

So maybe I would start with vHIT to help me identify is it semicircular canals that are involved? Which ones? On which side? If I'm not able to answer it directly with vHIT, I might add in calorics 'cause that's a lower frequency response to help me identify which side's involved. If I really wanna know about global loss, perhaps I would add in VEMPs that would help me identify if otoliths are involved, in addition to semicircular

canals. And we can even look at status of compensation by looking at functional measures and thinking about direction of any nystagmus that we're perceiving. So maybe I'd wanna add in rotational chair to answer that particular question. If we go into this other case of maybe somebody who presents with more unstable vision.

Oscillopsia they're reporting. They don't have any auditory complaints, neurologic complaints, but they're really struggling with imbalance, particularly, when in a darkened environment. I might start to think, okay, maybe this person has bilateral vestibular loss. And based on this, I would really wanna know if there is bilateral vestibular dysfunction to help account for those symptoms the patient is having, I would need some sort of evaluation to do that, to answer that question fully. And for this I might wanna think about testing that's gonna really help me identify bilateral hypofunction; so rotational chair, calorics, vHIT. If I wanna think about what signs I need to be looking for, for bilateral hypofunction, I might expect to see reduced caloric irrigation.

So if you have only that test, that would be your point where we wanna evaluate for that. Rotational chair gain that would be dysfunction or even corrective saccades on vHIT. If we think about a protocol, I might wanna know if it's bilateral loss, what part of the system is involved? And if I'm able to answer there's bilateral loss with just vHIT alone, that might be all I need to answer that particular question. Unless I really need to know if it's an isolated or global loss, then I may need to add some of these other tests into the protocol, including the status of compensation. If I really need to know how the patient is performing, I might need more functional measures or even visual acuity testing to let me know if they progress through compensation.

And then finally, if a patient presents with more brief symptoms, seconds to minutes of dizziness, maybe they have sensitivity to sound, some disequilibrium associated with loud sounds or pressure changes, I might start to wonder if the patient's presenting

with third window effect or lesion. And for this, I might wanna know if there's any signs of SSCD. And for testing, I probably would need some sort of testing to identify if the person has SSCD and I might wanna think about those tests that would really hone in on helping me to clinically correlate that. So a protocol might think about identifying if the patient has truly signs that align with their symptoms. So any nystagmus that would be characteristic of the superior canal involved, any enhanced VEMP responses or abnormal audiometric testing.

And a protocol I might wanna think about, kind of a series protocol, would be is there any sign of conductive hearing loss, not of middle air origin. If I have that identified, maybe then I'd wanna include just VEMP testing to help me kind of cross-check and then the patient would go on for medical management of that. So kind of in thinking about things in this series approach, there are many causes for dizziness and balance or vertigo. And often, our case history or even our direct physical examination are helpful tools in narrowing down what could be the diagnosis and what management we may need. Vestibular testing is useful to confirm the hypothesis and helps us to support further management decisions.

And we just, again, have to be very strategic in what we're doing and what we're trying to answer. And performing every test under the sun, we may not have time for it, the patient may not tolerate it. So we have to be very mindful in our critical thinking, planning and questioning needed when selecting our vestibular testing. So with that, I know I'm just like a minute or two over, but I so appreciate your time today. My references and if you have any questions, you are welcome to put them in the Q and A.

- [Jessica] I am not seeing any questions popping in, so I think we'll go ahead and wrap. And with that, this does conclude today's course. Thanks again, everyone. You guys have a great rest of your day.

- Thank you.