

Chapter 2

VESTIBULAR ASSESSMENT AND INTERVENTION

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REFERENCES

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INTRODUCTION

Vestibular deficits that arise in conjunction with concussion/mild traumatic brain injury (c/mTBI) can have complex etiologies; thus, treatment is individualized and specific to the cause. Initial assessment to characterize history, postural control, and basic vestibular functions will help determine possible etiology and direct intervention. Physical and occupational therapists who have not previously seen vestibular patients may need education in the techniques and assessments beyond what is described here and in Appendix A of the toolkit¹; however, certain basic assessment and intervention principles are appropriate for initial consideration.

Several references are provided to guide problem solving to determine possible causes of vestibular dysfunction. Figure 2-1 and Table 2-1² provide an initial point of reference for considering an injury sustained in a combat or military context, where c/mTBI consideration is also an important focus of assessment. For those with clear vestibular complaints, clinicians should refer to Figure 16-1 in Herdman's *Vestibular Rehabilitation, Third Edition*,^{3(p230)} to determine possible causes of the complaint. Of the possible causes Herdman outlines, benign paroxysmal positional vertigo (BPPV) and unilateral vestibular hypofunction or loss (UVH/L) may occur in the military c/mTBI population and are appropriate for the generalist clinician to evaluate and treat.^{2,4}

If the complaint is consistent with episodes of vertigo (a sense of spinning), an algorithm for assessing BPPV may help determine the injury location and best treatment options. An additional important resource for information on treating BPPV is the Clinical Practice Guideline: Benign Paroxysmal Positional Vertigo.⁴

Although not represented in Herdman's^{3(p230)} flow diagram, reports of other vestibular complaints have been described in military populations,

including exercise-induced and blast-induced dizziness (unsteadiness) with or without vertigo.^{5,6}

For assessing and treating complex etiologies such as perilymphatic fistula, bilateral vestibular hypofunction or loss, Ménière disease, or other dizziness complaints, service members should be referred to an ear, nose, and throat specialist; otolaryngologist; or neurologist for further evaluation and for treatment by therapists with specialized vestibular training.

This assessment section is intended to help a generalist therapist determine the possible cause of a vestibular complaint. The full components of a vestibular clinical examination, including the history and specialized vestibular tests, are beyond the scope of this toolkit. The reader is referred to Herdman³ for full information and is encouraged to seek consultation from therapists with specialized vestibular training.

The intervention section of this toolkit provides information on canalith repositioning maneuvers (CRMs) for BPPV of the posterior canal and of the horizontal (lateral) canal.⁴ Vestibular rehabilitation program elements included in the toolkit focus on adapting vestibular ocular reflex (VOR) mechanisms and improving gaze stability, improving postural control, and performing exercises that encourage habituation of symptoms associated with vestibular impairment. These principles may be applied to individuals with residual complaints after treatment for BPPV, UVH/L, as well as to individuals with migraine-associated dizziness (MAD).

This section of the toolkit provides assessments and interventions that are considered **practice standards** for BPPV and UVH/L based on the level of evidence available at this time. The vestibular rehabilitation protocols as described for UVH/L and MAD are considered **practice options**. Evidence for these practice recommendations is derived primarily from studies of the civilian population.

VESTIBULAR ASSESSMENT

Taking a history is the initial step in assessing a patient who complains of dizziness; the next step is a systems evaluation. Common mechanisms of vestibular injury in the warfighter often differ from those that cause civilian vestibular injury. Following a combat situation where a blast event occurs, initial assessment focuses on evaluation for alteration in consciousness consistent with a brain injury, and ensuring no red flags are present that

indicate the need for emergent care to manage a life-threatening condition. If signs and symptoms are more consistent with blast-induced dizziness, refer to the recommended physical therapy clinical evaluation found in Scherer and Schubert (see Figure 2-1).²

A number of clinical and laboratory tests are beneficial to further define possible vestibular pathology (see Table 2-1).² Although laboratory tests

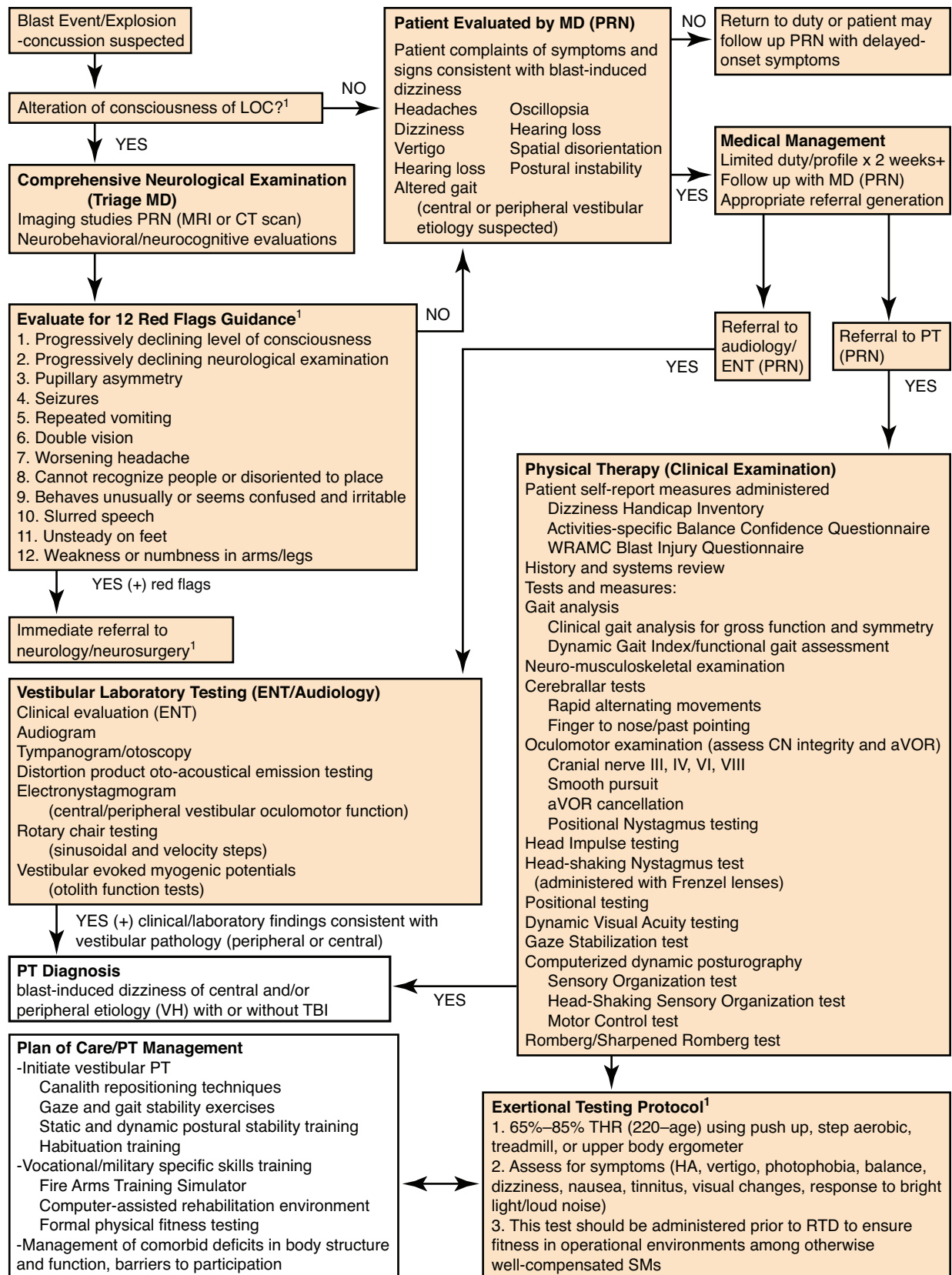


Figure 2-1. Traumatic brain injury and vestibular pathology after blast exposure.

Figure 2-1 caption continues

aVOR: angular vestibulo-ocular reflex
 CT: computed tomography
 HA: headache
 MD: medical doctor
 PRN: as needed/indicated by provider
 RTD: return to duty
 TBI: traumatic brain injury
 VH: vestibular hypofunction

CN: cranial nerve
 ENT: ear, nose, and throat (otolaryngology MD)
 LOC: loss of consciousness
 MRI: magnetic resonance imaging
 PT: physical therapy
 SM: service member
 THR: target heart rate
 WRAMC: Walter Reed Army Medical Center

1. Wrisley D, Marchetti G, Kuharsky D, Whitney S. Reliability, internal consistency, and validity of data obtained with the Functional Gait Assessment. *Phys Ther.* 2004;84:906–918.

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TABLE 2-1

CLINICAL AND LABORATORY TESTS FOR VESTIBULAR PATHOLOGY IN SUBJECTS EXPOSED TO BLASTS

Tests	Structures, Pathways, or Process Assessed	Applications	Abnormal Findings	Interpretation
Head impulse test ¹ (clinical)	Horizontal semicircular canals, superior branch of vestibular nerve	High-acceleration, moderate-velocity, low-amplitude head rotation with subject maintaining gaze on fixed target	Corrective saccade to target after head rotation	Abnormal angular vestibulo-ocular reflex (aVOR) attributable to peripheral vestibular hypofunction
Electronystagmography ² (laboratory)	Extraocular muscles, horizontal semicircular canals, superior branch of vestibular nerve, vestibular and oculomotor pathways within central nervous system	Exposure to aural and visual stimulation (eg, calorics, moving targets)	Abnormal nystagmus, abnormal eye movements	Abnormal 8th cranial nerve, abnormal smooth pursuit or saccades attributable to pathology within peripheral or central vestibular pathways, oculomotor pathways, or both
Rotary chair test ² (laboratory)	Horizontal semicircular canals, superior branch of vestibular nerve	Sinusoidal rotation at frequencies of 0.01–0.64 Hz; clockwise and counterclockwise rotation at 60°/s and 240°/s	Abnormal nystagmus, abnormal eye movements	Abnormal aVOR gain or phase attributable to pathology within peripheral or central vestibular or oculomotor pathways
Positional test ^{2,3} (clinical or laboratory)	Semicircular canals involved canal	Movement into gravity-dependent position	Patient-reported complaints of vertigo and pathologic nystagmus	Abnormal presence of otoconia in semicircular canal (ie, benign paroxysmal positional vertigo)

Table 2-1 continues

(Table 2-1 continued)

Tests	Structures, Pathways, or Process Assessed	Applications	Abnormal Findings	Interpretation
Dynamic visual acuity Test ^{2,4} (clinical)	Horizontal semicircular canals, vestibular nerve	Active or passive head movement while visualizing optotype direction	Inability to identify target during head movement	Abnormal aVOR attributable to peripheral vestibular hypofunction; uncompensated aVOR
Computerized dynamic posturography, ⁵ sensory organization test (SOT), motor control test (MCT) (clinical or laboratory)	Integration of multi-sensory input for balance	Challenge of balance with equipment and software under different conditions	SOT: inappropriate responses to inaccurate sensory inputs; MCT: delayed motor responses to unpredictable perturbations	SOT: age- and height-referenced responses to sway in sagittal plane; MCT: balance dysfunction and impaired reactive latencies
Balance Manager Dynamic InVision System*, ⁶ gaze stability, perception time, target acquisition, target tracking (clinical)	Horizontal semicircular canals, vestibular nerve, vestibular and oculomotor pathways	Head movement while visualizing letters; tracking of moving targets	Abnormal oculometric features compared with those of subjects who were healthy and matched for age	Behavioral measure suggesting cerebellar dysfunction; damage to central oculomotor pathways, vestibular pathways, or both

aVOR: angular vestibulo-ocular reflex

SOT: sensory organization test

MCT: motor control test

*The Balance Manager Dynamic InVision System (NeuroCom International Inc, Clackamas, OR) provides oculomotor and vestibular testing not available in other NeuroCom systems. Novel assessments include perception time, target acquisition, and target tracking. Gaze stability testing is provided in commercially available models such as the SMART Equi-Test System (NeuroCom International Inc). Visual testing typically is performed in a darkened room with a viewing distance of 390 cm (13 ft). Perception time is measured by calculating the time (in milliseconds) that a randomly presented target must be on the screen before accurate recognition by a subject. Target acquisition is the time (in milliseconds) required to make a saccade from the center of the screen to the new optotype position. Target tracking is the speed (in degrees per second) at which a subject can accurately track a symbol. Gaze stabilization is the speed (in degrees per second) at which a subject can move his or her head and accurately hold a target in view.

1. Halmagyi GM, Curthoys IS. A clinical sign of canal paresis. *Arch Neurol*. 1988;45:737-739. 2. Fife T, Tusa R, Furman J, et al. Assessment: vestibular testing techniques in adults and children—report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. *Neurology*. 2000;55:1431-1441. 3. Roberts R, Gans R. Background, technique, interpretation, and usefulness of positional/position testing. In: Jacobsen J, Shepherd N, eds. *Balance Function Assessment and Management*. San Diego, CA: Plural Publishing; 2008: 171-196. 4. Herdman SJ, Tusa RJ, Blatt PJ, et al. Computerized dynamic visual acuity test in the assessment of vestibular deficits. *Am J Otol*. 1998;19:790-796. 5. Shepard N, Janky K. Interpretation and usefulness of computerized dynamic posturography. In: Jacobsen J, Shepherd N, eds. *Balance Function Assessment and Management*. San Diego, CA: Plural Publishing; 2008: 359-378. 6. Gottshall, K. Vestibular-visual-cognitive interaction tests in patients with blast trauma. In: *Association for Research in Otolaryngology Midwinter Meeting*; February 14-19, 2009; Baltimore, MD. Abstract 180.

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(eg, electronystagmography, rotary chair, computerized dynamic posturography, Balance Manager InVision system [NeuroCom, Clackamas, OR]) would not be initiated or interpreted by a generalist therapist, awareness of these tests is beneficial.

Other clinical tests are described in this section that are appropriate for a generalist to administer.

According to Herdman,³ specific information is obtained on the temporal quality (onset and duration) and nature of the person's complaints

to clarify whether the complaint is vertigo (an illusion of movement, typically a sense of spinning) or disequilibrium (sense of being off balance; see Herdman, Figure 16-1).^{3(p230)} Some individuals with vestibular dysfunction experience symptoms only during particular head movements.

Individuals in combat situations may sustain c/mTBI with vestibular deficits as a result of blunt injury or blast exposure. Positional vertigo is associated with trauma in the civilian population, but has also been described following blast injury in a mili-

tary population.⁵ Hoffer et al⁶ have described MAD in association with blunt trauma, with symptoms including migraine headache, episodic vertigo, and balance disorder (although the headache and vertigo need not be simultaneous). Injury sustained in a blast incident has been associated with various patterns of symptoms, including positional vertigo, exercise-induced dizziness, and blast-induced dizziness with or without episodes of vertigo.^{5,7,8}

Basic clinical examinations are similar for all vestibular complaints. A thorough history is the initial

TABLE 2-2

TRAUMATIC BRAIN INJURY AND VESTIBULAR PATHOLOGY AFTER BLAST EXPOSURE*

Position	Nystagmus Elicited	Does Nystagmus Last < 60 Seconds?	Possible Diagnosis	Recommendation
Left Dix-Hallpike Test	Upbeating, leftward torsional	Yes	Left posterior canalolithiasis	Left posterior canal CRT
		No	Left posterior cupulolithiasis	Referral to vestibular specialist
	Downbeating, rightward/leftward torsional	Yes	Right/left anterior canalolithiasis	Anterior canal CRT initiate maneuver toward torsional direction/nystagmus
		No	Right/left anterior cupulolithiasis	Referral to vestibular specialist
Right Dix-Hallpike Test	Upbeating, rightward torsional	Yes	Right posterior canalolithiasis	Right posterior canal CRT
		No	Right posterior canal cupulolithiasis	Referral to vestibular specialist
	Downbeating, rightward/leftward torsional	Yes	Right/left anterior canalolithiasis	Anterior canal CRT initiate maneuver toward torsional direction
		No	Right/left anterior cupulolithiasis	Referral to vestibular specialist
Right/Left Roll Test	Geotropic [†]	Yes	Horizontal canalolithiasis	Horizontal canal CRT initiate maneuver toward side with most intense nystagmus
	Ageotropic [‡]	No	Horizontal cupulolithiasis	Referral to vestibular specialist

CRT: canalith repositioning therapy

*This is a guide for testing clients who have a history of episodic vertigo that is of short duration (< 1 min) indicating benign paroxysmal positional vertigo as a diagnosis. These recommendations are for general practice therapists with basic knowledge of vestibular interventions.

[†]“Geotropic” means nystagmus that beats toward the ground. Typically the affected ear is tested down toward the mat. This is nystagmus with the slow phase beating toward the ground (toward the mat table if affected ear is down) and fast correction away from the ground.

[‡]“Ageotropic” nystagmus beats away from the ground or “towards the sky.”

component of any vestibular examination. A history of episodic vertigo of short duration suggests the need for positional testing for BPPV (Table 2-2). Tests of the VOR (eg, dynamic visual acuity, head impulse testing, and head-shaking nystagmus [HSN]) and postural control (See Chapter 3: Balance and Functional Abilities Assessment and Intervention) clarify the extent of impairment and possible targets for intervention. Testing for body and position changes that may provoke symptoms (Motion Sensitivity Quotient [MSQ] Test, exertional testing; see Chapter 10: Fitness Assessment and Intervention) may be necessary to determine baseline symp-

tom intensity. Assessing self-perception of disability (Dizziness Handicap Inventory [DHI] or Vestibular Activities of Daily Activity Scale) from vestibular complaints allows for understanding of the impact of these deficits on quality-of-life issues. Videos of a number of the vestibular tests can be found in the Geriatric Examination Toolkit from the University of Missouri (web.missouri.edu/~proste/tool/vest/index.htm) and on the webpage of the Vestibular Special Interest Group of the Neurology Section of the American Physical Therapy Association (www.neuropt.org/special-interest-groups/vestibular-rehabilitation/resources).

DIX-HALLPIKE MANEUVER

Purpose/Description

The Dix-Hallpike maneuver is a diagnostic, clinical provocation test that attempts to reproduce positional vertigo with associated nystagmus. A positive test is indicative of posterior canal BPPV.^{3,4} The maneuver is used as part of a vestibular examination for imbalance, dizziness, and vertigo. It is indicated in clients who have a history of repeated episodes of vertigo with changes in head position relative to gravity.⁹ Typically the side with the suspected involved canal is tested first and, if found positive, the patient may be directly treated with CRM. This combination of assessment and treatment is often done to avoid repeated provocation of patients who have significant symptoms.

Administration Protocol/Equipment/Time

Administration time is less than 5 minutes. Interpretation is enhanced by Frenzel lenses or infrared goggles.

Factors that may affect diagnostic accuracy of the Dix-Hallpike maneuver include the speed of movements during the test, time of day, and the angle of the plane of the occiput during the maneuver.¹⁰ Because fixation on a visual target can suppress nystagmus, patients undergoing Dix-Hallpike testing may benefit from having their vision blocked.

Groups Tested With This Measure

Groups tested with this measure include those that present with characteristics of BPPV, such as brief, episodic, positional vertigo that is acquired spontaneously or may follow head trauma, labyrinthitis, or ischemia of the anterior vestibular artery.¹¹

Interpretability

The Dix-Hallpike maneuver is considered the gold standard in diagnosing posterior canal BPPV.⁴ Posterior canal BPPV is diagnosed when the client has a history of positional vertigo and, upon completion of the Dix-Hallpike maneuver, develops a provoked vertigo with a mixed torsional and vertical nystagmus. The vertigo and nystagmus begin within 5 to 20 seconds of the completion of the Dix-Hallpike maneuver and last less than 60 seconds.⁴

Sensitivity

- 50%–88% in a review article on the diagnostic evaluation of dizziness¹²
- 82% in patients with posterior canal BPPV primarily tested by specialty clinicians¹³
- 79% in a critically appraised topic review (95% confidence interval: 65%–94%)¹⁴

Specificity

- 71% in patients with posterior canal BPPV primarily tested by specialty clinicians¹³
- 75% in a critically appraised review¹⁴

Procedure

Use the following steps to test for suspected posterior canal BPPV (Figure 2-2):

- Help the patient into an initial position of long sitting on a mat so when the patient is moved into a supine position, only the trunk and shoulders are supported by the mat and the patient's head is supported by the examiner's hands over the edge of the mat.



Figure 2-2. Administration of the Dix-Hallpike maneuver. **(a)** For the right Dix-Hallpike, move the client's head to 45 degrees or rotation to the right side. **(b)** Quickly move the client into a supine position, maintaining 45 degrees of rotation, to where the patient's head is hanging in 20 degrees of extension and is supported by the examiner.

- Quickly move the client into a supine position, maintaining 45 degrees of rotation, to where the patient's head is hanging in 20 degrees of extension and is supported by the examiner.
 - Hold this position for 1 minute. Observe the patient's eyes for a mixed torsional and vertical jerk nystagmus; the vertigo and nystagmus will begin within 5 to 20 seconds of movement into the test position and will last less than 60 seconds.
 - Return the patient to the original long sit position.
 - For the left Dix-Hallpike maneuver, the client's head is placed into 45 degrees of rotation to the left. Then follow the sequence above.
- For the right Dix-Hallpike, move the client's head to 45 degrees of rotation to the right side.

The direction of the nystagmus indicates the posterior versus anterior canal (see Table 2-2 and refer to the Herdman text).^{2(p252)}

RECORD OF FINDINGS FOR DIX-HALLPIKE MANEUVER

Dix-Hallpike (circle): Right: positive/negative Left: positive/negative

Description of observed nystagmus:

Onset (sec): _____

Duration (sec): _____

Description of observed nystagmus: _____

Selected References

- Dix R, Hallpike CS. The pathology, symptomatology and diagnosis of certain common disorders of the vestibular system. *Ann Otol Rhinol Laryngol*. 1952;6:987–1016.
- Bhattacharyya N, Baugh RF, Orvidas L, et al. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngol Head Neck Surg*. 2008;139:S47–S81.

ROLL TEST**Purpose/Description**

The roll test is a diagnostic, clinical provocation test that attempts to reproduce positional vertigo associated with nystagmus. A positive test is indicative of horizontal (lateral) canal BPPV.^{4,15,16} The roll test is used as part of a vestibular examination for imbalance, dizziness, and vertigo. It is indicated if the patient has a history compatible with BPPV and the Dix-Hallpike maneuver gives negative results. Typically, the side with the suspected involved canal is tested first and, if found positive, the patient may be directly treated with the roll maneuver (also called the Lempert maneuver or barbecue roll maneuver). This combination of assessment and treatment is often done to avoid repeated provocation of patients who have significant symptoms.

Administration Protocol/Equipment/Time

Administration time is less than 5 minutes, and interpretation is enhanced by Frenzel lenses or infrared goggles. Patients undergoing the roll test may benefit from having their vision blocked with lenses or goggles because fixation on a visual target can suppress nystagmus.

Groups Tested With This Measure

Those that present with characteristics of BPPV, including brief, episodic, positional vertigo that is acquired spontaneously or may follow head trauma, labyrinthitis, or ischemia of the ante-

rior vestibular artery should be tested using this method.^{3,4,11,16}

Interpretability

Horizontal (lateral) canal BPPV is diagnosed when the client has a history of positional vertigo and, upon completion of the roll test, develops a provoked vertigo that is geotropic (canalithiasis).³ The vertigo and nystagmus tend to begin within 5 to 20 seconds after completion of the roll test and last less than 60 seconds.^{4,16} The side involved is considered the side with the most intense nystagmus. A positive supine roll test is the most frequently used test for diagnosing horizontal (lateral) canal BPPV.⁴ If nystagmus persists for greater than 60 seconds, this may be indicative of a more severe form of BPPV (cupulolithiasis or central origin) and the client should be referred to a vestibular specialist (see Table 2-2).

Sensitivity

Not determined

Specificity

Not determined

Procedure

To perform the roll test for suspected horizontal (lateral) canal BPPV (Figure 2-3):

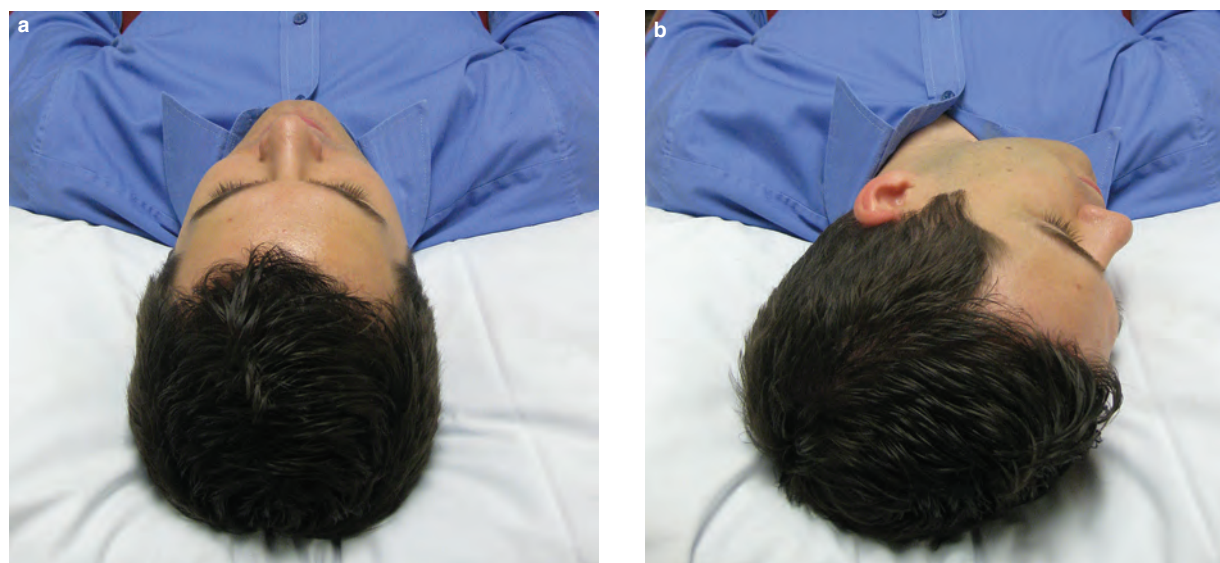


Figure 2-3. Administration of roll test. **(a)** Position the client supine with his or her head at 20 degrees flexion, supported by a pillow or by the therapist. **(b)** Quickly rotate the patient's head toward the right side 90 degrees and hold for 1 minute, or if the patient's orthopaedic limitations warrant, the entire trunk and head can be rolled (it is the head position in space that is important for this maneuver).

- Position the client supine with his or her head at 20 degrees flexion, supported by a pillow or by the therapist.
- Quickly rotate the patient's head toward the right side 90 degrees and hold for 1 minute, or if the patient's orthopaedic limitations warrant, the entire trunk and head can be rolled (it is the head position in space that is important for this maneuver).
- Observe the patient's eyes for geotropic (beats toward downward ear) or ageotropic (beats toward upper ear) nystagmus.

The vertigo and nystagmus will begin within 5 to 20 seconds of movement into the test position and last less than 60 seconds.

- When nystagmus subsides (or if no nystagmus is elicited), return the patient's head to a neutral rotation or "face-up" position.
- For the left roll test, the client's head is rapidly rotated 90 degrees to the left. The above sequence is then followed (see Table 2-2 and the Herdman text).^{3(p252)}

RECORD OF FINDINGS FOR ROLL TEST

Roll Test (circle): **Right:** positive/negative **Left:** positive/negative

Description of observed nystagmus: _____

Onset (seconds): _____

Duration (seconds): _____

Direction of nystagmus (circle): geotropic (bottom ear)
ageotropic (upper ear)

Selected References

Bhattacharyya N, Baugh RF, Orvidas L, et al. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngol Head Neck Surg.* 2008;139:S47–S81.

Fife TD. Recognition and management of horizontal canal benign positional vertigo. *Am J Otol.* 1998;19:345–351.

DYNAMIC VISUAL ACUITY TEST (CLINICAL)

Purpose/Description

The clinical Dynamic Visual Acuity Test is a procedural test that measures eye gaze stabilization with active head movement. It is a performance measure of the VOR^{17,18} that can be used in patients with suspected vestibular hypofunction as part of a vestibular examination for imbalance, dizziness, vertigo, and oscillopsia (blurred vision with head movement).^{16,19}

Administration Protocol/Equipment/Time

Administration takes less than 5 minutes and requires a Snellen eye chart or clinical equivalent, such as the Early Treatment Diabetic Retinopathy Study chart.

Groups Tested With This Measure

Those suspected of having UVH/L should be tested with this measure, including patients with vestibular neuronitis, Ménière disease, vestibular schwannoma, vascular lesions affecting the vestibular nerve, or TBI.^{19,20}

Interpretability

A two-line difference is considered normal; greater than two-line difference is a positive sign for oscillopsia.^{18,21}

Sensitivity

- < 50% of 115 clients with dizziness (for UVH, bilateral vestibular hypofunction, and dizziness)²²

Specificity

- 100% in clients with dizziness²²

Procedure

Perform the Dynamic Visual Acuity test (Figure 2-4) following these steps:

- The patient may be seated or standing. If the patient uses prescription glasses, the glasses should be worn during testing.
- Test static visual acuity by having the patient read the lowest line on a standard



Figure 2-4. Administration of the Dynamic Visual Acuity Test.

Snellen (or clinical equivalent) eye chart, keeping his or her head still. The lowest line readable is the line in which three or fewer errors are made. Record this line and identify the number of errors.

- Test dynamic visual acuity by having the patient read the lowest line possible on a standard Snellen (or clinical equivalent) eye chart while tilting the patient's head 30

degrees forward (to orient the horizontal canals with the horizontal plane) and passively oscillating the head horizontally at 2 Hz. The lowest line readable is the line in which three or fewer errors are made. Record this line and identify the number of errors.

- Note the difference between the lines read in the static and dynamic tests.

RECORD OF FINDINGS FOR DYNAMIC VISUAL ACUITY TEST (CLINICAL)

Lowest readable line (static): _____ Errors: _____
 Lowest readable line (2 Hz passive movement): _____ Errors: _____
 Line change between static and dynamic condition: _____

Selected References

Barber HO. Vestibular neurophysiology. *Otolaryngol Head Neck Surg.* Feb 1984;92(1):55–58.

Burgio DL, Blakley RW, Myers SF. The high-frequency oscillopsia test. *J Vestib Res.* 1992;2:221–226.

Schubert MC, Minor LB. Vestibulo-ocular physiology underlying vestibular hypofunction. *Phys Ther.* Apr 2004;84(4):373–385.

HEAD IMPULSE TEST (HEAD THRUST TEST)

Purpose/Description

The head impulse test is a clinical test that assesses the integrity of the VOR.²³ It may be used in a patient with suspected vestibular hypofunction as part of a vestibular examination for imbalance, dizziness, vertigo, and oscillopsia.^{16,24}

Administration Protocol/Equipment/Time

Administration takes less than 1 minute and no special equipment is required. The sensitivity of the head impulse test appears to be improved when the patient's head is pitched 30 degrees downward and the thrust is done with an unpredictable timing and direction.²⁴

Groups Tested With This Measure

Those suspected of having UVH/L, including patients with vestibular neuronitis, Ménière disease, vestibular schwannoma, vascular lesions affecting the vestibular nerve, or TBI may benefit from this test.^{20,24}

Interpretability

The head impulse test is considered positive when, after a small, high-speed movement of the head, a refixation saccade is noted.^{23,25} A client with vestibular hypofunction may use a refixation saccade after the head is moved toward the side of the hypofunction. With bilateral hypofunction, a refixation saccade may be seen with both the right and left tests. Individuals with normal vestibular function do not use corrective saccades after the head impulse test; their eyes stay fixed on the target (eg, examiner's nose). The head impulse test is only positive in vestibular loss or hypofunction, not in cerebellar stroke or migraine, so it may be useful in a differential diagnosis.

Sensitivity (35%–71%; enhanced when following specific protocol)

- 45% in 265 patients evaluated for symptoms of vertigo²⁶
- 35% in 105 patients who presented for evaluation of dizziness²⁷



Figure 2-5. Administration of the head impulse test. **(a)** With the patient in a sitting position, passively tilt the patient's head forward 30 degrees to orient the horizontal semicircular canals parallel to the horizontal plane. Instruct the patient to look at a target (eg, the examiner's nose). **(b)** Passively and slowly move the patient's head in right and left rotation (approximately 20-degree to 30-degree arc of motion) to assess that the patient is relaxed. **(c)** Quickly (3,000 degrees to 4,000 degrees/sec) move the patient's head from neutral rotation to 5 degrees–10 degrees of rotation in one direction and stop.

- 71% for identifying vestibular hypofunction in persons with UVH (176 persons with and without vestibular dysfunction)²⁴

Specificity (82%–95%)

- 91% in 265 patients evaluated for symptoms of vertigo²⁶
- 95% in 105 patients who presented for evaluation of dizziness²⁸
- 82% for UVH or BVH, 176 persons with and without vestibular dysfunction²⁹

Procedure

Perform the head impulse test following these steps (Figure 2-5):

- With the patient in a sitting position, passively tilt the patient's head forward 30 degrees to orient the horizontal semi-circular canals parallel to the horizontal plane.

- Instruct the patient to look at a target (eg, the examiner's nose). Passively and slowly move the patient's head in right and left rotation (approximately 20-degree to 30-degree arc of motion) to assess that the patient is relaxed.
- Quickly (3,000 degrees to 4,000 degrees/sec/sec) move the patient's head from neutral rotation to 5 degrees–10 degrees of rotation in one direction and stop.
- Observe the patient's eyes for a corrective saccade. The corrective saccade is a rapid eye motion that returns the eyes toward the target (eg, examiner's nose) and indicates a decreased gain of the VOR.
- Complete this test three times in each direction (if corrective saccade is noted in at least two of three thrusts, result is positive).

Note that ensuring the head is pitched 30 degrees down and the thrust is performed with an unpredictable timing and direction appears to improve the sensitivity of the head impulse test.³⁰

HEAD IMPULSE TEST RECORD OF FINDINGS

Circle findings:

Right impulse: Trial 1: ____ Trial 2: ____ Trial 3: ____ positive/negative

Left impulse: Trial 1: ____ Trial 2: ____ Trial 3: ____ positive/negative

HEAD-SHAKING NYSTAGMUS TEST

Purpose/Description

The HSN test is a clinical test that assesses for dynamic asymmetry in the vestibular system.³ It is used in patients with suspected vestibular hypofunction and is a simple screening evaluation for peripheral vestibular system disease. It is used as part of a vestibular examination for imbalance, dizziness, vertigo, and oscillopsia.^{16,19,31}

Administration Protocol/Equipment/Time

Administration takes less than 1 minute. Interpretation is enhanced by use of Frenzel lenses or infrared goggles. Therapists must screen for spontaneous nystagmus prior to testing for HSN. Patients undergoing HSN testing must have their vision blocked with lenses or goggles because fixation on a visual target can suppress nystagmus.

Groups Tested With This Measure

HSN is used to test those suspected of having UVH/L. These may be individuals with vestibular neuronitis, Ménière disease, vestibular schwannoma, vascular lesions affecting the vestibular nerve, or TBI.^{19,20}

Interpretability

When head movements stop, nystagmus that beats toward the more active (intact) side or away from the side of a unilateral peripheral vestibular lesion indicates a positive response. Three consecutive beats of nystagmus is considered a positive response. This test indicates an imbalance between the right and left sides; it does not define the source of imbalance. Those with symmetric peripheral vestibular input will *not* have HSN.



Figure 2-6. Administration of the head-shaking nystagmus test. **(a)** Once the patient is seated with eyes closed, have the patient tilt his or her head forward 30 degrees. **(b)** Rotate or shake the patient's head back and forth 20 times in 10 seconds (2 Hz) in approximately 45 degrees of rotation to either side. **(c)** Stop the movement and ask the patient to open his or her eyes and look straight ahead.

Sensitivity (Range 27%–66%)

- 66% for detecting greater than 20% canal paresis in 132 patients referred for full otologic and neuro-otologic examination with complaints of dizziness and balance problems³²
- 38% in 196 patients with peripheral vestibular dysfunction³³
- 27% in 116 consecutive dizzy patients seen for balance function testing³⁴
- 31% in 53 patients with unilateral peripheral hypofunction³⁵
- 35% in 105 outpatients who presented for evaluation of dizziness (ages 13–87 years)²⁷

Specificity (Range 77%–96%)

- 77% for detecting greater than 20% canal paresis, 132 patients referred for full otologic and neuro-otologic examination with complaints of dizziness and balance problems³²
- 79% in 196 patients with peripheral vestibular dysfunction³³
- 85% in 116 consecutive dizzy patients seen for balance function testing³⁶
- 92% in 105 outpatients who presented for evaluation of dizziness (ages 13–87 years)²⁷

- 96% in 53 patients with unilateral peripheral hypofunction³⁵

Procedure

Perform the test as follows (Figure 2-6):

- Once the patient is seated with eyes closed, have the patient tilt his or her head forward 30 degrees.
- Rotate or shake the patient's head back and forth 20 times in 10 seconds (2 Hz) in approximately 45 degrees of rotation to either side.
- Stop the movement and ask the patient to open his or her eyes and look straight ahead. Observe for nystagmus.
- When the head movements stop, nystagmus that beats toward the more active side or away from the side of a unilateral peripheral vestibular lesion indicates a positive response. Three consecutive beats of nystagmus is considered a positive response.

This test can also be completed with infrared goggles or Frenzel lenses. Signs of central etiology include prolonged nystagmus, vertical nystagmus, and dysconjugate nystagmus.³⁷

HORIZONTAL HEAD-SHAKING INDUCED NYSTAGMUS RECORD OF FINDINGS

Circle findings:

Positive/Negative

Horizontal nystagmus: right-beating/left-beating

Selected References

- Angeli SI, Velandia S, Snapp H. Head-shaking nystagmus predicts greater disability in unilateral peripheral vestibulopathy. *Am J Otolaryngol*. Nov 2011;32(6):522–527.
- Jacobson GP, Newman CW, Safadi I. Sensitivity and specificity of the head-shaking test for detecting vestibular system abnormalities. *Ann Otol Rhinol Laryngol*. Jul 1990;99(7 Pt 1):539–542.
- Goebel JA, Garcia P. Prevalence of post-headshake nystagmus in patients with caloric deficits and vertigo. *Otolaryngol Head Neck Surg*. 1992;106:121–127.
- Schubert MC, Minor LB. Vestibulo-ocular physiology underlying vestibular hypofunction. *Phys Ther*. Apr 2004;84(4):373–385.

DIZZINESS HANDICAP INVENTORY

Purpose/Description

The DHI is a 25-item questionnaire—with a total possible score of 100—designed to measure self-perception of disability from vestibular system dysfunction (Exhibit 2-1).^{36,38,39} The emotional scale (9 items) is 36 points, the functional scale (9 items) is 36 points, and the physical scale (7 items) is 28 points. Each question provides a choice of three responses: yes (4 points), sometimes (2 points), or no (0 points).

The DHI is the standard disease-specific tool used to assess health status and quality of life in individuals with vestibular disorders.⁴⁰ It is recommended for use at the initial evaluation and at follow-up after an episode of care for service members with vestibular complaints.

Administration Protocol/Equipment/Time

The DHI may be administered via a paper-and-pencil self-test or computerized answer self-test; each takes about 5 minutes to administer and 5 minutes to score.

Groups Tested With This Measure

The DHI is used to assess the effects of vestibular rehabilitation for dizziness of various origins.⁴⁰⁻⁴² Military populations tested with this measure included those with dizziness after brain injury⁴³ and exercise-induced dizziness.^{8,44}

Interpretability

- Norms: a score of “0” indicated no handicap. The higher the point total (either total score

or a subscale) a patient scores, the greater the perceived disability due to dizziness.

- Minimal detectable change (MDC): ± 9.32 (standard error of the mean for 95% confidence interval) for persons in a vestibular rehabilitation program.⁴⁰ The standard error would be 6.23 between pre- and posttreatment scores, indicating the scores would have to differ by at least 18 points (95% confidence interval) for a true change.³⁶ If the patient's score is less than the MDC value, it was considered indistinguishable from measurement error.

The DHI was found to be more responsive to change than the SF-36 questionnaire in patients with vestibular disorders. Guyatt's responsiveness statistic (mean change divided by the standard deviation of change in subjects who remained unchanged) was 1.66 for total DHI, 1.89 for functional subscale, 0.75 for physical subscale, and 1.14 for emotional subscale.⁴⁰

Reliability Estimates

- Internal consistency: high internal consistency reliability (Chronbach's $\alpha = 0.78-0.89$)³⁶
- Interrater: not applicable
- Intrarater: not applicable
- Test-Retest: 14 subjects (age range 26–71 years) were administered DHI face to face within a few days of each other. The total scores were as follows: $r = .97$, degrees of freedom = 12, $P < .001$, functional subscale ($r = .94$), emotional ($r = .97$), and physical ($r = .92$). These scores reflect excellent

EXHIBIT 2-1

DIZZINESS HANDICAP INVENTORY RESOURCES

This instrument can be obtained from the original publication:

Jacobson GP, Newman CW. The development of the dizziness handicap inventory. *Arch Otolaryngol Head Neck Surg*. 1990;116:424–427.

It can also be found in the Geriatric Examination Toolkit from the University of Missouri at: web.missouri.edu/~proste/tool/vest/index.htm, or from the Southampton Hospitals website, at: www.southamptonhospitals.org/Resources/10355/FileRepository/Forms/Dizziness%20Hanicap%20Inventory%20-%20English.pdf.

test-retest reliability, with internal consistency (Chronbach's alpha) for DHI at .89 for total score (.85 functional subscale, .72 emotional subscale, .78 physical subscale).³⁶ Twenty subjects (age range 36–78 years) with vestibular disorders who took DHI twice, 24 to 48 hours apart, showed excellent retest reliability with intraclass correlation coefficient (ICC) (2,1) = .94.⁴⁰

Validity

- Content/Face: established with an initial 37 questions developed empirically from case history reports of patients with dizziness and was reduced to 25 items by removing items that showed low-corrected item-total correlations or because of similarity in content to included items.³⁶
- Criterion: in a group of 367 adults seen consecutively for balance function evaluations (mean age 48.8 years; standard deviation 14.5 years) the DHI correlated with a patient's ability to remain upright as quantified by platform posturography ($r = 0.40\text{--}0.58$).⁴⁵

- Construct: 106 consecutive patients categorized as occasionally, frequently, or continuously experiencing dizziness had significantly different total DHI scores. The patient's age had no significant effect on self-perceived handicap as indicated by the total DHI score.³⁶ High correlations coefficients were found between total DHI score and the eight dimensions of the SF-36 questionnaire in ENT outpatients.⁴⁶ The construct validity of the sections of the DHI have not been fully studied.⁴⁷

In a group of 15 patients with symptoms of exercise-induced motion intolerance (nausea, disequilibrium, and "dizziness") brought on by exercise involving head motion, such as sit-ups, push-ups, running, or swimming, an individualized exercise program was administered to provoke and allow habituation to symptoms of motion intolerance. Mean time of return to duty was 4.6 weeks. Statistically significant improvement in DHI scores were noted, with a decrease of 17.3 points after treatment, coincident with significant improvements in the Activities-specific Balance Confidence Scale, Dynamic Gait Index, and computerized dynamic posturography.⁸

Selected References

- Enloe LJ, Shields RK. Evaluation of health-related quality of life in individuals with vestibular disease using disease-specific and general outcome measures. *Phys Ther*. Sep 1997;77(9):890–903.
- Gottshall KR, Moore RJ, Hoffer ME, et al. Exercise induced motion intolerance: role in operational environments. Paper presented at: Spatial Disorientation in Military Vehicles: Causes, Consequences and Cures; April 15–17, 2002; La Coruña, Spain.
- Gottshall KR, Drake A, Gray N, McDonald E, Hoffer ME. Objective vestibular tests as outcome measures in head injury patients. *Laryngoscope*. 2003;113(10):1746–1750.
- Jacobson GP, Newman CW, Hunter L, Balzer GK. Balance function test correlates of the Dizziness Handicap Inventory. *J Am Acad Audiol*. Oct 1991;2(4):253–260.

MOTION SENSITIVITY QUOTIENT TEST

Purpose/Description

The MSQ Test is a clinical technique to measure motion-provoked dizziness using a series of 16 quick changes to head or body position (Exhibit 2-2).⁴⁸ The severity and duration of the dizziness are recorded in each position and a cumulative score is calculated. The test was developed by Shepard and Telian⁴⁹ to establish individualized exercise programs for patients with chronic UVH. The 16 head and body movements in the MSQ protocol

described by Smith-Wheelock and colleagues⁴⁹ include:

1. sitting to supine,
2. supine to left side,
3. supine to right side,
4. supine to sitting,
5. left Dix-Hallpike (sitting to supine, head hanging to the left),
6. head up from left Dix-Hallpike,
7. right Dix-Hallpike (sitting to supine, head

EXHIBIT 2-2**MOTION SENSITIVITY QUOTIENT TEST RESOURCES**

This instrument can be obtained from the original publication:

Smith-Wheelock M, Shepard NT, Telian SA. Physical therapy program for vestibular rehabilitation. *Am J Otol*. 1991;12(3):218–225. Figure 1.

It can also be found in the Geriatric Examination Toolkit from the University of Missouri at: web.missouri.edu/~proste/tool/vest/index.htm.

- hanging to the right),
- 8. head up from right Dix-Hallpike,
- 9. sitting with head tipped to left knee,
- 10. head up from left knee,
- 11. sitting with head tipped to right knee,
- 12. head up from right knee,
- 13. head turns while sitting,
- 14. sitting head tilts,
- 15. 180 degrees turn to right while standing, and
- 16. 180 degrees turn to left while standing.

Scoring is based on symptom intensity via patient verbal report (0–5 scale) and symptom duration on a 0 to 3 scale (0–4 sec = 0; 5–10 sec = 1 point; 11–30 sec = 2 points; > 30 sec = 3 points). Symptom improvement on the MSQ Test is indicated by decreased number of provoking positions, increased number of repetitions before symptom onset, decreased intensity of symptoms, and shorter duration of symptoms.

Administration Protocol/Equipment/Time

The MSQ requires a mat table and chair. Administration time is less than 10 to 15 minutes, depending on the patient's tolerance and need for rest.

Groups Tested With This Measure

The MSQ was used in one study for those with motion-provoked dizziness (ages 43–86) and normal controls (ages 37–79)⁴⁸ to predict older driver safety in an on-road driving assessment,⁵⁰ and for those undergoing vestibular rehabilitation.⁴⁹

Interpretability

- Norms:
 - 0%: normal
 - 0–10%: mild motion sensitivity

- 11%–30%: moderate motion sensitivity
- 31%–100%: severe motion sensitivity³²
- Sensitivity: 100%⁴⁶
- Specificity: 80% for patients with motion sensitivity⁴⁶
- MDC: 8.5% (test-retest ICC = .98, SD 25.9).⁴⁶ If the patient's score is less than the MDC value, it is considered to be indistinguishable from measurement error.
- Responsiveness estimates: not available
- Reliability estimates:
 - Internal consistency: not available
 - Interrater: 15 subjects with motion provoked dizziness (ages 43–86 years), two examiners, ICC = 0.99⁴⁶
 - Intrarater: not available
 - Test-Retest: 15 subjects with motion provoked dizziness (ages 43–86 years) and 10 control subjects (ages 37–79 years) were tested at baseline and 24 hours later (8 subjects were also tested 90 minutes after baseline). ICC at 90 minutes = 0.98, ICC at 24 hours = 0.96⁴⁶
- Validity estimates:
 - Content/Face: not available
 - Criterion: not available
 - Construct: 100% of community-dwelling individuals from regional senior citizen centers who complained of motion-provoked dizziness during routine movements associated with daily living reported symptoms on the MSQ Test. Only 2 of 10 (test specificity of 80%) of community-dwelling individuals from regional senior citizen centers without complaints of motion-provoked dizziness during routine movements associated with daily living reported dizziness in either right or left up from Dix-Hallpike.⁴⁶

Selected References

Smith-Wheelock M, Shepard NT, Telian SA. Physical therapy program for vestibular rehabilitation. *Am J Otol*. May 1991;12(3):218–225.

Akin FW, Davenport MJ. Validity and reliability of the Motion Sensitivity Test. *J Rehab Res Dev*. Sep–Oct 2003;40(5):415–421.

VESTIBULAR DISORDERS ACTIVITIES OF DAILY LIVING SCALE

Purpose/Description

The Vestibular Disorders Activities of Daily Living (VADL) Scale is a 28-item questionnaire developed to assess self-perceived disablement and quality of life in patients with vestibular impairment.⁵¹ The functional, or basic, self-maintenance subscale includes 12 items; the ambulatory, or mobility, skills subscale has 9 items; and the instrumental subscale (more socially complex tasks outside the home) includes 7 items (Exhibit 2-3). This self-administered checklist uses a 10-point qualitative scale, but also includes a “not applicable” option if a subject wants to refrain from answering a question or if a question does not apply.^{50(p883)} Scale ratings range from 1 (independent) to 10 (not participating in the activity). The VADL Scale, which includes tasks like driving a car and using an elevator, may be more responsive to higher levels of impairment and therefore more useful for higher functioning individuals. It has been suggested that the VADL Scale is also more responsive to lesser levels of independence, given the 10-point scale in comparison to the 3-point scale on the DHI.⁵¹

Administration Protocol/Equipment/Time

The test consists of a paper-and-pencil self-test or a computerized answer self-test, each of which takes about 5 to 10 minutes to administer and 5 minutes to score.

Groups Tested With This Measure

The VADL is used to assess the effects of rehabilitation on chronic vestibular impairment for dizziness of peripheral origin.^{52,53} This questionnaire has been used to assess service members with

acute (within 72 hours), subacute (4–30 days), and chronic (> 30 days) vestibular complaints following blast exposure.^{5,51}

Interpretability

- Norms: healthy subjects were independent (scale rating of “1”) on the items on the VADL.⁴⁸

Scale ratings range from 1 (independent) to 10 (too difficult to perform, not participating in the activity).

- MDC: not available. If the patient’s score is less than the MDC value, it is considered indistinguishable from measurement error.
- Responsiveness estimates: not available
- Reliability estimates:
 - Internal consistency: alpha = 0.97 (total score), $r = 0.92$ – 0.97 (dimensions).⁴⁸
 - Interrater: not available
 - Test-Retest: tested over a 2-hour time period; $rc = 1$ (concordance coefficient), $rc = 0.87$ – 0.97 (dimensions).⁴⁸
- Validity estimates:
 - Content / Face: face validity established by a group of experts from a list of items taken from existing scales of self-perceived disablement in patients with vestibular impairment.⁴⁸
- Criterion: moderately correlates with the Dizziness Handicap Inventory, Spearman’s $\rho = 0.66$.⁴⁸
- Construct: differentiates healthy adults from patients with BPPV or chronic vestibulopathy.⁴⁸

Selected References

Cohen HS, Kimball KT. Development of the vestibular disorders activities of daily living scale. *Arch Otolaryngol Head Neck Surg*. Jul 2000;126(7):881–887.

Cohen HS, Kimball KT. Increased independence and decreased vertigo after vestibular rehabilitation. *Otolaryngol Head Neck Surg*. Jan 2003;128(1):60–70.

EXHIBIT 2-3**RESOURCES FOR THE VESTIBULAR DISORDERS ACTIVITIES OF DAILY LIVING SCALE**

This instrument can be obtained from the original publication:

Cohen HS, Kimball KT. Development of the Vestibular Disorders of Daily Living Scale. *Arch Otolaryngol Head Neck Surg.* 2000;126:881–887.

It can also be found on a number of external websites through internet search engines.

VESTIBULAR INTERVENTION

Intervention strategies must be tailored to the symptom profile of the patient with vestibular dysfunction. Interventions designed to address positional vertigo are very specific, with particular maneuvers based on the semicircular canal that is involved. The use of repositioning maneuvers is often effective for positional vertigo symptoms. The CRM is used to treat BPPV of the posterior semicircular canal (posterior canal canalithiasis) with an 83% to 93% rate of remission of reported BPPV.^{4,54,55} The roll maneuver (barbecue roll) is used to move canaliths from the horizontal (lateral) canal into the vestibule to treat horizontal (lateral) canal BPPV. The effectiveness of this maneuver is approximately 75%, according to summary information provided in the *Clinical Practice Guideline on BPPV*.⁴

Home instructions for precautions following the CRM and instruction in Brandt-Daroff habituation exercises for milder residual complaints of dizziness or vertigo have been suggested.³ Herdman also suggests instructing patients in the appropriate CRM so they may repeat the maneuver on their own, as long as they are experiencing vertigo during treatment.³ It has been suggested that posttraumatic BPPV is different from the idiopathic form. Gordon et al reported that 67% of patients with traumatic BPPV required repeated treatment before complete symptom resolution, compared to 14% of patients with idiopathic BPPV. This group also reported that posttraumatic patients had significantly more frequent recurrences.⁵⁶

Intervention for UVH includes exercises designed to facilitate central nervous system compensation or adaptation rather than alter underlying vestibular disease. Service members can learn to compensate for UVH with appropriate vestibular rehabilitation and gaze stability exercises.⁵⁷ Exercise-based interventions can be applied to patients with a range of vestibular issues and are categorized in three main areas: 1) gaze stabilization exercises that address VOR

functions and gaze stability as a means to facilitate adaptation and improvement of vestibular function; 2) motion-sensitivity exercises for individuals who have increased complaints associated with conditions of visual conflict or increased optic flow, or associated with exercise-induced dizziness to structure practice for habituation to provoking stimuli; and 3) postural stability exercises to improve balance and postural control (see also Chapter 3: Balance and Functional Abilities Assessment and Intervention).

The characteristics of vestibular dysfunction as a result of combat exposure have been described by Gottshall and Hoffer.⁵⁷ In addition to possible positional vertigo, symptoms could include exertional (or exercise-induced) dizziness, blast-induced disequilibrium, and blast-induced disequilibrium with vertigo. Components of a comprehensive exercise program for service members in this context include the following:

- exercises that target vestibulo-ocular and cervico-ocular reflexes;
- activities that challenge somatosensory and depth perception by manipulating head motion, visual, and surface conditions;
- integrating challenges to dynamic gait; and
- graded aerobic exercise (see Chapter 10: Fitness Assessment and Intervention).

MAD has been described in a military population and is characterized by episodic vertigo with periods of unsteadiness, headaches, and abnormalities in VOR testing.⁶ The use of medication and control of dietary triggers is helpful in controlling MAD.⁵⁸ Vestibular rehabilitation has also been effective for MAD,^{58,59} especially when combined with an anti-migraine medication and physical therapy intervention.^{60,61} Rehabilitation strategies are similar to those for UVH/L and include habituation exercises, balance retraining, and daily aerobic exercises.

CANALITH REPOSITIONING MANEUVERS

Background

Individuals with BPPV frequently report positional dizziness, disrupted vision, nausea, imbalance and general motion intolerance, and falls. Typically, positional vertigo occurs with activities of daily living (rolling in bed, looking up, tying shoes), with the dizziness impacting the person's postural stability and interrupting daily activities.^{62,63} The characteristics that distinguish vertigo of BPPV are a history of episodic vertigo of short duration (< 60 seconds) that has a brief delay (seconds) in onset when a person moves into a provoking position and is fatigable.³

Strength of Recommendation: Practice Standard

Posterior semicircular canal CRM (also called Epley maneuver) is the gold standard for treatment of posterior semicircular canal BPPV.^{3,4,64} Standard treatment for horizontal (lateral) semicircular canal BPPV is the horizontal CRM (barbecue roll).³

Intervention

- See specific instruction sheets for CRM for the posterior or for the horizontal (lateral) canal.
- A firm surface, such as a treatment table or mat table, is needed, and Frenzel lenses or infrared goggles are helpful.
- The treatment takes about 5 to 10 minutes to administer.
- Following appropriate CRM, residual postural control impairments and fitness limitations are addressed as indicated for the individual patient.

Once the CRM procedures are completed, patients should:

- try to remain upright for the rest of the day (patients can be taught to complete the CRM at home),
- be reassessed in 1 month or less after the initial treatment to confirm symptom resolution, and
- be referred to a vestibular specialist for further assessment if initial treatment is unsuccessful.

CANALITH REPOSITIONING MANEUVER FOR POSTERIOR CANAL BENIGN PAROXYSMAL POSITIONAL VERTIGO (EPLER MANEUVER)

Treatment for posterior canal BPPV canalithiasis (ie, otoconia is free-floating) is via the CRM.^{3,4} The affected ear is identified as the side that causes dizziness with rolling and turning and results in a positive Dix-Hallpike test. Perform the following steps for right-sided posterior semicircular canal BPPV (Figure 2-7):

- Place the patient in a long sitting position with his or her head turned 45 degrees toward the affected (eg, right) ear (see Figure 2-7a).
- Quickly move the patient to the supine supported position, with the patient's head in 45 degrees right rotation and 20 degrees extension over the edge of the bed or table. Maintain this position until the dizziness stops, plus an additional 20 seconds (see Figure 2-7b).
- Continue to support the patient's head and turn it 45 degrees in the opposite (eg, left) rotation, maintaining 20 degrees of extension over the edge of the mat or table. Hold this position until the dizziness stops, plus an additional 20 seconds (see Figure 2-7c).

- Continue to support the patient's head and turn it so the 45 degrees rotation (eg, left) is maintained and the client is rolled onto the same-side shoulder (eg, left). The head should be turned 45 degrees down toward the floor. Hold this position until the dizziness stops, plus an additional 20 seconds (see Figure 2-7d).
- Slowly bring the patient to the upright sitting position, head still rotated 45 degrees to the opposite side (eg, left; see Figure 2-7e).

Patients should be informed that:

- they should keep their eyes open during the treatment;
- they may experience vertigo during the treatment;
- they must remain in the treatment positions until the vertigo has stopped;
- if they absolutely cannot remain in the treatment position, the therapist will help them slowly return to a sitting position; and
- the therapist will not let them fall.



Figure 2-7. Administration of the canalith repositioning maneuver for posterior canal benign paroxysmal positional vertigo. **(a)** Place the patient in a long sitting position with his or her head turned 45 degrees toward the affected (eg, right) ear. **(b)** Quickly move the patient to the supine supported position, with the patient's head in 45 degrees right rotation and 20 degrees extension over the edge of the bed or table. Maintain this position until the dizziness stops, plus an additional 20 seconds. **(c)** Continue to support the patient's head and turn it 45 degrees in the opposite (eg, left) rotation, maintaining 20 degrees of extension over the edge of the mat or table. Hold this position until the dizziness stops, plus an additional 20 seconds. **(d)** Continue to support the patient's head and turn it so the 45 degrees rotation (eg, left) is maintained and the client is rolled onto the same-side shoulder (eg, left). The head should be turned 45 degrees down toward the floor. Hold this position until the dizziness stops, plus an additional 20 seconds. **(e)** Slowly bring the patient to the upright sitting position, head still rotated 45 degrees to the opposite side (eg, left).

Selected References

Bhattacharyya N, Baugh RF, Orvidas L, et al. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngol Head Neck Surg*. 2008;139:S47–S81.

Hilton MP, Pinder DK. The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo. *Cochrane Database Syst Rev*. 2004;2:CD003162.

CANALITH REPOSITIONING MANEUVER FOR HORIZONTAL (LATERAL) CANAL BENIGN PAROXYSMAL POSITIONAL VERTIGO (BARBECUE ROLL MANEUVER)

The barbecue roll maneuver is the most commonly used maneuver for horizontal (lateral) canalithiasis (ie, otoconia is free-floating).^{3,4} The affected ear is identified as the side that causes more nystagmus and vertigo during the roll test (Figure 2-8). Perform the following steps:

- Lie supine on the examination table or bed with the affected ear down (see Figure 2-8a).
- Slowly roll your head away from the affected ear to the face-up position; maintain this position until dizziness stops plus an additional 20 seconds (see Figure 2-8b).
- Continue to roll the head in the same direction until the affected ear is pointed up; maintain this position until dizziness stops plus an additional 20 seconds (see Figure 2-8c).
- Roll your head and body in the same direction until your face is down and remain in this position until dizziness stops plus an additional 20 seconds. You may support your forehead with your hands. If the treatment has been effective, your vertigo should be resolved (see Figure 2-8d).
- Continue to roll in the same direction (completing a 360 degrees roll) until returning to the supine position with your head turned to the initial position (see Figure 2-8e).

Selected References

Bhattacharyya N, Baugh RF, Orvidas L, et al. Clinical practice guideline: benign paroxysmal positional vertigo. *Otolaryngol Head Neck Surg*. 2008;139:S47–S81.

Hilton MP, Pinder DK. The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo. *Cochrane Database Syst Rev*. 2004;2:CD003162.

REHABILITATION FOR UNILATERAL VESTIBULAR HYPOFUNCTION OR LOSS

Background

Unilateral peripheral vestibular dysfunction can occur postoperatively or as a result of disease or trauma. Clients with UVH/L frequently report problems with visual acuity (blurring) during head movement (oscillopsia) and reduced postural stability⁶⁵ that affects ambulation⁶⁶ and the ability to participate in activities of daily living. Visual acuity complaints can be particularly devastating for a service member in a deployed setting. Interventions follow a problem-based approach and are driven by the specific impairments identified during the physical therapy examination as well as by the client's goals. Intervention for this disorder includes exercises designed to facilitate central nervous system compensation by adaptation, substitution, or habituation.^{3,67}

Strength of Recommendation: Practice Standard

In a Cochrane review, Hillier and Holohan⁵⁷ found moderate to strong evidence that vestibular rehabilitation is a safe, effective management for unilateral peripheral vestibular dysfunction.

Intervention

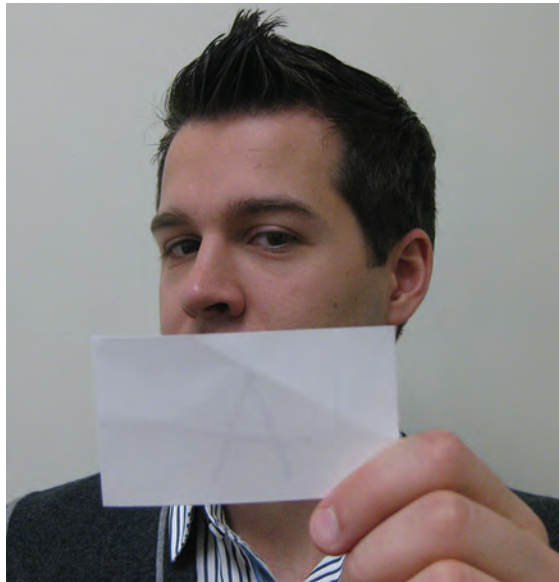
Acute: Individuals with acute UVH/L typically have prolonged continuous vertigo even at rest, severe nausea and vomiting, and spontaneous nystagmus (beating away from the affected [lesioned] side) seen in room light during the first several days to a week following the onset or causative incident.²¹ A person may have bilateral vestibular hypofunction with one side more involved than the other and will exhibit similar symptoms. Treatment considerations:



Figure 2-8. Administration of the canalith repositioning maneuver for horizontal canal benign paroxysmal positional vertigo. **(a)** Lie supine on the examination table or bed with the affected ear down. **(b)** Slowly roll your head away from the affected ear to the face-up position; maintain this position until dizziness stops plus an additional 20 seconds. **(c)** Continue to roll the head in the same direction until the affected ear is pointed up; maintain this position until dizziness stops plus an additional 20 seconds. **(d)** Roll your head and body in the same direction until your face is down and remain in this position until dizziness stops plus an additional 20 seconds. You may support your forehead with your hands. If the treatment has been effective, your vertigo should be resolved. **(e)** Continue to roll in the same direction (completing a 360 degrees roll) until returning to the supine position with your head turned to the initial position.

EXHIBIT 2-4

GAZE STABILITY: X1 VIEWING EXERCISES



- Start out looking straight ahead at a stationary target (eg, a letter, number, or word written on an index card) held in your hand or placed on a wall 12 to 18 inches from your face.
- Move your head back and forth (45° in either direction) while trying to keep the target in focus.
- Slowly increase the speed of your head turns as you are able, always keeping the target in focus. Your symptoms will likely return with this exercise.
- Practice for up to 60 seconds, then rest.
- Complete these X-1 exercises in a horizontal direction, 4 to 5 times per day in each direction.
- Advance to the following background: _____.

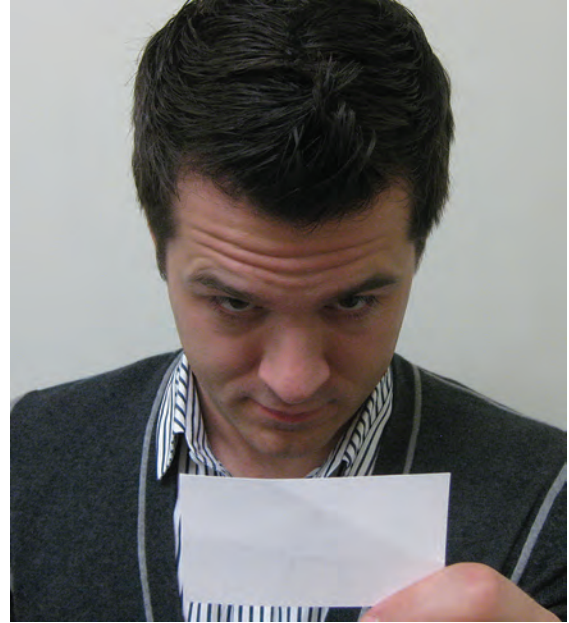
- Antiemetics and vestibular suppressants may be useful acutely but should be withdrawn as soon as possible (preferably after the first several days).
- Prolonged use of vestibular suppressants may impede the process of central vestibular compensation.⁶⁸
- Early resumption of normal activity should be encouraged to promote compensation.
- Patient education regarding diagnosis, prognosis, and the process and rationale for vestibular rehabilitation is important throughout treatment.
- There is some evidence that a supervised vestibular rehabilitation program in combination with vestibular suppressants may be more beneficial than vestibular suppressants alone in addressing vestibular ataxia.^{69,70}

Chronic: For individuals with chronic UVH/L, interventions address chronic dizziness and disequilibrium, the dynamic aspects of gaze stability, and postural control.^{3,21} Goals of treatment include:

- improvement in the ability to see clearly during head movements,
- improvement in balance and ambulation during functional tasks,
- decreased sensitivity to head movements,
- improvement in general conditioning and fitness, and
- a return to normal occupational and social roles and participation.^{3,21,71}

Treatment Considerations:

- continued rapid tapering and discontinuation of vestibular suppressant medication^{72,73};

EXHIBIT 2-5**GAZE STABILITY: X1 VIEWING EXERCISES PERFORMED IN A VERTICAL ORIENTATION**

- Start out looking straight ahead at stationary target (eg, a letter, number, or word written on an index card) held in your hand or placed on a wall 12 to 18 inches from your face.
- Move your head up and down (45 degrees in either direction) while trying to keep the target in focus.
- Slowly increase the speed of your head movement upward and downward as you are able, keeping the target in focus. Your symptoms will likely return with this exercise.
- Practice for up to 60 seconds, then rest.
- Complete the exercise in a vertical direction, 4 to 5 times per day in each direction.
- Advance to the following background: _____.

- continued patient education regarding diagnosis, prognosis, and the process and rationale for vestibular rehabilitation throughout the treatment episode; and
- initiation of vestibular exercises.^{3,57,74,75}

Oscillopsia is addressed through visual-vestibular exercises such as the VOR X1, VOR X2, imaginary targets, and gaze shifting, eye-head movement exercises (see Exhibits 2-4–2-8).^{18,71,74,75}

These exercises are performed with a visual target (beginning large, with progression to smaller targets), with the head moving either horizontally or vertically. Exercises need to include near and far targets, with particular focus on near targets.⁷⁶ The three main goals of gaze exercises are to “1) improve visual acuity during head movements, 2) improve visual-vestibular interactions during head move-

ments, and 3) decrease the individual’s sensitivity to head movements.”^{77(p501)}

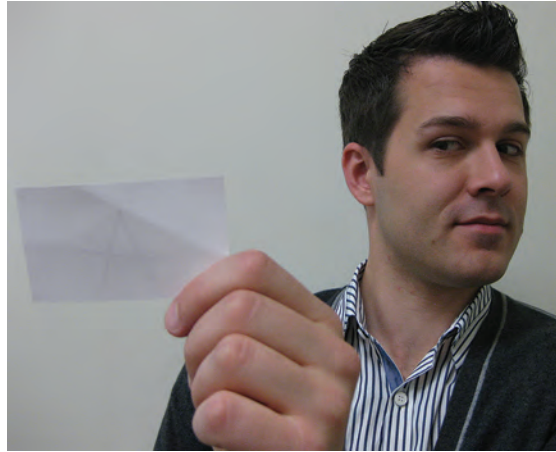
Viewing exercises should advance through more difficult postures; for example, progressing from sitting, to standing, to standing on foam or other compliant surfaces, to standing on a trampoline, to bouncing on trampoline, and so on. Gait tasks can be advanced using level surfaces, inclines, varying speeds, jogging and treadmill activities.

Viewing exercises should also advance through progressively busier environments. Patients should exercise in a quiet area initially, then progress to busier and louder environments. Distracting backgrounds, including horizontal lines and checkboard patterns,⁷⁸ can be used to change visual target complexity.

Viewing exercises should advance in number of repetitions, time, frequency, and speed. Work

EXHIBIT 2-6

GAZE STABILITY EXERCISES: X2 VIEWING EXERCISES



In this activity you will view a target that moves in the opposite direction from your head. This is a difficult activity to coordinate and will require practice.

- Start out by turning your head 45 degrees to the right and positioning the target 45 degrees from midline to the left.
- View the target. The target could be a letter, number, or word on an index card and should be held in your hand about 12 to 18 inches from your face.
- Then move your head to the left and the card to the right, while trying to keep the target in focus.
- Once your head is 45 degrees to the left and the target is 45 degrees to the right, reverse the directions and return to the original position.
- Repeat, slowly increasing the speed of your head turns with the goal of keeping the target in focus. It is expected that you will get a return of your symptoms with this exercise.
- Practice for 60 seconds, then rest.
- Complete in horizontal and vertical directions.
- Try to do these X2 exercises 4 to 5 times per day in each direction.
- Advance to the following background: _____

EXHIBIT 2-7

GAZE STABILITY: HEAD-EYE MOVEMENT BETWEEN TWO TARGETS*

- Place two targets in front of you about an arm's length away and slightly wider than shoulder width apart. The first target should be positioned so that when you look at one target, you can see the other target in your peripheral vision without difficulty.
- Begin with your head and eyes turned to directly face the target on the right.
- Shift your eye gaze to the target on the left and immediately follow your gaze with a head turn toward the target on the left. Repeat going toward the right (eye gaze followed by a head turn), and continue back and forth between the targets.
- Vary the speed of your head movement, making sure to keep the target in focus. Attempt to perform this gaze exercise as quickly as possible.
- Practice for 60 seconds and increase the time, as tolerated, up to 5 minutes.
- This exercise can also be performed with targets placed vertically (one target above the other).

*These exercises are most often used for individuals with bilateral vestibular hypofunction. They may be used at the therapist's discretion for those with unilateral vestibular hypofunction or loss.

EXHIBIT 2-8**GAZE STABILITY: HEAD-EYE MOVEMENT BETWEEN TWO TARGETS (GAZE SHIFTING)***

- Place two targets in front of you about an arm's length away and slightly wider than shoulder width apart. The first target should be positioned so that when you look at one target, you can see the other target in your peripheral vision without difficulty.
- Begin with your head and eyes turned to directly face the target on the right.
- Shift your eye gaze to the target on the left and immediately follow your gaze with a head turn toward the target on the left. Repeat going toward the right (eye gaze followed by a head turn), and continue back and forth between the targets.
- Vary the speed of your head movement, making sure to keep the target in focus. Attempt to perform this gaze exercise as quickly as possible.
- Practice for 60 seconds and increase the time, as tolerated, up to 5 minutes.
- This exercise can also be performed with targets placed vertically (one target above the other).

*These exercises are most often used for individuals with bilateral vestibular hypofunction. They may be used at the therapist's discretion for those with unilateral vestibular hypofunction or loss.

toward completing an exercise up to 1 minute at a time, 4 to 5 times daily.^{3,74} Initially, a metronome may be used to promote increased head speed. As soon as tolerated, unpredictable head movements should be introduced.⁷⁹ Demonstrable improvement may take up to 6 weeks^{74,80}; recovery optimization may take up to 1 year.⁷¹

Points to Remember

- It is important that patients do the exercises and movements quickly enough and through sufficient range of motion to elicit at least mild symptoms.⁸¹ Vestibular rehabilitation should simulate rotational head perturbations during functional activities such as ambulation (0.5–5.0 Hz).⁸²
- The patient should begin with a lower frequency and duration of exercise and

progress as tolerated, particularly if he or she has increased motion sensitivity.

- It may take at least 4 weeks before symptoms begin to decrease; a conditioning program should be introduced as soon as tolerated to counteract physical deconditioning from inactivity (see also Chapter 10: Fitness Assessment and Intervention).
- Practitioners should also consider referring patients to occupational therapy for a driving assessment. Patients should not drive if they cannot see clearly during head movements or if head movements result in significant dizziness or disorientation.
- A home-based physical therapy program is typically followed by periodic clinical follow-up (eg, weekly to monthly).
- Referral to a therapist specializing in vestibular rehabilitation may be indicated if the patient does not progress.

TREATMENT OF MOTION SENSITIVITY AND EXERCISE-INDUCED DIZZINESS

Sensitivity to motion (dizziness and nausea), especially head motion, is a common finding in those with vestibular disorders as well as those with dizziness complaints following TBI. Patients may also have visual motion sensitivity with increasing symptoms in busy and crowded environments.⁷⁷

The provoking positions found on the MSQ Test (see Motion Sensitivity Quotient Test Purpose/Description above) may be used to design a treatment program based on the concept of habituation by repeated exposure to the symptom-provoking posi-

tions and movements. Three or four test movements are selected from the Motion Sensitivity Test, typically ones that caused a mild to moderate increase in symptoms (not a severe increase). The patient should then perform those motions 2 to 3 times, twice daily. After each performance of the exercise, the patient should wait for the symptoms to resolve or return to baseline. This program is advanced by increasing movement speed or altering the movement activity. Improvements may take 6 to 8 weeks. If no progress is made within 2 months, patients may need to alter their lifestyle or vocation.³ The

TABLE 2-3

POSTURAL CONTROL ACTIVITIES: GENERAL SUGGESTIONS

Static Activities	Wide base of support standing	Advance to compliant surfaces
	Narrowed base of support standing	Advance by adding perturbations and distractions
	Modified tandem stance	
	Tandem stance	
	Single-leg stance	
Dynamic Activities	Weight shifts in:	Advance to compliant surfaces, unstable surfaces
	- wide base of support standing	Advance by adding head movements
	- narrowed base of support standing	Advance by adding upper extremity activities
	- modified tandem stance	- reaching
	- tandem stance	- throwing/catching a ball, throw outside of midline
	- single-leg stance	Advance by adding lower extremity activities
Gait Activities		- marching
		- kicking ball
	Braiding	Advance by changing surfaces, inclines
	Sidestepping	Advance by adding head movement
	Tandem ambulation	Advance by adding dual task activity (motor or cognitive)*
	Heel walking	
	Toe walking	
	Lunging	
	Running	
	Skipping	

*See Chapter 8: Dual Task Assessment and Intervention.

program should be updated periodically based on patient response.

Another example of a generalized program to address motion sensitivity problems is found in Shepard et al.^{77(p504)} In addition to activities similar to those based on findings from the MSQ Test, the therapist can choose from functional activities that are symptom provoking for an individual patient.

Exertional, or exercise-induced, dizziness results in nausea, disequilibrium, and feeling “dizzy” or unsteady during or immediately following exercise. These symptoms appear to be a form of motion intolerance, as they are associated with exercise that involves head motion (sit-ups, push-ups, running, swimming), but not with exercise that is more stable (eg, riding a stationary bike). Exercise-induced dizziness has been described in a military population as having a disabling effect because physical training and active duty often require individuals to be very physically active.⁸ These symptoms may be missed if more basic motion sensitivity testing is conducted that does not require repetitive and rapid head movement or physical exertion.

Interventions may include exercises using vestibular rehabilitation principles that include

an exertional component to provoke vestibular symptoms by requiring maximal tolerable effort. Some have advocated for exercise that includes diagonal and spiral movement patterns, use of gravity, acceleration, resistance, and an unstable base of support to simulate operational conditions. One particular program included progressive conditioning that began with a timed walk that progressed to a 3-mile run.⁸ Improvements in clinical measures of balance and self-report of dizziness handicap were noted for all patients, with an average of 4.6 weeks to return to active duty.⁷ See Chapter 10, Fitness Assessment and Intervention, for further evidence supporting a progressive fitness program in cases where complaints linger beyond 2 or 3 weeks after c/mTBI.

Postural Stability Exercise Progression

A postural stability exercise program should also be initiated and advanced.^{21,83} A typical and generalized postural stability exercise program can be found in *Brain Injury Medicine Principles and Practice*, by Zasler, Katz, Zafonte⁸⁴ (see Table 28-3 in that text); exercises are assigned at the therapist’s discretion (Table 2-3). If cervical range-of-motion

limitations are identified, range of motion, stretching, or manual therapy may be indicated. Fitness and conditioning programs should be introduced as soon as tolerated, including a walking program, or stationary cycling program as strategies to combat fatigue secondary to deconditioning.

Postural control is addressed throughout the vestibular rehabilitation program by advancing the patient through a paradigm such as the following:

- Advance viewing exercises (X1, X2, imaginary targets, etc.) through more difficult postures.
 - Progress from sitting to standing, to standing on foam or other compliant surfaces, standing on trampoline, bouncing on trampoline, etc.
 - Progress gait tasks on level surfaces;

use varying speeds, inclines, treadmill, jogging.

- Advance viewing exercises through progressively busier environments.
 - Exercise in a quiet area initially; progress to busier and louder environments.
 - Use distracting backgrounds, including horizontal lines or checkerboard patterns.⁷⁸
- Advance the number of repetitions, time, frequency, and speed of viewing exercises.

The patient can still have postural stability impairments after improvement with gaze stability. Refer to the section of this toolkit on higher-level balance and functional abilities (Chapter 3: Balance and Functional Abilities Assessment and Intervention) for additional interventions.

FITNESS AND CONDITIONING PROGRAM FOR BALANCE RETRAINING FOLLOWING VESTIBULAR DYSFUNCTION

A fitness and conditioning program should be introduced as soon as tolerated. This program should include balance retraining and a walking or stationary cycling program to combat fatigue secondary to deconditioning. All healthy adults aged 18 to 65 years need moderate-intensity aerobic physical activity for a minimum of 30 minutes 5 days a week and activities to increase muscular strength and endurance for a minimum of 2 days each week.⁸⁵ Exercise may improve mood and aspects of health status in individuals with TBI.⁸⁶ The following are some key points to remember when designing an exercise program:

- Start slowly and increase the duration and intensity of exercises over time.
- Monitor heart rate or rate of perceived exertion.
- Vary the exercise program to keep from

becoming bored.

- Use a calendar or notebook to keep track of exercise days and times.
- When cleared by the referring physician, progress from walking or stationary cycling to other aerobic exercises, such as running and swimming.⁸⁶
- Include avocational activities that are fun and challenge balance and vision simultaneously, such as golf, bowling, tennis, racquetball, ping-pong, cycling, cross-country skiing, and hiking.
- Alternative balance activities can include yoga, tai chi, and other non-contact martial arts.
- Incorporate service-specific physical fitness requirements for running, push-ups, and sit-ups (see Chapter 10: Fitness Assessment and Intervention, for service-specific websites).

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