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Vestibular Rehabilitation Therapy (VRT)

Effectively Treating Vestibular Disorders/Impairments

Ryan Blumer, DPT, CBIS, AIB-VRC

SMALL STEPS. GIANT STRIDES.

1

Focus

The purpose of this presentation is for clinicians to be able to identify and utilize effective treatment strategies to manage a variety of vestibular disorders/impairments from various causes.

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Objectives

- Understanding the difference between Benign Paroxysmal Positional Vertigo (BPPV) and other vestibular disorders to appropriately guide treatment.
- To identify disorders/conditions and impairments that are indicated for participation in VRT (diagnosis-based strategies)
- Applying appropriate treatment strategies for effective management of the vestibular conditions/impairments identified: including habituation, adaptation and substitution.
- Understanding the role of central compensation, cognition, attention and dual-tasks during the treatment/rehabilitation process.
- Setting up an appropriate home exercise program.
- Identifying precautions for VRT and red flags during assessment.
- Understanding how to use transdisciplinary team for effective treatment.

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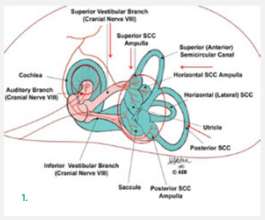
3

Vestibular System 101



Equilibrium and Balance

3 Primary Sensory Inputs:
- Visual (external info)
- Somatosensory (external info)
- Vestibular (internal info)

Two Components of the Inner Ear:
- Vestibular system and cochlea (hearing component)
  - Closely related due to sharing of nerve innervation and fluid mechanisms
  - Disorders of vestibular system may effect hearing

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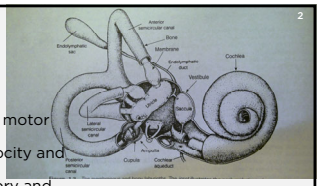
Vestibular System 101 Cont.



Vestibular System:
- Peripheral vestibular system -> CNS -> motor output
- Sends info regarding head angular velocity and linear acceleration
- CNS combines vestibular, somatosensory and visual info to determine head and body orientation

Functions:
- Gravity sensation (linear translation/acceleration): **utricle and saccule**
- Detection of head movement and velocity (angular acceleration: **semicircular canals**
- Hair cells within ampulla (SCCs) and otoliths organs (utricle and saccule) lead to neural firing from head movement

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BPPV vs. Other Vestibular Disorders

Benign Paroxysmal Positional Vertigo (BPPV): #1 cause of vertigo
- Canalithiasis Theory: otoconia (within **utricle** and saccule) → moves into semicircular canal (idiopathic, head trauma, otologic diseases) → person moves their head within plane of canal → otoconia drops to lowest point of canal → endolymph moves and causes cupula to be deflected via suction or pressure → abnormal stimulation of cupula → causes false sensation of movement (vertigo)
- Characteristics of BPPV:
  - BPPV is benign; it is not causing damage like other vestibular disorders
  - BPPV is fatigable
  - Most often can be treated quickly (i.e. 1-2 sessions)

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Vestibular Rehabilitation Therapy (VRT)

Vestibular Rehabilitation Therapy:

"VRT consists of systematic repetitive exercises and protocols that extinguish, or ameliorate patients' motion provoked symptoms, reset the gain or precision of the vestibular ocular reflex (VOR) as well as enhancing postural stability and equilibrium. It allows the brain to see the error signals coming from the impaired labyrinth. The underlying physiological basis for VRT is the plasticity of the central nervous system." [4]

-Richard E Gans, PhD, Founder and CEO of The American Institute of Balance

Goals of VRT[1]:

1. Improve Vestibular Ocular Reflex (VOR)
2. Reduce excess feeling of motion
3. Strengthen the unimpaired systems (vestibular, somatosensory, visual)
4. Decrease dependence on healthy systems to strengthen weakened system

VRT Treatment Principles:

- Adaptation (1)
- Habituation (2)
- Substitution (3 and 4)

*Adding Cognition

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Stabilized and Non-Compensated

Most appropriate persons served for VRT:

- Stabilized:
  - Those who are past the acute phase of their vestibular insult (no longer a debilitating episode)
    - Should not complete higher-level balance or visual exercises if person served is experiencing acute symptoms of vertigo
- Non-compensated:
  - Chronic symptoms/impairments remain from acute episode
    - Symptoms often worsen/triggered by movement of the head and body, changes in position or external movement
  - Non-compensated: "Meaning residual functional impairments are present…The goal of VRT is to address the residual functional impairments left as a result of the acute episode."[1]

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Stabilized and Non-Compensated Cont.

Example:

Person served with Unilateral Vestibular Dysfunction that is non-compensated may have symptoms that include:

- Oscillopsia: blurry vision with head movement
  - indication of VOR impairments and cardinal sign of non-compensation of unilateral vestibulopathy
- Excess feeling of motion/movement when moving head
- Difficulty with external movements (i.e. traffic)
- Spatial disorientation
- Imbalance during daily activities and transitional movements

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Conditions/Disorders Indicated for Participation in VRT

- **Stable and non-compensated vestibular lesion:** "VRT is indicated for any condition characterized by a stable vestibular deficit, in which evaluation reveals no evidence of a progress process and the patient's natural compensation process appears to be incomplete." [3]
- **Unilateral and Bilateral Peripheral Vestibular Disorders/dysfunction**
- **Central lesions or mixed central/peripheral lesions**
- **Head Injury:**
  - Concussion (cortical and/or labyrinthine concussion)
  - Traumatic Brain Injury (TBI)

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Conditions/Disorders Indicated Cont.

- **Psychogenic Vertigo:**
  - Persistent Postural-Perceptual Dizziness (PPPD): consists of visual vertigo, space and motion discomfort, chronic dizziness, phobic postural vertigo. PPPD is an "all encompassing term to describe patient with this myriad of symptoms that are ultimately psychogenic in nature."[1]
  - Space and Motion Discomfort (SMD): sensitivity to stimuli related to vision and motion (i.e. driving car or walking in grocery store)
- **Vertigo of Uncertain Etiology:** "Identifying patients for whom the symptoms are not the direct result of a vestibular lesion does not prevent the use of vestibular rehabilitation as an adjunct treatment"[3]

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Conditions/Disorders Indicated Cont.

- **Dizziness in the Elderly:** dizziness is #1 complaint of older individuals to doctors[1,3]
- **Migraineurs who have developed peripheral vestibular dysfunction:** 44% migraineurs have vestibulopathy[1]
  - higher likelihood that those with migraine develop peripheral vestibular condition, leading to symptoms of dizziness
  - Is it true vestibulopathy or the migraine causing symptoms?
  - "If migraine itself is causing attacks of dizziness, phonophobia, light sensitivity… vestibular therapy will not manage the patient's chronic neurological, genetically inherited condition."[1]
  - If symptoms are not from a true peripheral vestibulopathy, VRT will not fix the migraine; VRT will assist with compensation of the peripheral vestibular dysfunction

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12

Path to Vestibular Rehabilitation Therapy

Referral from Physician with medical diagnosis and medical clearance

↓

Physical Therapy Evaluation conducted (history, clinical examination, etc.)

↓

Physical Therapy Diagnosis Identified: Functional Impairments and Symptoms

↓

Vestibular Rehabilitation Therapy as indicated

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Vestibular Disorders: Physical Therapy Diagnosis

Diagnosis Based Strategies (Diagnosis-Driven Treatment):

"Diagnosis can be defined as 'the art of distinguishing one disease from another.' In medicine, the identification of a particular disease leads to specific medical and/or surgical treatment. A physical therapy (PT) diagnosis differs from a medical diagnosis in that, rather than attempt to identify a particular disease, a constellation of symptoms and signs is identified toward which a physical and occupational therapy will be directed. Once the PT diagnosis is achieved, the vestibular exercise approach can be identified." [2]

- Susan J. Herdman PT, PhD, FAPTA

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Diagnosis Based Strategies:

Table 1: Diagnosis based VRT strategies. 4

SYMPTOM TYPE	CLINICAL FINDING	CONDITION	TREATMENT	TX OUTCOMES
Positional vertigo	Positive m-Hallpike (PC) vertical-rotary nys. Positive lateral body (HC) horizontal nys.	BPPV- PC BPPV- HC *increased prevalence bilateral / multiple canal	CRM - PC protocols CRM - HC protocols	Extinguish subjective vertigo and associated nystagmus Improved clinimetric
Dizziness - worse w / head movement	Vestib / CNS pattern on vestibular sensitive tests e.g. SOT Fukuda	Labyrinthine Concussion Peripheral / Central	Adaptation / Habituation and Substitution w / cognition	Normal / improved function Improved clinimetric
Blurred vision - trouble reading worse with head movement	Degraded dynamic visual acuity (DVA) with active head movement	Oscillopsia Abnormal VOR gain / phase	Adaptation - gaze Stabilization: context specific for direction and velocity	Recovery of VOR DVA improves to non-movement baseline
Imbalance	Abnormal - Balance Assessment tools e.g. DGI, CTSIB etc.	Labyrinthine Concussion Peripheral / central	Substitution, Somatosensory Training	Normal / improved function Improved clinimetric

"These strategies link the underlying physiological changes that occurred due to the disease or insult with the patient's functional symptoms."[4]

- Richard E Gans, PhD

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VRT Treatment Principles:
Adaptation

- Reset or retune Vestibulo-Ocular Reflex (VOR)[1]
  - Normal function: Gain 1:1 (e.g. head moves 5 degrees to right and eyes move 5 degrees to left)
- Completed via repetitive activities (situation or movements) that provoke the person served's symptoms[1]
- Gaze stabilization exercises: assist in resetting the VOR gain for improving gaze stability while head is moving[1]

*Add cognition as able

*Adaptation is accomplished via CNS plasticity

Oscillopsia: blurred vision with head movement. "is the cardinal indicator of non-compensated unilateral vestibulopathy."[1] It is a lack of coordination of the eyes moving with the head.

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16

VRT Treatment Principles:
Adaptation cont.

Adaptation Exercises:

- Saccades
- Visual Tracking
  - Smooth pursuits
- Focusing while turning head
  - VOR 1, VOR 2, VOR cancellation
- Visual Targets
  - Horizontal and vertical head movements
- Circle Sways

Variables to Exercises:

- Speed/frequency, direction/head movement, font size, static/dynamic activity, surface variations, *cognition

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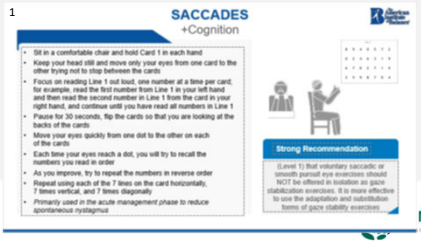
17

VRT Treatment Principles:
Adaptation cont.

Saccades Exercise Example



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18

VRT Treatment Principles:
Adaptation cont.

Smooth Pursuits Exercise Example

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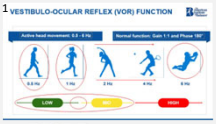
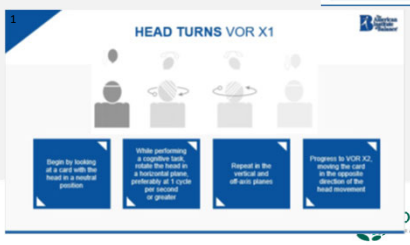
19

VRT Treatment Principles:
Adaptation cont.

VOR Exercise Example





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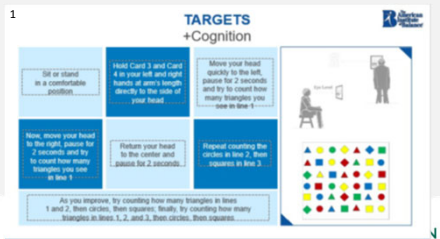
20

VRT Treatment Principles:
Adaptation cont.

Visual Targets Exercise Example



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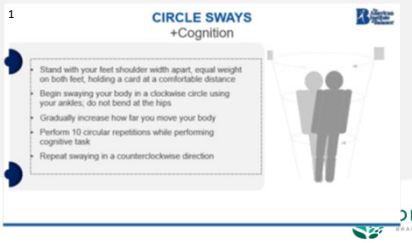
21

VRT Treatment Principles:
Adaptation cont.

Circle Sways Exercise Example



22

VRT Treatment Principles:
Habituation

- Closely related to adaptation
- Repeated exposure to provocative movements, which results in reduced abnormal response to the stimulus[1]
- "Reduce the hallucination of motion or movement as well as extinguishing the sensation of after-motion."[4]
- Assists with visual-vestibular integration, motion sensitivity and vestibular recruitment[1]

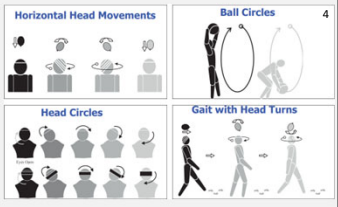
*Speed and direction are very important

*Habituation is accomplished via CNS plasticity

23

VRT Treatment Principles:
Habituation cont.

<u>Habituation Exercises:</u>
- Horizontal Head Movements
- Ball/Body Circles
- Head Circles
- Ball Stabilization
- Ankle Sways and Circle Sways
- Wall Rolls
- Gait with Head Turns

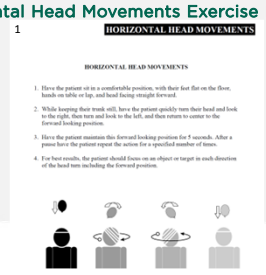


Variables to Exercises:
- Speed, direction, vision/no vision, conflicted vision, surface variations, *cognition

24

VRT Treatment Principles:
Habituation cont.

Horizontal Head Movements Exercise Example



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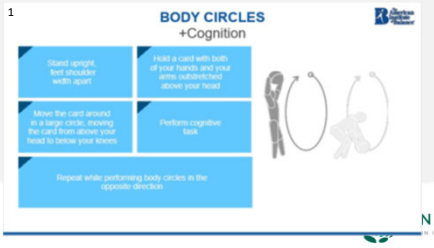
VRT Treatment Principles:
Habituation cont.

Ball/Body Circles Exercise Example



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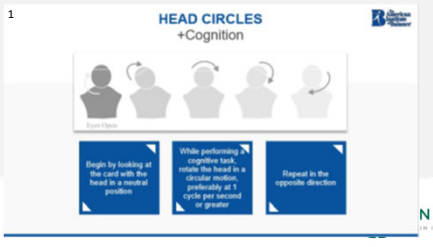
VRT Treatment Principles:
Habituation cont.

Head Circles Exercise Example



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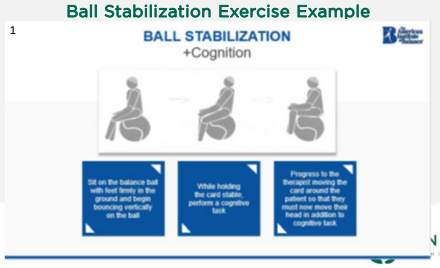
27

VRT Treatment Principles:
Habituation cont.

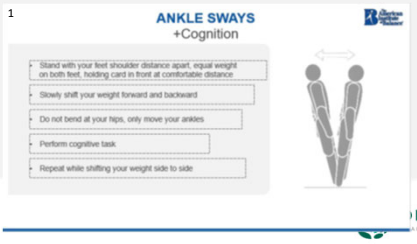
Ball Stabilization Exercise Example



28

VRT Treatment Principles:
Habituation cont.

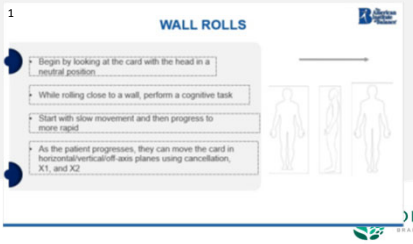
Ankle Sways Exercise Example



29

VRT Treatment Principles:
Habituation cont.

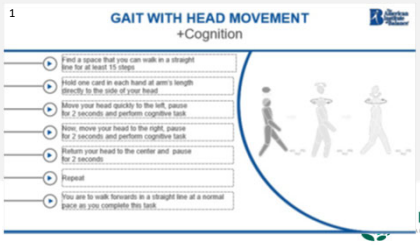
Wall Rolls Exercise Example



30

VRT Treatment Principles:
Habituation cont.

Gait with Head Turns Exercise Example



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31

VRT Treatment Principles:
Substitution

- Decreasing dependence on unimpaired systems by strengthening the weakened systems[1]
  - E.g. forcing the weakened vestibular system to be more dominant by challenging the somatosensory system by standing on foam or trampoline[4]
- Strengthening the remaining systems if a system is missing[1]
  - Most often combined with adaptation and habituation (with cognition) while strengthening the remaining systems

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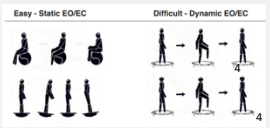
32

VRT Treatment Principles:
Substitution cont.



Substitution Exercises:
- Walking on balance beam
- Ankle and circle sways on different surface conditions (e.g. foam)
- Balance Board + VOR
- Dynamic + VOR
- Trampoline walk with eyes closed
- Ball Toss
- Cross over steps
- Gait with head movement on different surface conditions

Variables to Exercises:
- Eyes open, eyes closed, surface conditions, static/dynamic activity, *cognition

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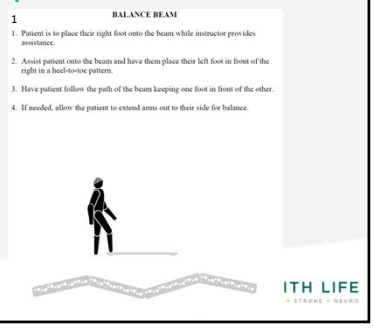
VRT Treatment Principles:
Substitution cont.

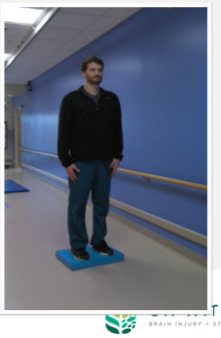
Walking on Balance Beam Exercise Example



34

VRT Treatment Principles:
Substitution cont.

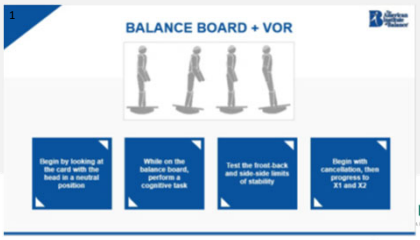
Ankle and Circle Sways on Different Surface Conditions Example



35

VRT Treatment Principles:
Substitution cont.

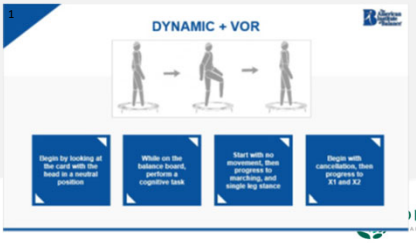
Balance Board + VOR Exercise Example



36

VRT Treatment Principles:
Substitution cont.

Dynamic + VOR Exercise Example



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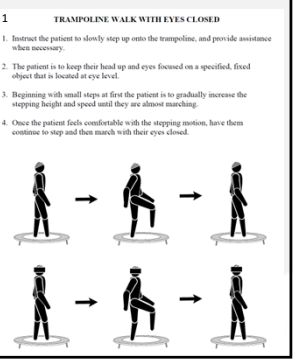
VRT Treatment Principles:
Substitution cont.

Trampoline Walk with Eyes Closed Exercise Example



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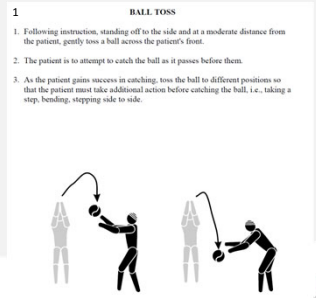
38

VRT Treatment Principles:
Substitution cont.

Ball Toss Exercise Example



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39

VRT Treatment Principles: Substitution cont.

Cross Over Steps Exercise Example

1

CROSS OVER STEP

1. Have the patient stand near a wall with their feet slightly apart.
2. Instruct the patient to cross their right foot in front of the left, hold it there for 5 seconds, and then return the foot to its starting position.
3. Repeat this action with the left foot.
4. Have the patient repeat Steps 2 and 3 repetitively for a specified number of times.

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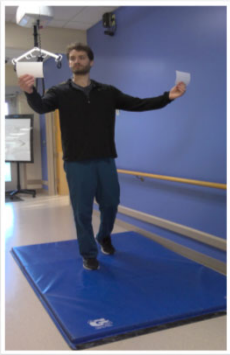
VRT Treatment Principles: Substitution cont.

Gait with Head Movement on Different Surface Conditions Exercise Example



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Role of Central Compensation in VRT

- VRT is “brain therapy”
- Compensation occurs within the cerebellum, brainstem, subcortical regions and some cortical areas
- Functional improvement via VRT is completed via CNS compensation
- Central compensation does not fix the damage caused by a vestibular disease/disorder; Central compensation establishes a “new normal”
- Central compensation “allows the brain to process the difference in a more efficient and acceptable way that does not provoke symptoms”[1]

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42

Role of Cognition, Attention and Dual-Tasks in VRT

- Goal of cognitive tasks during VRT is to create optimal outcomes via:
  - Selective attention
  - Memory
  - Processing speed
- Cerebellum plays a key role in motor coordination and balance, but also activates memory
- Vestibular system incorporates cognition and processing of information
- Cognitive tasks assist with central compensation
- "Attention modulates process in a perceptual-motor task that includes sensory selection, central processing, and response."[1]

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43

Home Exercise Program

Revised Clinical Guidelines from the Academy of Neurologic Physical Therapy for Peripheral Vestibular Hypofunction

Article Title:

Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Updated Clinical Practice Guideline From the Academy of Neurologic Physical Therapy of the American Physical Therapy Association

Published online 2021 Dec 4.

"There is strong evidence that vestibular physical therapy provides a clear and substantial benefit to individuals with unilateral and bilateral vestibular hypofunction."[6]

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44

Home Exercise Program Cont.

Revised Clinical Guidelines from the Academy of Neurologic Physical Therapy for Peripheral Vestibular Hypofunction

Moderate to weak evidence: weekly clinic visits plus home exercise program of gaze stabilization exercises consisting of a minimum of:

"(1) 3 times per day for a total of at least 12 minutes daily for individuals with acute/subacute unilateral vestibular hypofunction; (2) 3 to 5 times per day for a total of at least 20 minutes daily for 4 to 6 weeks for individuals with chronic unilateral vestibular hypofunction; (3) 3 to 5 times per day for a total of 20 to 40 minutes daily for approximately 5 to 7 weeks for individuals with bilateral vestibular hypofunction."[6]

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45

Home Exercise Program Cont.

Revised Clinical Guidelines from the Academy of Neurologic Physical Therapy for Peripheral Vestibular Hypofunction

Moderate evidence for balance exercise: "clinicians may prescribe static and dynamic balance exercises for a minimum of 20 minutes daily for at least 4 to 6 weeks for individuals with chronic unilateral vestibular hypofunction and, based on expert opinion, for a minimum of 6 to 9 weeks for individuals with bilateral vestibular hypofunction." [6]

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46

Home Exercise Program Cont.

Additional Information:

The Academy of Neurologic Physical Therapy states:

"Based on strong evidence and a preponderance of harm over benefit, clinicians should not include voluntary saccadic or smooth-pursuit eye movements in isolation (ie, without head movement) to promote gaze stability."[6]

*More effective to use adaptation and substitution forms of gaze stability exercises

"At-home sessions should be performed by the patient daily for at least 15-30 minutes, and for those who can perform tow or three 15-20 minutes sessions, that would be ideal."[4]

- Richard E Gans, PhD

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47

Red Flags during Vestibular Assessment and Precautions for VRT

Red Flags during Asessment[1]:

- Abnormal fatigue, shortness of breath, slurred speech, unexplained weight loss, syncope or loss of consciousness recently, bowel or bladder difficulty, unexplained weakness in arms or legs, double vision, blurred vision, difficulty swallowing, numbness tingling, poor coordination

Precautions for VRT[1]:

- Comorbidities (other medical conditions)
- Performing VRT without diagnosis
- VRT for symptoms that are non-vestibular
- Appropriate medical triage for non-vestibular person served

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48

Use of Transdisciplinary Team for Effective Management

- **Physician/neurologist:** initial medical diagnosis, therapy referral and for medical clearance
- **Audiologist and/or Otolaryngologist** (ENT): **:** impairments with hearing; close relationship between vestibular and hearing systems; additional vestibular testing
- **Occupational Therapist and/or Neuro Optometrist:** if visual impairments also present
- **Physical Therapist:** for participation in VRT as indicated

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49

References

1.) Gans, R. E., Rutherford, K., Rylander, T., Sakumura, J., Spinks, S. E., & Steinweis, A. (n.d.). *Vestibular Rehabilitation & Concussion Certification*. American Institute of Balance. Retrieved March 20, 2023.

2.) Herdman, Susan J. *Vestibular Rehabilitation, Third Edition*. F.A. Davis, 2007.

3.) Han, Byung In, et al, "Vestibular Rehabilitation Therapy: Review of Indications, Mechanisms, and Key Exercises." *Journal of Clinical Neurology*, vol. 7, no. 4, 2011, p. 184., https://doi.org/10.3988/jcn.2011.7.4.184.

4.) Gans, Richard E. "Vestibular Rehabilitation Therapy: Diagnosis Based Strategies." *ENT and Audiology News*, vol. 24, no. 5, 18 Nov. 2015, pp. 77–79., https://dizzy.com/wp-content/uploads/ENT-Audiology-News-_Gans-Rehabilitation.pdf. Accessed 21 Mar. 2023.

5.) Gans, Richard E., and Kimberly Rutherford. "ENT and Audiology News." *A Multidisciplinary Approach to the Management of the Adult Balance - Dizzy Patient* , vol. 29, no. 2, 2020, pp. 2–4., https://www.entandaudiologynews.com/features/audiology-features/post/a-multidisciplinary-approach-to-the-management-of-the-adult-balance-dizzy-patient. Accessed 21 Mar. 2023.

6.) Hall CD, Herdman SJ, Whitney SL, Anson ER, Carender WJ, Hoppes CW, Cass SP, Christy JB, Cohen HS, Fife TD, Furman JM, Shepard NT, Clendaniel RA, Dishman JD, Goebel JA, Meldrum D, Ryan C, Wallace RL, Woodward NJ. Vestibular Rehabilitation for Peripheral Vestibular Hypofunction: An Updated Clinical Practice Guideline From the Academy of Neurologic Physical Therapy of the American Physical Therapy Association. J Neurol Phys Ther. 2022 Apr 1;46(2):118-177. doi: 10.1097/NPT.0000000000000382. PMID: 34864777; PMCID: PMC8920012.

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50

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51