

CMV CONFERENCE, SALT LAKE CITY
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Hearing and Vestibular Monitoring Protocol for Infants and Children with Congenital Cytomegalovirus

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About Us

Karen Hendrick, AuD

- Vestibular Clinical Practice Specialist
- AuD from University of Washington in 2015



Elissa Jodon, AuD

- Vestibular team member
- AuD from University of Texas at Austin in 2016



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CHCO Vestibular Program

Number of Vestibular Evaluations

- 2017 = 7
- 2018 = 44
- 2019 = 53
- 2020 = 83
- 2021 = 186 (Rotary Chair installed in January)
- 2022 = 170
- 2023 = 179 (year to date)

TOTAL = 722



Vestibular Appointment Types

Comprehensive Evaluation

- Children ≥ 7 years
- VEMP, vHIT, VNG, Rotational Chair, Caloric

Limited Evaluation

- Infants and children 12 months - 6 years
- VEMP, vHIT, Rotational Chair

Balance Clinic

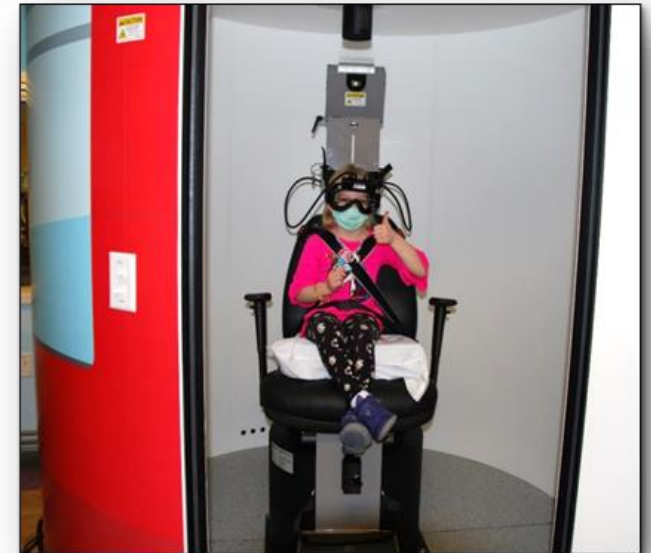
- Otolaryngology, Audiology, Physical Therapy, Neurology

Vestibular Screen in Colorado Springs

- VEMP, vHIT, Bedside screens
- Combined with a PT evaluation

Vestibular Evoked Myogenic Potential (VEMP) Testing

- Pre-op Cochlear Implant surgery
- cCMV 12-month vestibular screening



Learning Objectives

1

Hearing loss
and vestibular
dysfunction
risks with
cCMV

2

CHCO
hearing and
vestibular
monitoring
guidelines

3

Vestibular test
modifications
for all ages and
developmental
levels

4

Vestibular
screens at
different
ages



Anatomy

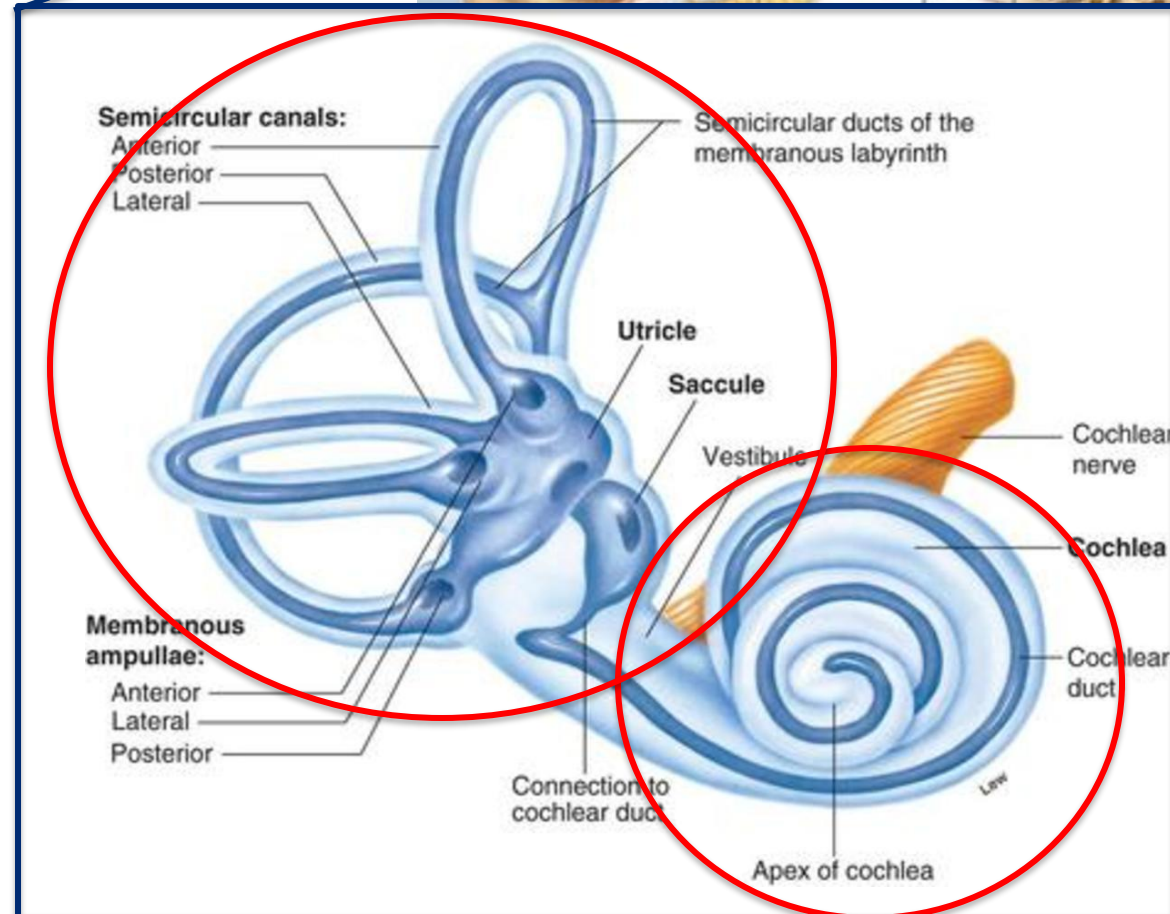
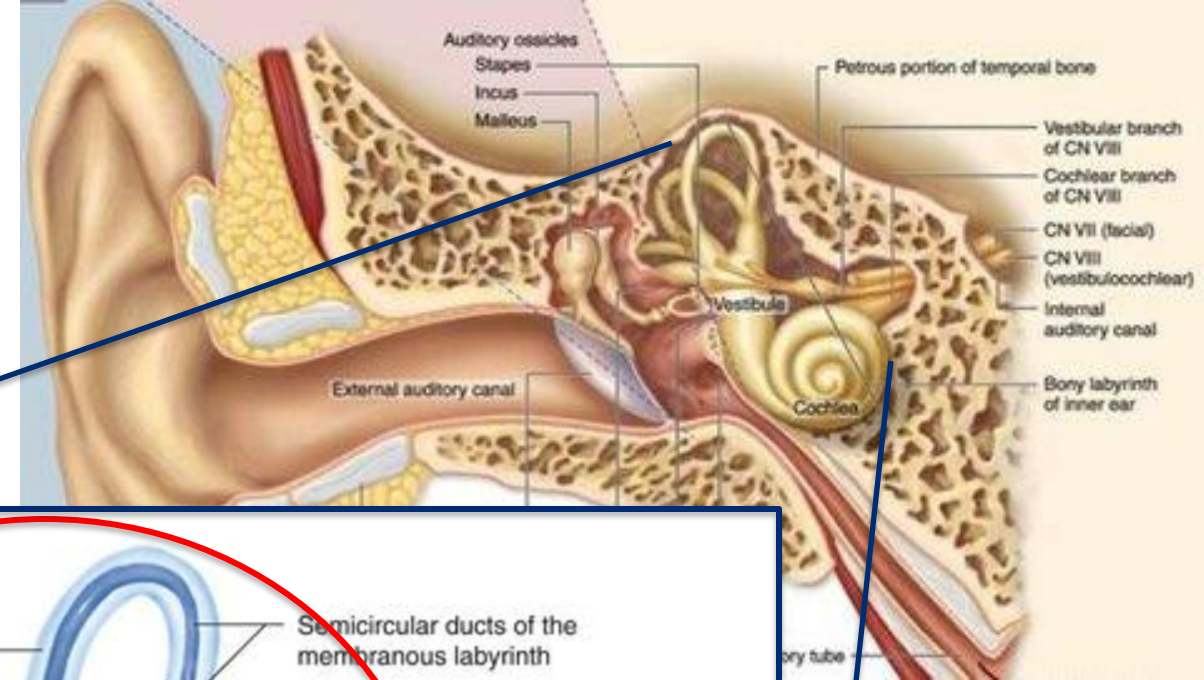
Hearing:

- Cochlea

Vestibular:

- Utricle
- Saccule
- 3 Semicircular canals

All inner ear structures are connected through a continuous labyrinth



Hearing Loss and Congenital Cytomegalovirus (cCMV)

- It is well established that cCMV can cause sensorineural hearing loss.
(Dollard et al., 2007; Goderis et al., 2014; Cannon et al., 2014)
- There are national recommendations to closely monitor hearing in children with cCMV.
 - Joint Committee on Infant Hearing (JCIH) Position Statement, 2019: recommends diagnostic follow-up at 3 months of age and annually until age 3
 - American Academy of Audiology (AAA) Position Statement, 2023: recommends diagnostic evaluations every 3-6 months for the first year of life, every 6 months until 3 years of age, annually until 6 years of age



CHCO Hearing Monitoring Guideline for cCMV

- Diagnostic auditory evoked potential (AEP) evaluation at birth/diagnosis of cCMV
 - Monitor hearing:
 - every 3 months until 1 year of age
 - every 6 months until 3 years of age
 - annually until 6 years of age
- ❖ More frequent evaluations may be recommended if results are abnormal or incomplete, or per audiologist recommendation.



Vestibular Function and cCMV

Shears et al., 2022 published a systematic literature review of vestibular function in children with cCMV

- 12 studies performed vestibular tests on children with cCMV.
- Found 10/12 studies showed at least 40% or more of children with cCMV had vestibular loss.
 - Included was Bernard et al., 2015, who found 92% had vestibular loss.
- Vestibular dysfunction was more common in children with symptomatic cCMV, although still occurs in children with asymptomatic cCMV
- 2 studies showed a progression of vestibular dysfunction over time through serial testing

Considerations when developing our protocol:

- Vestibular dysfunction is common in children with cCMV.
- Vestibular dysfunction can occur with cCMV regardless of hearing status.
- Vestibular dysfunction can be progressive in children with cCMV.



CHCO Vestibular Monitoring Guideline for cCMV

- 12 months of age: Cervical vestibular evoked myogenic potential (cVEMP)
 - 3 years of age: Limited vestibular evaluation
 - VEMP, vHIT, Rotary chair
 - 7 years of age: Comprehensive vestibular evaluation
 - VEMP, vHIT, Rotary chair, VNG (oculomotor, positionals, calorics)
- ❖ Additional or repeat testing may be recommended if there are other abnormal findings.



Why is Monitoring the Vestibular System Important?

Bilateral vestibular hypofunction:

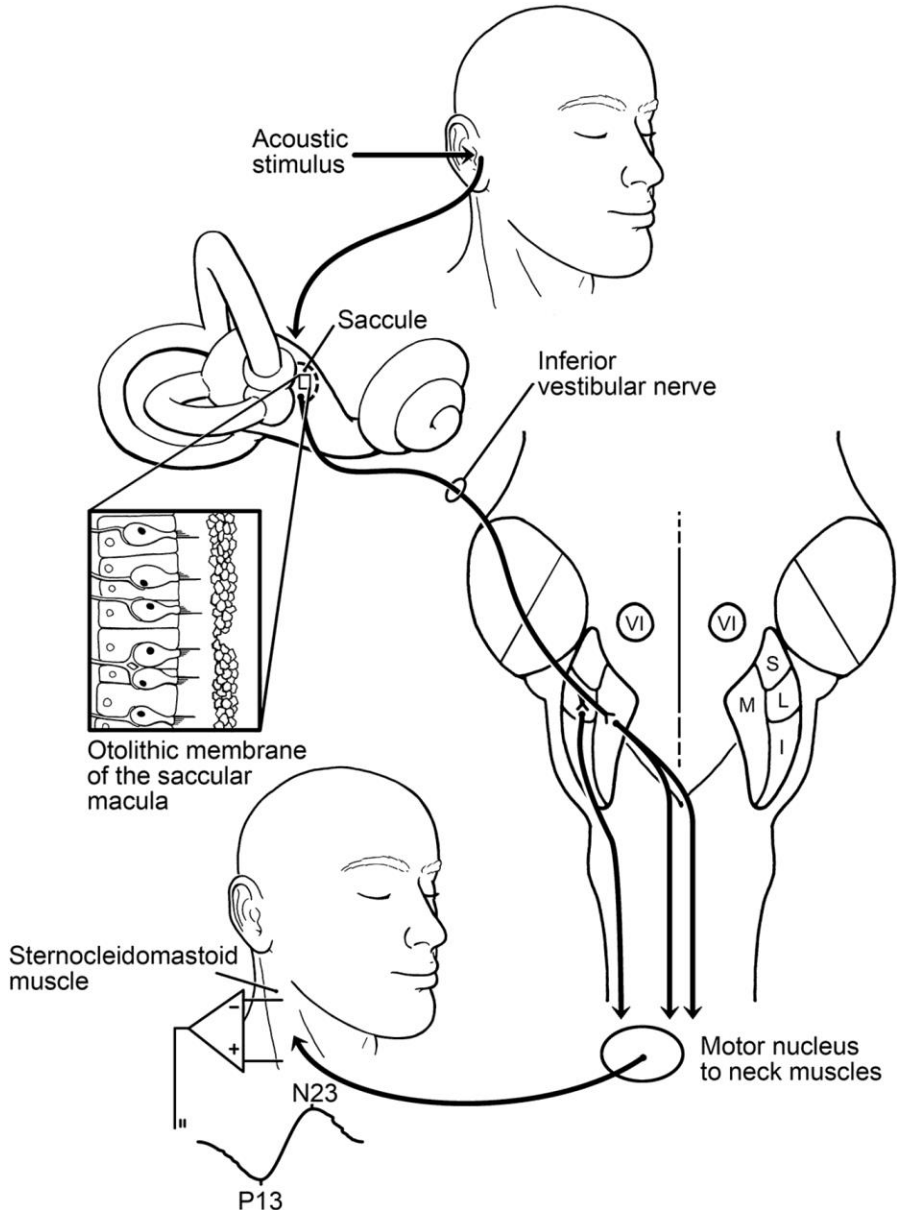
- Gross motor delays and imbalance
- Increases risk of cochlear implant internal device failure by 8 times (Wolter et al., 2015)
- Associated with deficits in memory, executive function, behavior, and school performance (Bigelow & Agrawal, 2015; Franco, 2008)

How can we reduce these problems?

- Early identification of hypofunction and participation in vestibular rehabilitation improves balance outcomes (Rine, 2018)



Cervical Vestibular Evoked Myogenic Potential



cVEMP: Sacculi and Inferior Vestibular Nerve

- Sacculi: senses vertical movement
- Utricle: senses horizontal movement (oVEMP)
- Can be completed on infants
- Short and non-invasive
- Ear-specific
- Not affected by sensorineural hearing loss
- Air or bone conduction stimulus
- Contraction of the Sternocleidomastoid (SCM)
- Electrodes measure the response sent from the sacculi along the vestibulospinal tract

cVEMP Testing: 12-month-old



cVEMP: Alternative Testing Position



Record Edit... Latency

Latency times

	ms	μ V
P1	18.00	-56.9
N1	24.67	88.52
P1'		
N1'		

CR		
RA		
INC		

	ms	μ V	Amp
N1-P1	6.67	145.5	
(LA-SA)/(R+L)			0.07

Cursor

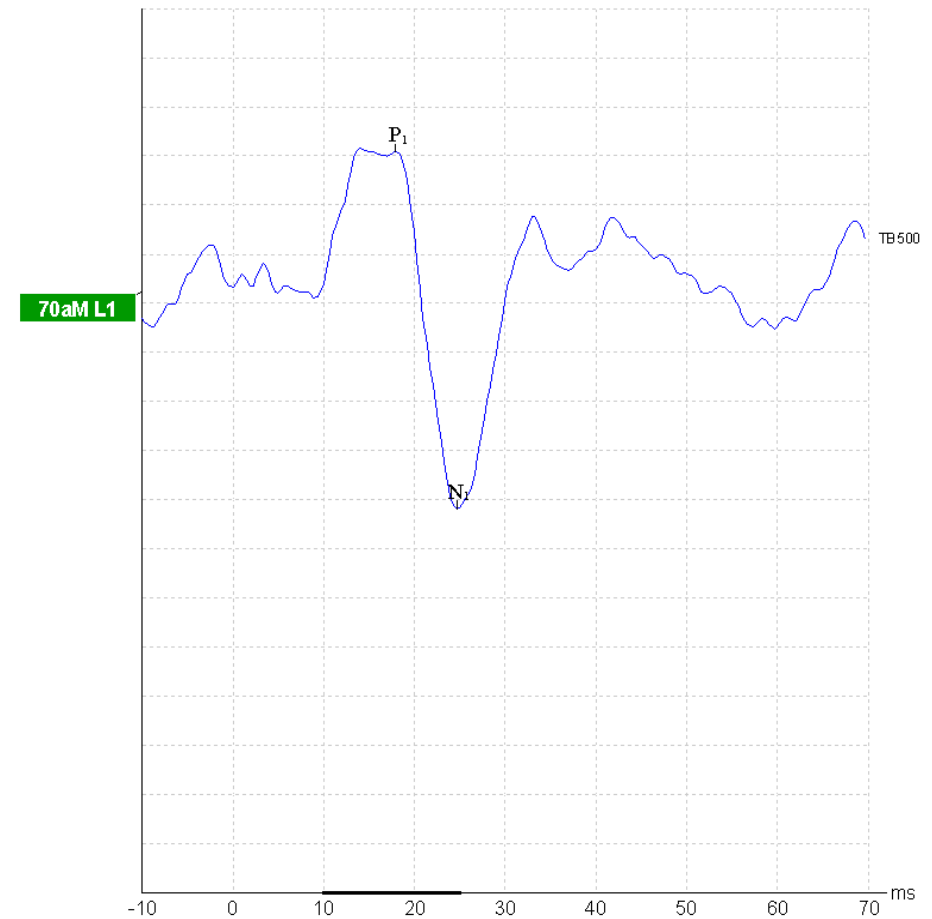
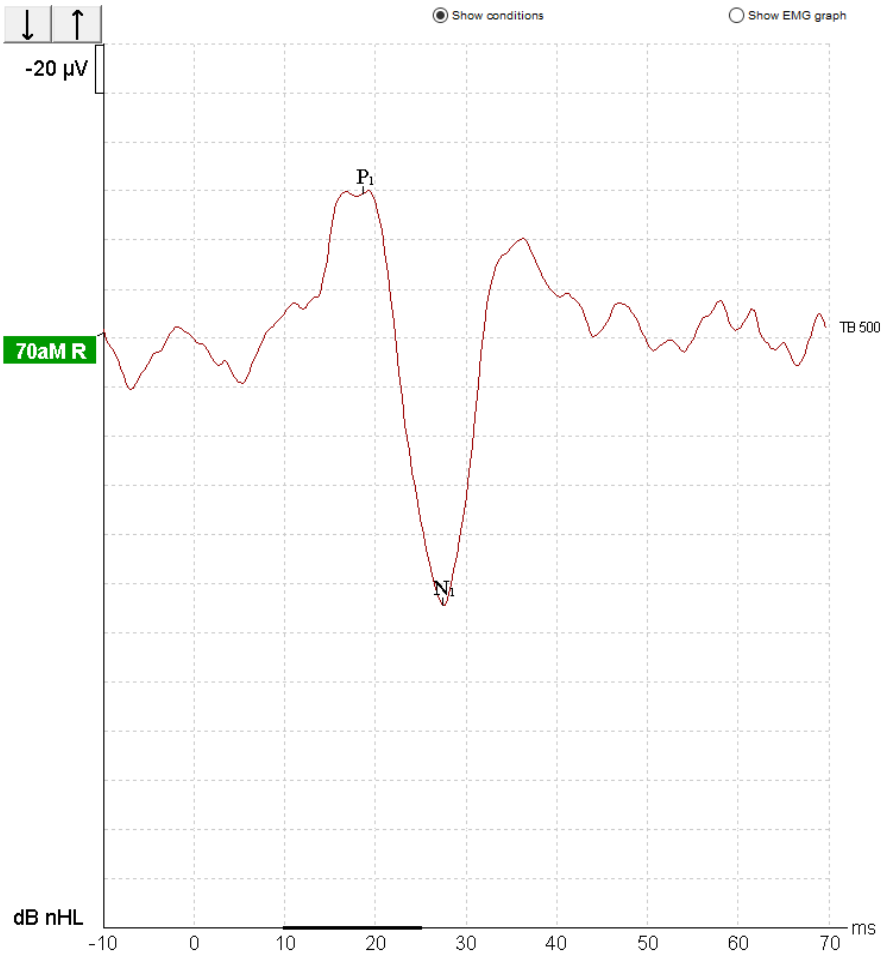
	Fixed	Cursor	Diff.
ms			
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Display filter setting

Low pass	High pass
None	None

Recorded	160	Masking	Off	Wave repro.	87 %	LP	750 Hz	HP	10 Hz 6/oct
Rejected	0%	Stim./Sec	5.1	Residual noise	---	Fmp	---	Ratio	N/A
Rejection	$\pm 800 \mu$ V	Headset	Bone	Polarity	Alter. A=Rare,B=Cond	Stim.	TB,500,Manual (2-1-2)		

Comments



Ready...

For Help, press F1

Current session

VEMP



Abnormal cVEMP

Follow Up

- Asymmetric cVEMPs at 12 months: Repeat in 3 months.
- Absent cVEMP bilaterally at 12 months: Rotational chair testing to assess for bilateral hypofunction.
- Vestibular physical therapy evaluation if there is bilateral hypofunction.



Rotational Chair Testing

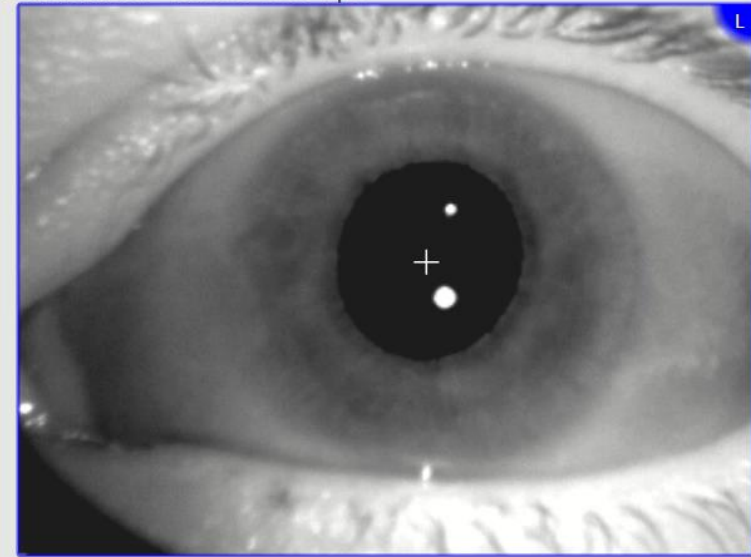
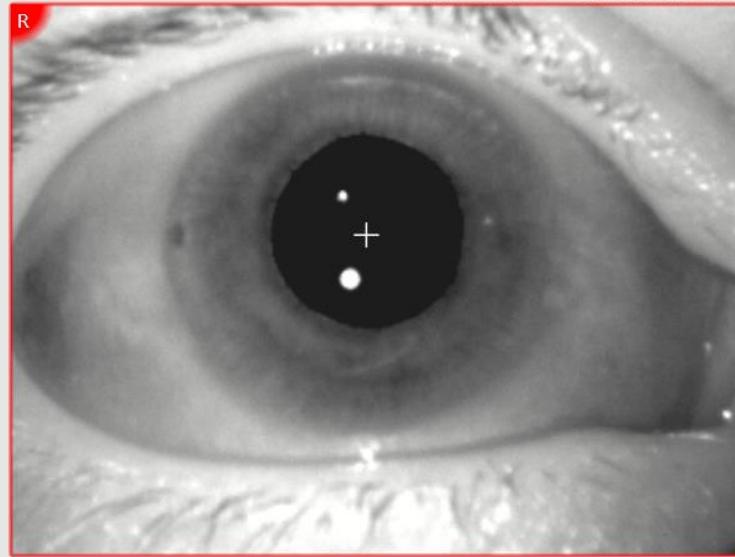
Sinusoidal Harmonic Acceleration (SHA) Test

- Shows how the vestibular system senses different speeds of chair rotation.
- Continuous rotation of the chair to the right and left at multiple test frequencies in a blacked-out enclosure.
- Measure nystagmus - eye movement that occurs when there is a functioning vestibular system in response to the chair movement.
 - If there is bilateral hypofunction, there will be no nystagmus.

Nystagmus is measured by video goggles, electrodes, or infrared observation camera.



Sinusoidal Harmonic Acceleration - .08 Hz 50 dps

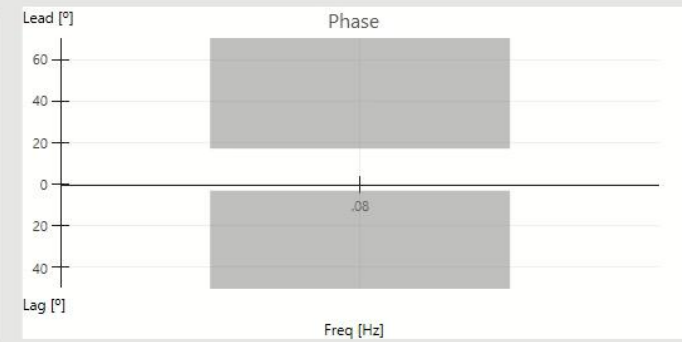
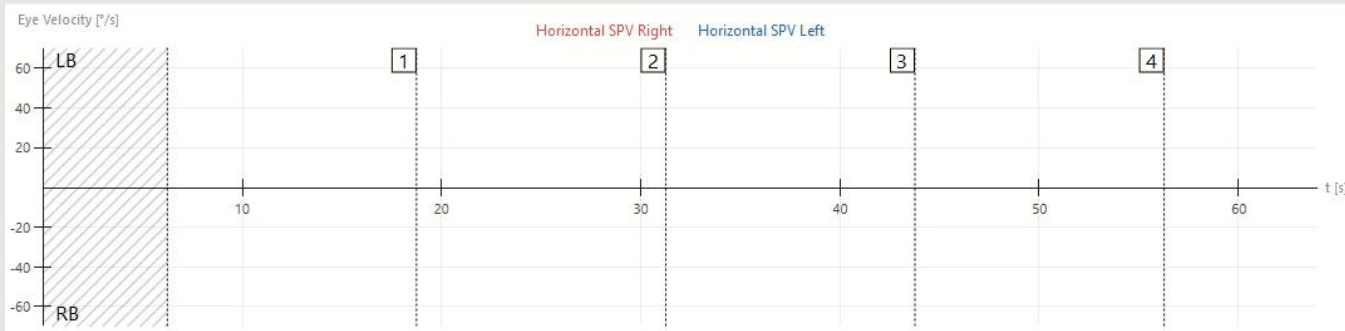
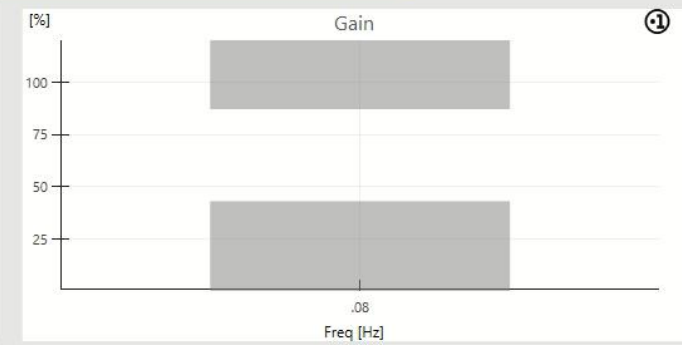
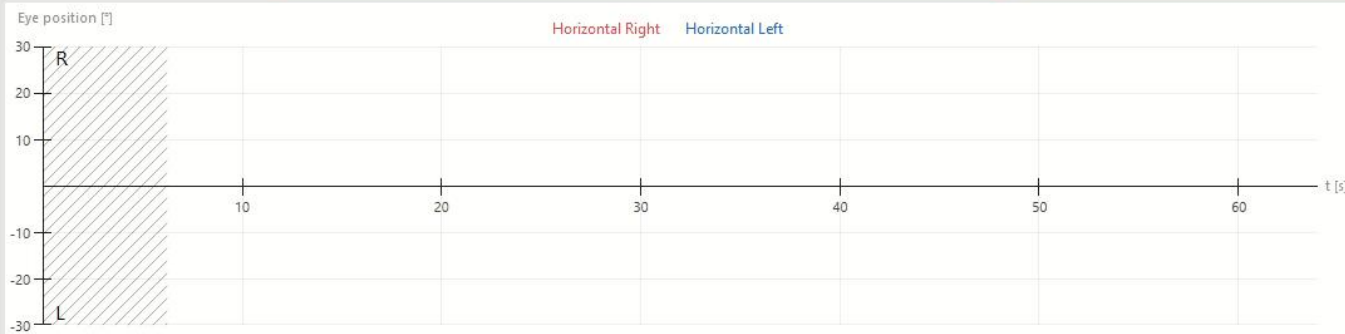


58^s

START

Calibration

Home Chair



Back

Next

Pediatric Setup for Rotary Chair



Electrode setup
in parent's lap or
car seat



Pediatric Observation
Camera



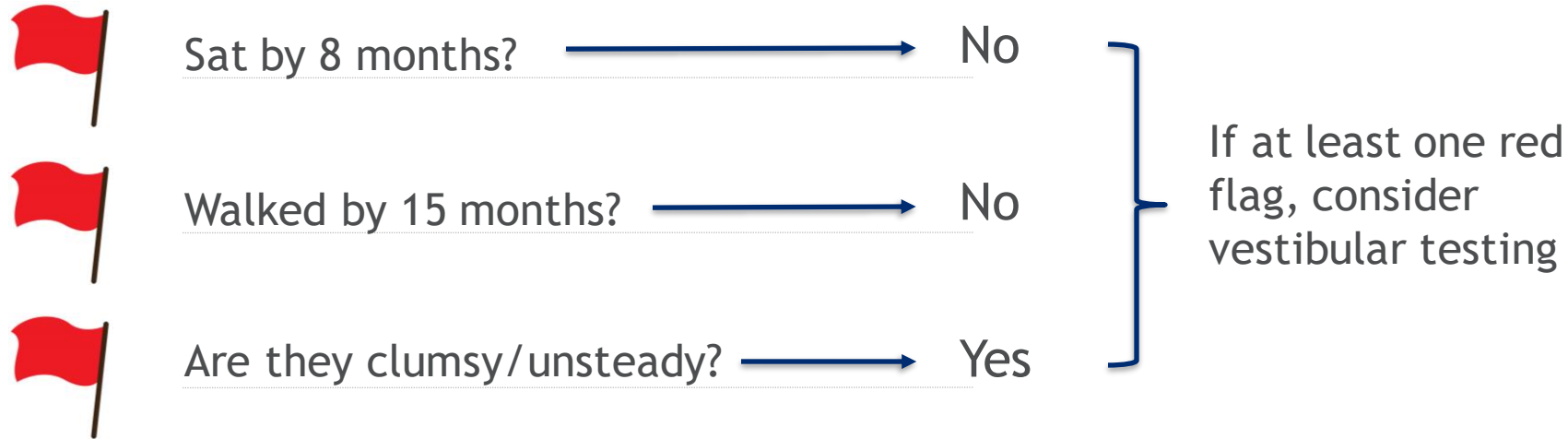


Screening for Possible Vestibular Dysfunction

- Pediatric vestibular centers are limited, and some states do not have this testing for younger ages at all.
- Due to the high prevalence of vestibular dysfunction in children with cCMV and/or sensorineural hearing loss, gross motor delays may be an indicator of vestibular involvement.
- If your patient/child has gross motor delays, vestibular rehabilitation physical therapy should be added and if possible, vestibular testing should be pursued.



Predictive Factors for Vestibular Dysfunction in Children with Permanent Hearing Loss



Children with sensorineural hearing loss, especially moderately-severe or greater, and who have at least one "red flag," should consider a vestibular evaluation.

Janky, K., et al., 2018



Reflex & Gross Motor Screening

Patient Age	Screening
9+ months	Parachute Reflex
2y – 2y 11m	Stand on two feet with eyes closed for 5 seconds
3y – 3y 11m	Stand tandem feet with eyes closed for 5 seconds
4y – 6y 11m	Stand on one foot with eyes closed for 8 seconds
7+ years	Modified Clinical Test of Sensory Interaction on Balance (mCTSIB)



Parachute Reflex

- Begins to develop around 6 months of age and matures by 12 months of age. Most infants demonstrate by 9 months. (Romeo, D.M. et al., 2009)
- Infant should put their arms outward if they are suddenly moved towards the ground.
- Lack of arm extension may suggest a delay in reflexes/gross motor development.



Gross Motor Screening



2y - 2y 11m
Two feet for 5 seconds
With eyes closed



3y - 3y 11m
Tandem feet for 5 seconds
With eyes closed



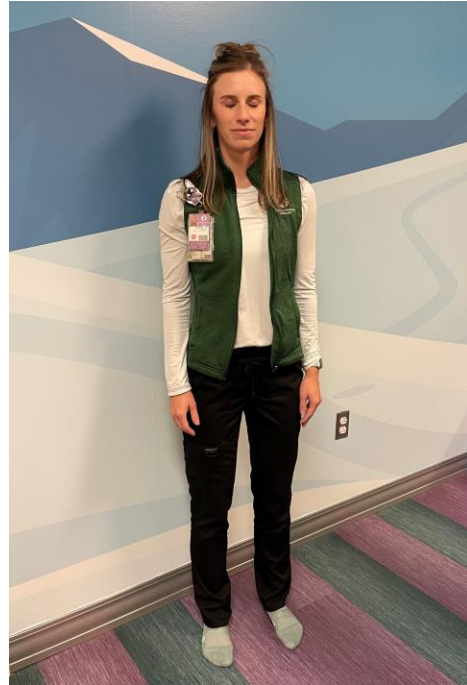
4y - 6y 11m
One foot for 8 seconds
With eyes closed



Modified Clinical Test of Sensory Integration on Balance (mCTSIB)



Floor
Eyes open



Floor
Eyes closed



Pad
Eyes open



Pad
Eyes closed

Grading: No sway, Some sway, Fall





Vestibular Rehabilitation

Physical Therapy Treatment Strategies: patient specific treatment programs that are goal oriented and based on dysfunction, activity and participation restrictions.

- **Habituation**: repeated exposure to dizzy provoking stimulus to help habituate the nervous system
- **Adaptation**: the vestibular system changes to adapt to the neural stimulus (head and/or body movement)
- **Compensation/substitution**: alternative strategies for lost or ineffective system
- **Canal re-positional technique (CRT)**: e.g., Epley maneuver
- **Balance Training**
- **Oculomotor Exercises**



Final Takeaways

- Infants/children with cCMV are at high risk for progressive hearing AND vestibular loss.
- Bilateral vestibular hypofunction can lead to problems with balance, cognition, academics and social skills.
- Vestibular testing can be done on infants, young children or children with developmental delays.
- Vestibular Physical Therapy helps reduce the negative consequences of vestibular hypofunction and helps the child meet academic and recreational goals.
- Developmental and gross motor screens can help identify infants/children with cCMV who are likely to have vestibular problems, and they can begin PT without formal vestibular testing.



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Questions?

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