A Positive Spin on Things: Understanding Rotary Chair

Presenter: Kaitlin Ryan, AuD, CCC-A

It's my pleasure to welcome back Dr. Kaitlin Ryan. Today, she'll be presenting to us on the rotary chair. If you'd like to learn more about Dr. Ryan, you can read her bio on the course registration page.

But at this time, I'll hand the mic over to you. Dr. Ryan, thanks so much for having me. Again, I really enjoyed making a presentation about this topic. It helped me learn a lot of things that maybe I can be even doing to kind of maximize my practice.

So I'm hopeful that we can all take some more things away together today. These are my disclosures, and these are the limitations and risks that are inherent to today's course, and these are the learning outcomes of the course today. So without further ado, we'll get into it. For the rotary chair in general, I'll be talking about three different tests within rotary chair. I'll be talking about sinusoidal harmonic acceleration, VOR suppression, and velocity step testing.

Those are sort of the three most common and more widely used rotary chair tests. There are many others that you can involve with the rotary chair, but I find these ones to be the ones that I turn to the most. For each of them, we'll go through the background of the test a little bit, what the test is, how to do the test, how to interpret the test, and sort of a protocol that you could put into your clinical practice. We'll go through the clinical utility of each test and why you should be doing it, why maybe you don't need to do it. We'll talk about troubleshooting these tests if something doesn't look right or if things are going wrong.

And then I'll try to demonstrate some of all of this through case studies throughout.

Generally speaking, for rotary chair, the history dates back to the 19th century. It was at one point used for individuals that they thought to be mentally ill. They would kind of lay them down and spin them in circles. And I'm not really sure what the end goal was, but that is sort of one of the more early iterations of the rotary chair. Robert Barony, sort of the father of all of this dib, first described his version of

rotational testing in 1907, which, based on sort of my deductions, is more in line with like a velocity step versus something like a sinusoidal harmonic acceleration.

But it wasn't until the 1970s that the engineering of different motors and physical principles allowed rotational testing to be revolutionized and more utilized like it is today. So it's a relatively new group of tests that we're able to use so first we'll be talking about sinusoidal harmonic acceleration, which I will refer to moving forward as Shaw, just to save me a few words. So Shaw started to be more studied in the late 60s or the early 60s and the 1900s. And there was a scientist by the name of Kramer who studied the VOR in CATS by rotating them, which sounds awesome to have watched. And like I mentioned, it wasn't until precision torque motors in the 1970s were sort of revolutionized and invented to allow for individuals of different sizes to be evaluated at different speeds.

So it kind of opened up the world of Shaw to us a little bit more. There was a study done in 1972 as well that first produced early normative values for this test. So it really hasn't been around for very long. And another thing that Matlog did as well was he designed the chair in a way that it could reduce some of the auditory and the kinesthetic cues that are inherent to those motors that helped drive the validity of the test upward so that they didn't have cues kind of cluing them into the world around them. So what the shot is, is it is a test that will assess the vor, and it will assess the horizontal semicircular canals as velocity step will, as does as well.

But the patient is rotated clockwise and counterclockwise, or right and left in different cycles and different speeds to elicit compensatory nystagmus. So they are sort of accelerated and then decelerated, accelerated and decelerated back and forth. And what we're looking for when we are rotating the patients in this way is we're measuring the gain of the vor. So how is their head moving relative to their eyes? We're looking at phase, and we're looking at the symmetry of right versus left.

So we conduct this test in sort of a stepwise pattern. My personal philosophy when dealing with patients and kind of loading them into the rotary chair is I will explicitly instruct them on what's going to happen first. Because I do find there is nothing more unnerving than starting to kind of strap somebody into this chair or possibly a tube, depending upon the iteration that you have, without them really not understanding what's going on. So I'll instruct them about what might happen. The chair will kind of rotate side to side at different speeds and in different amounts.

You won't be able to see anything. I want you to keep your eyes open. I'll be talking to the whole time, and I will let you know what amount of Speed and amount of movement you can expect each time. We'll pause in between. Then I will give them the seat belt first, try to make a joke that I will not be sending them to space, and then I will strap their head in to the straps or kind of the contraption that comes with your chair.

You have to make sure that their eyes are covered and the lights in the room are off. We have a computer that's near to our rotary chair, so we will either turn it against the wall or shut it off altogether. And make sure there's as little light in the room as possible. And then the most important thing that you can do for this test is task them and have your tasking at the ready and be quick with the tasking, which I will get to in a moment. I do find that the tasking speed on rotary chair in general has to be a bit more continuous versus some other tests that maybe you're tasking on once you've done.

One condition of sha, you'll pause in between. And this serves a couple of different purposes. I check in on my patient, make sure that they're not about to vomit, make sure that they're okay, that they're comfortable with what's going on, and that they're willing to continue on. I will allow whatever nystagmus is left over at the end. Stop.

Sometimes it only takes 30 seconds or so. Sometimes I'll wait a little longer, and then I will also make sure. While that's all happening, I'm checking the validity of my test, that I don't need to repeat anything,

that things are shaping up in the way that I'd like them to. So that's kind of my order of how I'm conducting the test. The typical frequencies that you will test with SHA is 0.01 Hz, which is quite a low frequency, and up to 0.64 Hz.

My clinic just updated our equipment, and we did not have access to 0.64Hz prior, so we were going only up to 0.32Hz. Now we are able to extend up to 0.64Hz if we need to, which is great anecdotally in my clinical practice, but also what I've read in literature is that anecdotally 0.01 Hz is the most intolerable frequency, which is really unfortunate because it is the most helpful. It can be quite nauseating to patients, especially if they've done the whole test already. So there are some suggested protocols that you can order the test in that will reduce the amount of nausea that might come about. And then there's also some shortened approaches that you might also take.

So one of the more widely suggested protocols, if you are going to do the entirety of Shaw, would be starting with 0.08 Hz, which is moving side to side. So they are not making a full rotation. I find it is not very threatening for patients to be moving side to side. If they're a little nervous, they tend to tolerate it very well. It kind of dips their toe into the pool and makes them feel more comfortable to continue on.

0.04Hz is like a three quarter turn, I think. So it's a little bit more, but it's not a full turn at that point. Then we would do 0.01. If they're feeling up to it, then they would do some shorter ones. And then depending on the equipment that you have,.02 would be tossed at the end.

Tossed in at the end. The protocol from the literature I looked at did not include.02, but that is one that I use quite frequently in my practice. Some shortened approaches that the literature has sort of validated as far as what could be used if things aren't going well. So what is more important to gain first? And it would be 0.08 Hz, 04 Hz and 0.01 Hz.

Those are the most useful clinically, that if you can get those and you can't get anything else, you're probably going to be okay. In my clinical practice, we do a similar version. We do 0.028 Hz first, always. Then we'll do 0.02 Hz and then we would do 0.32 Hz. Depending upon what we think we might be getting, what we're expecting and how the patient is feeling, we would then potentially go back and fill in some gaps.

Usually what I will do if I need to do more than that is I will add in 0.04 and 0.01 Hertz and usually between all of those frequencies, I've got my basis covered. The suggestion that this shorter approach may also be effective is not doing 0.01 entirely and instead just doing 0.02 hertz with 0.04 and 0.08 hertz. It's something that I have been experimenting in my clinic. When it comes up and it seems to be just as good, I have started to accept that 0.01 Hz is really, really important in our clinical practice. I have a case demonstrating why So I am trying to work up to doing that a little bit more as well.

So what we're measuring for all of this, so all those protocols is fine, but what are we gaining from it is sort of the question that really comes up. And for Shaw, we're looking at gain, which is, like I mentioned, the measure of the velocity of the head movement, which is really the chair, if they're tucked in tightly, and that is relative to the velocity of the slow phase eye movement when the patient is in motion. So is it equal, is it less than what are we looking at? We're also looking at phase, which is the degree to which the eye movement produces a lead or a lag from the head movement, which is a natural thing that we have. And we're just measuring that a little bit more.

It is natural for us to have a phase lead in the movement of the head in low frequencies. A phase lead is a natural thing that we're experiencing. Then as our head moves quicker, it might fall to a lag we're measuring. Is that within a normal range, is that outside of a normal range? And how does it kind of correlate to what we're looking for?

We're also looking at symmetry, which is analogous to the directional preponderance you would find on calorics. So how strong is the right beating eye movements produced compared to the left beating eye movements produced? And that's an important distinction to note versus left versus right peripheral weakness, because with sha, it is not overly localizing. So gain and phase do not give us information about which ear may or may not be involved on its own. The gain of the VOR that we're looking at is an additive right and left put together.

So the symmetry can help us understand where the, the results that we're getting might fall. And we would use it in consideration with lots of other tests. Something else to take into consideration with shot is the spectral purity of the data. So it's how good is the data. And if we're.

Sometimes we want it to be really good and other times we're expecting it to be bad, just based on the nature of the beast, which I will explain a bit more in a few minutes. So with the basic interpretation of Shaw is that widely Shaw is used sort of as the gold standard for understanding, understanding peripheral loss bilaterally. But there's lots of different parameters that you might find that can help you understand what the lesion is that you might be dealing with. For phase, primarily, you'll see phase leads that are significant phase leads that start to kind of decrease a bit with increased frequencies. And this can be a unilateral peripheral indicator or even a bilateral peripheral indicator, depending on what the gain is showing you.

This can also be in the absence of any concern for peripheral lesions. It could be something related to a brainstem lesion with gain. Reduced gain universally would indicate a bilateral vestibular insult. This can suggest a unilateral peripheral insult that might be acute and uncompensated for. So that's an important thing that you would be looking for in your history and the other test results that you're getting.

And then pretty rarely the gain will be quite high. And if the gain is high, that is a pretty strong cerebellar involvement indicator, which you would also have iterated in other tests as well. So standalone is not overly diagnostic. But if you get these results, you should be able to see it mimicked among other tests in your battery. And then symmetry is really used for things like compensation status, just like directional preponderance and if there's a right beating or a left beating preference.

So I'll kind of scoot by this one. This is a more in depth version of what I just mentioned. It is the interpretation of phase gain in symmetry for a unilateral bilateral central involvement as well as some things to look for if we're thinking that maybe inattention is involved. So it's a little bit more of a longer winded message from the last slide. Just as a demonstration of sort of what a normal body of results might look like.

This woman was somebody that had a beautiful, normal, perfect vestibular test. She wanted every test. She was very motivated to move through the entire thing whether or not it was necessary. But she was a good sport. So I we did as much testing as we could.

So she had beautiful calorics. She had a 7% right weakness and a 1% directional preponderance to the left. She had absolutely perfect V hit and she had no spontaneous nystagmus, no gaze evoked nystagmus, no her smooth pursuit, random saccades and optokinetic were beautiful. Beautiful. She had no high frequency head shake nystagmus and her positional assessment was also beautiful.

So we had a pretty great slate going into all of this. And so the first thing that we did together was Shaw. And you can see on the left hand side is gain. And her gain falls beautifully in a normal range in the middle one, that's phase. And her phase fell into a normal range.

But you will notice that with increased frequency, that normative range slopes downward. And that's because that's the natural way that our eyes move in relation to our head at different speeds. She did

have a little bit of an symmetry over toward the right, which was not significant. But if you'll remember, she had a left beating directional preponderance, which shows up on shot as a right directional weakness, which would suggest a left directional preponderance. So it all kind of starts to match.

I mentioned spectral purity before and what we would see on this test, if you look at the second picture, the smaller one off to the right, is if our spectral purity was quite poor, we'd see a lot of little sort of rain fall underneath the sinusoidal wave that we're getting, which would indicate that maybe her eyes weren't tracking very well. There was a lot of poor data that was thrown away and the line of best fit kind of went over where things were best. If we're getting a lot of fallout like that, we might think that our spectral purity is not very good. We would then want to check the validity of our results. You can see that she has barely any little rainfall underneath her wave there.

So her spectral purity was pretty good. So happy with that. So next up we've got VOR suppression. And VOR suppression is one that builds off of sha. So you have to have done Shaw first before you can do VOR suppression.

And it is done nearly the same way. The special thing about VOR suppression is it is a test of the cerebellar mechanism almost entirely, which is very analogous to a fixation suppression index on caloric irrigation. So it allows you to build some redundancy in that way. You will perform VOR suppression almost identically to sha, except you are turning on a fixation light in the goggles. And I personally don't task them.

I want them to be as focused as possible. Sometimes I will task them if they're having trouble staying awake. But I do find that patients will start to chat with you anyways. But the idea is that they're focused, laser focused on that light the whole time. What we're looking for is their nystagmus to completely go away by at least 80%.

That is what's considered normal. And a less than 80% reduction in their nystagmus while they're fixated on something does suggest a cerebellar involvement. And this can be highly correlated with psychotic intrusions on smooth pursuit. So I find it's a good cross check for a couple of things. This is a patient that I had been following for a while.

She had a left cerebellar stroke about three years ago. It was in her pica and she has recurrent positional vertigo. Her vestibular test was almost entirely normal. She did have some psychotic intrusions on smooth pursuit, but only when tracking left. And she had normal everything El normal, Clorox.

Her ocular motor was otherwise normal. It was pretty unremarkable. But she is going to see an OTO neurologist and they wanted this test, so I did it for her. You can see that her Shaw was beautifully normal, which kind of reiterates that she has absolutely no concerns for a peripheral lesion of any kind. And then on the VOR suppression, what you have to do is match up which frequencies you did on SHA so that you can see the reduction of their nystagmus on VOR suppression.

So I personally picked 0, 2 and 0.08. I find that if I'm doing this shortened version, like I mentioned, that those two frequencies typically are the ones that provide the best, most reliable results. And you can see that her nystagmus reduced 72 and 78%, which is sort of borderline, which does suggest that her cerebellum is involved in some of her symptoms. What I did find interesting is that the suppression of the nystagmus is again like the gain of Shaw. It's additive, so it does not separate out right and left.

And when I was watching her tracking while this was going on, she had almost no nystagmus at all when moving to the right. But when her eyes were moving to the left, that's when she had the issue suppressing the nystagmus, which sort of drives home that left sided stroke. So I found that to be very interesting. I made sure to document that well in her note, even though her results were borderline, I did notice a more significant difficulty suppressing the nystagmus when her eyes were beating low left. So

next we're going to talk about Velocity Step, which is a little bit more involved and it predates Shaw.

Like I said, it's a pretty easy test to replicate on your own at home. If you've got a desk chair, you can just whip somebody around and see how their eyes move when they start and stop. It is something that has been described into the 1800s. And like I mentioned, because there wasn't a lot of motor technology available, the repeatability and the reliability of Velocity Step testing was very quite poor at first due to operator error. It was hard to control the speed.

But it wasn't until 1979 that the Central storage mechanism and the velocity storage integrator was really discovered and studied. So that is something that we really capitalize on with velocity step testing. And we're looking at things like pushing past coupular deflection to get to the full vestibular integrator. And that's where all those time constants and max metrics come into play, which I'll break down. How this test works is it is a quick burst of acceleration with a constant velocity of motion for one minute with a quick deceleration.

What that looks like is the patient is set up the exact same way as Shaw. I give them all the instructions, I tell them about the speed that they're going to go, and the chair takes off to the right or left and it will quickly start to get up to velocity and it will continue turning for one minute. At that one minute mark, it grinds to a halt and that's that quick deceleration. What we're measuring is a per and post rotary phase of the cupular deflection and the velocity storage influence over the eye movement in order to push past that cupular deflection to get to the velocity storage integrator. It takes several seconds to do so, which is when those time constant normative data come into play.

And then there's a lot of advantages and disadvantages to this test because you can gain so much information from the velocity storage integrator. One of the main advantages of velocity step test is that you are measuring one ear with minimal input from the other. So it's not quite as good as calorics, but it is certainly more unilateral than sha. A major disadvantage of this test is that the reliability can come

into question based on the patient tolerance. It's a lot to ask of a patient depending upon where in your test battery you're tossing this in and how motion intolerant they might be.

Similar to shot. We are measuring gain and symmetry, but instead of phase, this time we are measuring the time constant, which is how much time it takes for the velocity storage integrator to kind of reach peak and start to come down, which pushes us past that just kind of basic cupular deflection. How we can duck this test, like I said, is that we'll set them up similarly to Shaw, make sure that they're very secure in the chair where they will be moving relatively quickly. And this one, again, tasking is included. Incredibly important, making sure that the tasking is paced well, something that doesn't, I think, always get reiterated enough is that you should pause in between directions and speeds.

If you're doing multiple speeds similar to caloric, you need time for the body to kind of release the rest of that nystagmus and kind of come back to normal. So it is the similar pacing as a caloric irrigation. One ear takes about two minutes to complete. You take a two to three minute break, then you do the other ear. This again allows you to check in on the patient, allows the previous response to completely clear the system, check the validity, and make sure that things are going in the way that you need them to go.

If not, you can take a break. The test works based on the amount of velocity stored while in the per rotary phase and then the amount of velocity released in the post rotary phase. So once the velocity storage integrator has reached that maximum capacity while the patient is turning, you'll actually see their eyes, for the most part, stop producing a nystagmus. However, once the chair stops, that nystagmus starts swinging back the other way, and that is that post rotary phase kicking in, where that velocity storage integrator is completely released. And we're measuring the time it takes to go from peak nystagmus to 37% reduction in nystagmus in that post rotary phase and then a 63% reduction in the post rotary phase.

And I find it to be something that surprises me, excites me every time I do it, to watch their eye movements completely stop and then swing back the other way. So what are we even measuring and how do I use that knowledge? So the slow phase that you're tracking is very similar to Shawn. It's very similar to calorics. If the chair is turning rightward, if the chair is turning clockwise, that in the per rotary phase, the nystagmus slow phase is beating to the right.

So it's being pulled to the right, snapping back to the left. When the chair stops beating and that begins the post rotary phase, the nystagmus slow phase switches to the left. So when you're kind of breaking down all four measurements that you gain from doing a velocity step to the right and the left. When you're measuring the per rotary clockwise, turning to the right and the post rotary counterclockwise, which is to the left, that is measuring the right peripheral system in the inverse, when you're measuring the per rotary left and the post rotary right, that is keeping track of the left peripheral vestibular measurements. So this is sort of another Way to illustrate that as well is that per rotary to the right, the eyes are being pulled to the right in that slow phase, snapping back to the left in the fast phase.

And we are measuring that right beating slow phase. And then when the chair stops that will switch to the left. And overall you're getting four measurements, two for the right and two for the left. If you complete a condition in each direction. What we're measuring here, like I mentioned, is the gain, the time constant and the symmetry.

And the gain is again additive right to left, the peak slow phase velocity of the eye movement compared to the head movement. So the chair and it's averaged between right and left. So it is not single sided, just like with Shaw. The time constant is the one that can be of the most value. It is the length of time it takes to go from the peak slow phase velocity eye movement to a 37% reduction in nystagmus.

And we're calculating the amount of time that takes because we're looking for moving past the cupular deflection, which takes about six seconds to complete. And if we can push past that six seconds, we do

know that there is a velocity storage integrator that is alive and well and doing its job. And that usually takes in the market between 10 to 15 seconds depending on the literature. You look at the symmetry very similar to Shaw and directional preponderance is the average slow phase velocity of the right ear versus the left ear, similar to the right beating versus left beating. So it's we're looking at how strong eye movements are to one side versus another.

So what we're looking at for gain is we want the gain to be about 0.4 out of 1 in most studies. That's the norm that we use. In my clinic I've seen studies as low as 0.27 and I think that's a little too catch all. It is not as strong of a metric to use on its own unless the gain is high. But you would use gain in conjunction with symmetry, which can help you understand an uncompensated lesion or help you understand unilateral versus bilateral high gain, just like with Shaw, is hyperactivity and typically cerebellar involvement.

And it is quite rare. The time constant, like I said, we want to push past that cupular deflection. We find that about 10 seconds is the low end of normal and then up to about 30 seconds under 10 seconds, you're just usually getting the Cooper activity rather than velocity storage integrator. And that's Considered to be a reduced function greater than 30 seconds, again is likely cerebellar involvement. A poor regulatory mechanism in the cerebellum is causing that nystagmus to go on and on.

Symmetry very similar, like I mentioned, to directional preponderance. We look for about 30% as a metric of significant versus not and in used in conjunction with gain, it can help understand compensation status. So just like I had with Shaw, this is sort of a more laid out version of how to interpret the velocity step. Unilateral, bilateral and central as well as normal. This is in your reference, so I'm not going to go too much over it where I just mentioned a lot of it, but it is a little bit more laid out.

Now here is a demonstration of a normal velocity step. It was the same woman from before. So you can see on the paper there's kind of a lot going on on. At the top we've got our three metrics and then at the

bottom it does give us some time constant. So we've got one here, we've got one here and we've got one on either side.

So what we've got is our left per rotary and our right post rotary. Those are our left ear measurements. And then we've got our post rotary left and our per rotary right, which give us the right peripheral measurements. And you can see that her gain is excellent. Her time constants are in the market of 11 to 16, which is fabulous.

And she has absolutely no symmetry, so she has a perfect velocity step.

So again, I'm going to kind of move past this one quickly. It's in a reference guide. And this is sort of all three Shaw, VOR suppression and velocity step put together for unilateral, bilateral and central involvement that you might find, as well as some other tests that you might look for to determine if you're really onto something with what your rotary chair is saying. Down at the bottom is a little note for particularly peripheral. If you have a time constant that's in the market of five to seven seconds and there's a significant phase lead or reduced gain at 0.01 Hz on Shaw, then that's a pretty significant peripheral indicator for one or both ears, depending upon what velocity step shows you.

So you'd look for a reduced time constant and 0.01 Hz specifically for Shaw. So now you're probably asking yourself, what do I do with this? How do I use this? Where does the clinical reasoning come in? And so that's what we'll talk about next Is SHA in particular is considered, as I mentioned, to be the gold standard for bilateral peripheral vestibular involvement.

Specifically things like monitoring ototoxicity with time, monitoring recovery from an insult over time, and monitoring sort of of where along the way the lesion kind of goes sideways. It can be used in the diagnosis of unilateral peripheral dysfunction. However, you would really need to combine it with other tests in order to understand that it is unilateral versus bilateral. And it also, as I mentioned, can be used

to monitor compensation with time. So I find it to be very helpful.

VOR suppression has limited clinical utility, but it is very important and it will help monitor and confirm cerebellar involvement. And it will confirm things like if their saccades were not very, their smooth pursuit was full of saccades and not very good, or if their fixation on calorics was not very good, but you're not convinced it was cerebellar. I find that certain physicians that I work with get kind of squirrely about some of those results. So having redundancy that kind of proves or disproves some other findings really can be helpful. I find that if a patient has very poor fixation on calorics but very good VOR suppression, they probably were just panicking.

So they weren't really able to find the light. Maybe the light wasn't where they expected and kind of things got a little hectic for them. VOR suppression can help kind of reduce that. With velocity step, there is quite a bit of clinical utility as well, but it's usually for unilateral peripheral lesions. But you can also use it for bilateral as well.

And the reason why it's more unilateral than SHA is because you do get the separate ear information, whereas SHA is really non localizing. It can also be used to confirm other findings and support and uphold other suspected diagnoses that you may have found along the way. For velocity step, you can also use it for compensation status information as well. Particularly in a two speed paradigm. It is time intensive, so it's not always feasible.

But what you would do is a low speed and a high speed. The low speed is a great kind of baseline for like overall information. What is the time constant? What is the gain? Is there an asymmetry?

But the way that you would really use a higher speed, so I would use 180 DPS for this, would be to really drive the velocity storage integrator to its maximum capacity and highlight any asymmetry that may be hiding or otherwise compensated for at a slower speed. So it can help you understand if really

there's any compensation left to go through which may explain a patient's symptoms. So I can find that to be very helpful. Another thing that I would just like to highlight quickly is that there's sort of a timeline and a frequency range in which all of these tests work on. You've got calorics way down the end at 0.003 Hz.

It is not a real world realistic measure of movement. It is an artificial measure of movement. And you've got VHIT, which is 1 to 5 Hertz, which is sort of a very quick kinesthetic movement. But then in between 1 and 0.003, you've got rotary chair, which leaves a lot of information on the table if you need it. So it can in real life, sort of head movement side to side start at about 0.08Hz.

So that's really in the thick of rotary chair. So it can be an incredibly helpful test to start to use. So if your calorics is bad, so let's take that for example, your Clorox is bad and or your calorics is not able to be done. So let's say they've got a perf, or let's say they had a mastoidectomy, or it's in some way contraindicated. You can gain a lot of information from rotary chair if you're also still able to do vhit.

VHIT plus rotary chair can be quite helpful, but in the kind of if you're able to do calorics, you can think about some different outcomes that might drive where your decision goes with rotary chair. So if you have calorics and VHIT that are both normal, you can pretty much expect that your rotary chair should be normal. So it may not be clinically useful. It may not have any value added, and that's perfectly fine. Then you know if your calorics is normal, but maybe your VHIT is bad, which I don't see very frequently.

And it's usually a human error. What if you have a false positive? Is there any value added in rotary chair? Or should you just repeat VHIT and see if it improves? Or maybe is there a central issue?

So that's where you might start to think, I might add a little rotary tear and see what happens. Or you can cut your loss and just repeat vhid. If you are short on time. Then there's also the iteration of if calorics is bad but your VHIT is normal, are you Experiencing a low frequency lesion that recovers in

the high. So is it something like a Meniere's disease?

I had a gentleman not too long ago that had a low frequency lesion and you could clearly see 0.01 and 0.02 Hertz were abnormal, but it recovered 0.04 through 0.32 Hertz. It was very cool. And he had normal VHIT. So it helped us confirm a lesion that was a very low frequency lesion. And lastly, your calorics is bad, your vhit is bad.

You can be relatively certain somewhere in there your rotary chair is not going to be very good. But it can help you illuminate. Maybe if there's a compensation problem. If one ear is truly weaker than the other, if they're both weak, it helps clear up a lot of information. For central lesions.

You might use rotary chair, like I mentioned, to understand more about the cerebellar mechanism. Or even if you think a brainstem lesion is involved, you would have other abnormal tests that maybe you'd like to confirm. Maybe, like I mentioned, the fixation is poor, the smooth pursuit is overly psychotic. Maybe they have gaze evoke nystagmus and you want to delve into it a bit more. Shock VOR suppression and velocity step can really help you drive some of those suspicions forward.

So how can you incorporate it reasonably? That's another great question. I am going to just summarize this study. So this study was done to determine the best kind of protocol with the least amount of impact. And it studied rotary chair, 100 DPS velocity step, SHA and Calorix.

And the goal was to see what the combination would be the most sensitive. And overall what they discovered is that Shaw gain and phase at 0.025 Hz plus 100 DPS velocity step plus calorics was the single most predictive sort of combination of results that you could use to predict a unilateral or bilateral vestibular lesion peripherally. So that is something that I have started to use more. I've started to incorporate that into my practice and I have found that it, it does really seem to like produce the results that you're looking for. So I found this study to be incredibly helpful, incredibly informative.

So there's a couple of evidence based protocols that sort of have sprung to mind through that study, through the literature I read peripherally, if you've got good vhit, and this is in, I should mention the order that I conduct tests in my clinical practice. We start with VHIT and Kind of move our way to rotary chair last. Your VHIT is good, your ocular motor is good, your positional assessment is good, your caloric irrigation is good, you're probably fine. You probably do not need to do rotary chair. There is little if any value added unless you're trying to maybe establish some clinic norms.

So you want some normal information in there. If your caloric irrigation is bad, the literature suggests that you start with velocity step. It will help you understand right versus left a little bit more unilateral and you would try at least at a slow speed first. If you can get away with a high speed speed, I would it helps with compensation status but at least a slow speed velocity step would be good. If velocity step is normal again you can probably just stop there.

You're probably dealing with a low frequency caloric only weakness. If your velocity step is not good at the slow speed you can do the high speed if tolerable. But then you would also want to do shot at least 0.01 Hz. Maybe an abridged protocol is all you need. You can start to delve into it from there.

There on the central side you'll your VHIT is good, but maybe your ocular motor is not. And you start to say maybe they've got some gaze of oak nystagmus, maybe they have poor smooth pursuit. Their positional assessment might be good. Their caloric fixation is pretty good. You might consider doing a SHA vor suppression combination to confirm some of the results that you got on the ocular motor findings.

If your ocular motor is good and your positional assessment is good, and your caloric irrigation fixation index is not good. You may also consider doing a SHA VOR suppression combination to really refute if the fixation index was a valid measure or if it was one of them potentially panicking, not looking at the

light, not understanding the task. And so there's a lot that you could gain from that in that regard. And again, I should also mention if your VHIT is bad, you're kind of in for it. You know that something's wrong and you've kind of moved through the flowchart the same way.

Velocity step can be very helpful with compensation as I've mentioned previously. So this is sort of a summary slide of that. Other signs of compensation that you would have available to you if you do a full battery of testing would be spontaneous nystagmus. Any positional nystagmus that might be there, as well as the directional preponderance on caloric Irrigation. If you've got any questions about it.

SHA and velocity step testing can be very, very helpful in further understanding compensation status. Some of the things that can go wrong with rotary chair, though, kind of negate a lot of that. And you really have to be on top of what is valid and what is not. So these are some of the things that might go wrong with each of the test and what the finding may be suggesting. So things like goggle slippage, maybe they're not paying attention, maybe they're nauseous, maybe they're tapped out.

They just don't want to be here anymore. And then my favorite one that will happen to everyone, no matter how seasoned you are, is you will forget at some point or another to put the COVID on their eyes and they'll be able to see the room whizzing by them. Thankfully, this is not an attractive thing for people, so they will tell you usually quite quickly, but you will do this at least once in your life and it will skew your results. And then this is my little experiment that I did where I had my student test me normally and then test me in all the ways that things can go wrong. And you can see that the 0.04 is the normal.

That's our control. And then 0.08, I was not tasking and I produced some low gain, which I don't typically have. On point 1 6, I had significantly reduced phase, which was because I was. My head was slipping from the goggles and the headrest. And then on point three two, I did not have the COVID on my eyes.

So my gain went way high and nothing really seemed to make sense. It was kind of all over the map. So things can go wrong in a way that can have you scratching your head. So make sure that you, if your results are not looking as you're expecting based on your new expertise of rotary chair, you start to look at some troubleshooting options. I mentioned mental tasking a little bit, and this was a study that I just wanted to include about mental tasking.

This study actually found that there was no difference in tasking versus not tasking. I did find the study to be a little limiting in both participants and age group. And all of the people had no vestibular disease because I believe it was a college group. And I did find that. I do find in my clinical practice, tasking significantly impacts the results and the validity of the results.

And so when things come up like language barriers or kids versus adults, I task them differently to still be effective. I tend to Ask if I'm using an interpreter, I instead of sort of spitting questions out that the patient, I will ask a more open ended question that keeps them talking for a bit longer so that there's less back and forth between me and the interpreter. And I find that that can be incredibly helpful as well. So this is a study that I did want to include, but I don't. I find that in my clinical practice tasking really does matter.

And then that's sort of my note on that. So with our few minutes left, I do just want to go through a case study of an abnormal rotary chair. We have a couple of minutes, so I'll spend the rest of my time doing that. This is a gentleman who was 80 years old and he had a history of what he described as BPPV about three years ago. And over the last couple of months he had a sudden onset of intense imbalance to the point that he was falling.

He wasn't able to participate in things the way that he used to. He was previously very active and now he noticed that he very much was not. And he did also mention that he, his ambulatory abilities were

significantly impacted if his vision was reduced or if his proprioception was compromised. He mentioned thick socks, fuzzy slippers, uneven ground, really just made him feel completely unbalanced. He had an asymmetric hearing loss, so his right ear was markedly worse than his left, which I did find interesting.

And he was really pushing for this test. He really advocated for himself and I'm very glad that he did so when I did the test, as I said, I start with VHIT on everyone and you can see his right ear VHIT is relatively good. But then we see his left lateral VHIT is low gain with huge saccades and he's got a borderline gain with smaller saccades on left posterior canal. So to me, that was my first indicator that we were maybe really onto something here.

And then he had some spontaneous nystagmus. He had some positional nystagmus, all right beating and he did not have any additional post head shake nystagmus. It was just still that 2 degrees right beating from the spontaneous nystagmus. So in a left lesion I would expect that there would be some additional post headshake nystagmus. And I was surprised to see that.

I did not find that his central testing was pretty okay. He had some pretty poor vision. So I did attribute his reduced accuracy across multiple attempts to his vision. But his smooth procedure pursuit was not very good. Tracking left and his OPK was also not as strong tracking to the left.

So I thought maybe there was something there as well. His gaze was good. His calorics, he had negative one for the left and he had about 21 for the right combined conditions, which in our clinical practice we do find that 20 or so could suggest a weakness. So I thought maybe I have to do rotary chair anyways. Maybe I can really gain some more information about that right ear where I'm I now know fee hit is not good and Clorox is not good for that left ear.

I really wanted to understand that right ear a bit more. So I first did velocity step. I followed the sort of protocol that came to light. While his gain was very good almost across the board in all four conditions, his time constants were seven at the best, and he had one at 11, but seven at the best, which, based on what we've talked about, that is purely cupular, that is not velocity storage integrator. At that time, he had a pretty good asymmetry in the lower frequency, but in the higher frequency he did not.

My best guess is that I started to lose him a little bit in the high, low frequencies. We took a break, we came back to the high frequencies, and there was no asymmetry. So I'm pretty sure he's well compensated at this point. But this has started when I started to really think he did have a bilateral vestibular problem. That lined up much better with the symptoms he was presenting with.

And then I did Shaw last, and my smoking gun was 0.01 Hz. He had reduced gain and he had a pretty good phase lead. And the phase lead started to come down with increasing frequencies. He did not really have any significant asymmetry, but it was left leaning, which tells me he had a right directional preponderance which I had been correcting and correcting for based on his spontaneous nystagmus. So this test confirmed to me that he did indeed have a bilateral vestibular weakness.

It was just significantly weaker to the left, which really confirmed a lot of the symptoms that he had been describing to me. So it felt good to be able to explain that. So as I just kind of summarized, these are the results that I had interpreted from this gentleman. So right ear versus left Earth. His compensation status and then my overall impression, like I said, he had a bilateral peripheral vestibular weakness with a significant loss of function to the left.

Compensation was pretty established, but still lingering a little bit due to the spontaneous nystagmus that he had. And just As a note, I did not do VOR suppression given his good fixation index and I did have a low suspicion of central involvement. I also just didn't really have time. So I found what was most important to me first. So in summary, we kind of slid home right in time.

Rotary chair can be very good for an alternative with individuals in which calorics is contraindicated. It is not something that I do commonly but I will use it and I can use it and get similar information, especially if I'm doing VHIT as well. It can really bolster the results and provide for more comprehensive information if you are doing calorics and VHIT together. And it can also provide some really strong information about central vestibular function that you may not be getting from somewhere else or you may not have been able to confirm from somewhere else. So with that being said, I have these two quick reference guides that I've talked about in the presentation.

But I do find they're good things to take away and you can save them and use them if you decide to include rotary chair in your clinical practice. So those are them and I'll toss it back to you Chris. Thank you Dr. Ryan. We'll go ahead and open up the floor now for any questions or comments that you might have.

Here's one. So in the case study can you explain why rotary chair trumps your caloric findings to ultimately diagnose a bilateral weakness? That is a good question. So let me change back to that slide here. So I don't think it trumps the finding because I I use we use our metric clinically is that 12 total chloric SPV for both right and cool and warm condition would be weak.

I have been finding a lot in my clinical practice that calorics that are only total of 20 or so can also produce a bilateral weakness. So I don't think it necessarily trumps it. But it did raise my suspicion that may maybe his vestibular function. Although it looks significantly stronger compared to the left ear that has nothing. I did not particularly think it was that strong.

So I used rotary chair to confirm whether or not that left ear was truly weak but also if the right ear might also be quite weak as well. So I don't think it trumps it necessarily. But I do think that it helped kind of confirm a sneaking suspicion I may have had. That is a good question. Another question is what

happens to these patients after they are diagnosed?

Are they referred for physical therapy, given medication? What are the next steps? That is also a good question. So typically, at least in my clinical practice, I always go through the results with patients. I don't necessarily diagnose them with anything, but I do explain to them what the results might indicate.

And then based on what the results are, are. If they're more ear related, I will offer to have them see an ear, nose and throat doctor. If they're more central, maybe they're migraines or they were intended to be seen by neurology in the first place, I will have them see neurology. If they're normal, I will have them return to their primary doctor or whomever referred them. But for patients like this gentleman, vestibular rehabilitation would be super helpful.

I don't think there's any medication out there that would help him, but vestibular rehabilitation takes tailored to his specific needs would be incredibly helpful. The woman I talked about who had a stroke, she's going to physical therapy focused on gay stabilization and balance. This gentleman with the bilateral weakness, he would need to focus on things like substitution so his ears aren't really pulling their weight. Let's focus on using our proprioception, using our vision. So physical therapy would be incredibly helpful to these patients.

That's a good question, Ryan. I don't think there are any other questions in the queue. We'll go ahead and fast forward to that very last slide just to remind the participants to complete the exam. That exam will be available within 15 minutes once this webinar closes. And this is if you Wish to earn CE credit.

If you are an Audiology Online CE member, we'd like to take this time to thank Dr. Ryan for coming back on and presenting today today's presentation. We hope you enjoyed it and hope to see you all soon. Thank you so much.