Vestibular Rehabilitation and Factors That Can Affect Outcome

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Abstract

This review will discuss the developmental, environmental, medical, psychological, visual, and other sensory-related factors that affect recovery after vestibular dysfunction. A general overview of the evidence for vestibular rehabilitation for patients with peripheral and central vestibular disorders is provided. Recent findings suggest that age, physical activity, certain congenital disorders, length of symptoms, musculoskeletal, visual and neuromuscular comorbidities, cognition, sleep, and medications are all factors that influence the effectiveness and outcome of vestibular rehabilitation. Psychological factors that also affect outcome include anxiety, depression, fear of movement, and fear of falling. Recovery in patients with vestibular disorders may be enhanced if the practitioner recognizes and attempts to remediate modifiable factors.

Keywords ► vestibular rehabilitation  ► vestibular physiotherapy  ► physical therapy  ► prognosis  ► dizziness  ► vertigo

During treatment planning, it is important to consider negative prognostic factors that relate to recovery in patients with vestibular disorders. Negative prognostic factors will affect the duration of the episode of care and need to be identified to set realistic expectations with the patient during goal setting. Factors that negatively affect recovery after a vestibular disorder will influence how interventions should be provided and will affect the person’s prognosis. This article will review multiple factors that impact recovery, including demographic, medical, and cognitive/behavioral factors (► Table 1). Factors that can be managed with pharmacological interventions will be discussed. Prognosis of various subclassifications of patients with vestibular disorders will be discussed first followed by demographic factors.

Type of Vestibular Disorder

Certain vestibular disorders may predict less favorable outcomes. Vestibular disorders discussed include unilateral vestibular hypofunction, benign paroxysmal positional vertigo (BPPV), Meniere’s disease, bilateral vestibular hypofunction, and central vestibular disorders including vestibular migraine (VM), mixed central and peripheral dysfunction, cerebellar disorders, and mild traumatic brain injury (concussion).

Peripheral Vestibular Disorders

Unilateral Vestibular Hypofunction

In patients with unilateral peripheral vestibular dysfunction, there is moderate-to-strong evidence for improvement, and the interventions have been shown to be safe.1 A clinical practice guideline2 suggests that expected recovery in patients undergoing vestibular rehabilitation (VR) with unilateral loss is 4 to 6 weeks and that customized exercises appear to be superior to optimize recovery.

Benign Paroxysmal Positional Vertigo

The Barany Society has developed a consensus document to assist in the diagnosis of BPPV.3 The most recent clinical practice guideline update for BPPV makes strong recommendations for making the diagnosis of BPPV through the Dix–Hallpike and the supine roll tests.4 There is clear evidence that BPPV and

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Patients with bilateral vestibular loss, for example, secondary to gentamicin or cisplatin, have limitations in their activities of daily living and ability to participate in their communities. Factors that appear to limit their ability to recover include progressive loss of vestibular function over time, low vestibulococular reflex (VOR) gain values on rotational chair testing (<0.2 at several frequencies), and having more than four comorbid conditions. Treatment considerations for patients with bilateral loss include counseling, balance and vestibular exercises, interventions to address the cause of the bilateral loss, and prevention of additional damage to the vestibular labyrinth. Active head movement in patients with bilateral loss has been shown to be superior to eye movement exercises only. In addition, dynamic visual acuity during passive head movement improved between 60 and 75%. The authors suggested that the patients with bilateral loss had learned how to perform compensatory saccadic eye movements during their VOR active exercises.

Brown et al reported clinically meaningful changes in various outcome measures in 33 to 55% of patients. More recently, Herdman et al reported that between 38 and 86% of patients with bilateral vestibular loss had meaningful changes after physical therapy in the outcome measures used. People with bilateral loss improved with physical therapy but not as much as in patients with unilateral vestibular loss. A systematic review suggests that there is moderate evidence for rehabilitation outcomes with bilateral vestibular hypofunction associated with less rhythmicity when walking, especially at slower speeds, and causes an increased fall risk.

Central Vestibular Disorders

VM has been associated with worse physical performance and less favorable self-report outcomes. Numerous pharmacological and nonpharmacological remedies have been described for VM. Vitkovic et al found equal benefit from rehabilitation regardless of which migraine medications were used. Others have reported better rehabilitation outcomes with migraine preventative medication and physical therapy. Postural control, as measured with the Balance Evaluation Systems Test, and cognition (Stroop test) were compared in patients with VM and those with migraine alone. The patients with migraine or VM had worse balance and cognition compared with age-matched control patients.

People who present with mixed central and peripheral vestibular disorders do not improve as much as patients with peripheral vestibular dysfunction do. There are, however, improvements noted in function and self-rated dizziness handicap scores, especially when they were poor at the outset of physical therapy. Patients with cerebellar disorders and dizziness appear to have the most guarded prognosis. Damage to the cerebellar flocculus may disrupt the brain’s ability to modify the VOR. In a pilot randomized trial, exercise may

Table 1 Factors that may delay or alter recovery after a vestibular disorder

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<td>Anxiety and depression</td>
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unilateral vestibular disorders are conditions that respond to VR based on a recent Cochrane review.

Meniere’s Disease

In a recent systematic review, the effects of VR on patients with Meniere’s disease were deemed to be equivocal. Based on two randomized trials and three prospective cohort studies, two-thirds of the patients demonstrated balance improvements and 20% of the patients showed positive changes in their Dizziness Handicap Inventory scores. Others have reported improvements in balance after vestibular ablation for Meniere’s disease.

In addition to pharmacotherapy with a diuretic or betahistine, nonpharmacological recommendations for the treatment of Meniere’s disease includes lifestyle changes such as reduced sodium intake, psychotherapy, and physical therapy between attacks based on an international consensus panel. The perception of disability of a patient with Meniere’s disease is based on the number of attacks, time between attacks, whether they have had attacks of Tumarkin (vestibular drop attacks), and how unstable they are between Meniere’s attacks. Magnusson et al. have reported that performing exercises prior to gentamicin injection for chronic vertigo in patients with Meniere’s disease resulted in faster recovery postinjection.

Bilateral Vestibular Hypofunction

Two systematic reviews and one clinical practice guideline suggest that physical therapy interventions are helpful for patients with bilateral vestibular loss. However, few studies report on the challenges that these people experience with dual tasking, spatial navigation, and memory deficits that can occur with bilateral loss.
have improved the VOR functioning as recorded using the gaze stabilization test in patients poststroke.31

Patients postmild head injury ( concussion) experience both symptomatic and functional improvements after VR.32–34 Others have reported that VR may speed up recovery after concussion.34 Factors that may affect outcome negatively for patients postconcussion include immediate dizziness,35 larger changes in gait speed and cadence with dual tasks while walking,36 anxiety or depression,37 greater number of symptoms and symptom severity,38 and the complaint of fogginess.25

Age

Age is a factor that should be considered when treating a patient, but there is little evidence that age affects recovery with VR.18,39–41 Obviously, older adults fall more frequently than younger people, and falls and vestibular disorders have been shown to be correlative.42 Falls and fall risk have been shown to decrease after the successful treatment of BPPV and VR.43–46 BPPV has been related to utricular dysfunction, which may be related to the higher incidence of BPPV in older adults.47 Older adults were 2.5 times more likely to have abnormal ocular vestibular evoked myogenic potentials, suggesting utricular dysfunction.47 Interestingly, Hall et al48 reported that older adults with dizziness who had normal vestibular test results benefited from gaze stabilization exercises compared with a control group with resultant decreases in their risk of falling.

Age did not affect the recovery of patients after vestibular schwannoma resection,49 and others have reported that VR improved dizziness and Activities-Specific Balance Confidence score in older patients.50 Comorbid medical conditions that can occur with aging will modify how rehabilitation is performed. The older adult may have comorbidities such as osteoporosis and osteopenia, fear of falling, diabetes, hypertension, changes in visual abilities, changes in distal sensation, and cognitive dysfunction. Modifications to their exercise program, both in the clinic and at home, may be necessary because of multiple comorbidities. Safety is emphasized both in the clinic and in the home exercise program to minimize the risk of falling and maximize functional recovery for an older person who is dizzy. Examples might include standing in the corner with a chair in front of the patient to maximize safety during a standing exercise or having someone in the home or nearby when performing more challenging gait activities that may be a part of the patient’s home exercise program.

Herdman et al18 reported that age did not affect recovery of visual acuity scores in patients with unilateral vestibular hypofunction, and Whitney et al41 reported no differences in outcomes due to age in a group of people with mixed vestibular diagnoses in their Dizziness Handicap Inventory or Dynamic Gait Index scores. Older adults with BPPV get better, but they tend to have a shorter time between recurrences of the BPPV and may have residual balance deficits and greater self-perceived handicap.51 Osteoporosis and osteopenia have been recently related to the incidence of BPPV in older people.52,53

Physical Activity and Conditioning

There is no strong evidence that individuals with low physical fitness have worse outcomes in VR. However, Gauchard et al54 reported that after inpatient VR for vestibular schwannoma resection, physically active patients had enhanced short-term recovery of balance compared with patients who were sedentary.

Morimoto et al55 reported that patients with unilateral vestibular loss of more than 3 months duration spent more time in sedentary activities and were less physically active than age-matched control patients. Active older adults without vestibular impairment have better postural control and gaze control than sedentary older adults.56 suggesting that physical activity may be a factor in VR. A similar study suggests the same outcome in young adults.57 In young athletes compared with young nonathletes (mean age: 19 years), dynamic postural control and visual acuity were better in those who exercised regularly compared with healthy nonathletes.57 suggesting that those who participate in sport may have greater reserve if there is a vestibular insult.

Congenital Disorders

There is emerging evidence that hearing impairment and cochlear implantation are both associated with balance impairment in children.58,59 Hearing loss may affect not only children but also older adults. Older adults with hearing loss take more steps to regain balance during a backward translation and may have a higher fall risk as a result.60 Childhood strabismus may be a negative predictive factor related to recovery in patients with vestibular disorders.61 There are no data in the literature on the effect of congenital blindness or congenital nystagmus on rehabilitation outcomes.

Temporal Factors

In a large cohort of patients with unilateral vestibular hypofunction, the time since onset of symptoms did not affect outcome.62 However, others reported that the initiation of VR later was associated with worse balance outcomes compared with those who were treated earlier.62 Other investigators found that patients with unilateral vestibular loss who were seen in a tertiary care clinic within 6 months had lower Dizziness Handicap Inventory scores than those who were referred after 6 months.63 Still, other studies have shown that the duration of symptoms does not impact outcomes in patients with unilateral hypofunction,18,64 and therefore the time to initiation of VR remains unclear as to its significance in functional recovery. White et al65 reported that following repositioning for BPPV, changes in health-related quality of life and postural control in older adults improved. Faralli et al66 have suggested that late identification of BPPV may lead to residual dizziness posttreatment.

Musculoskeletal

Musculoskeletal impairments can complicate the rehabilitation program and require modifications to perform exercises safely. Neck stiffness or pain makes canalinth repositioning maneuver (CRM) challenging but not impossible. Techniques
such as bridging (lifting the buttocks off the treatment table) and the use of a Trendelenburg bed can assist in optimizing the amount of neck extension during the performance of the CRM. When performing the CRM, one must be careful when rolling a patient who has recently undergone a total joint replacement. Lack of neck movement can also make the performance of the vestibulo-ocular exercises more difficult. There is evidence that manual therapy improves dizziness from the cervical spine. It is not clear if trunk or neck stiffness interferes with VR.

**Acquired Visual Disorders**
Patients who wore progressive lenses and bifocals were two times more likely to have reported a fall compared with those who did not wear glasses or those who had low vision. It has been suggested that single focal lenses are safer for walking. Binocular vision abnormalities have been related to visual vertigo symptoms and appear to be related to refractory symptoms in patients with vestibular disorders. Stair climbing has been analyzed in older patients with multifocal lenses. There was no difference in stair climbing clearance or descent in either group; however, the sample was small. Bifocals and progressive lenses make adaptation exercises difficult for patients to perform, as they have difficulty keeping the target in focus with the two different focal lenses. In addition, after cataract surgery, there is an increased incidence of reported falls when wearing progressive lenses. Supuk et al also reported that dizziness decreased after cataract surgery, most likely due to improvements in their “best eye” acuity. Patients who develop glaucoma or macular degeneration or have an uncorrected refractive error are at a higher risk of falls and have worse balance.

**Neuropathy and Somatosensory Loss**
People with peripheral neuropathy and diabetes can improve with VR, but they may not improve as much as those with diabetes alone.

**Anxiety/Depression**
Psychological factors such as preexisting anxiety or depression can have a significant influence on outcomes in individuals with vestibular disorders. The prevalence of anxiety and depression is higher in patients with vestibular dysfunction compared with the general population. A cross-sectional U.S. survey demonstrated that in patients with vestibular vertigo, 62% had depression, 46% had generalized anxiety, and 26% had panic disorder. These prevalence rates led to odds ratios of >3 for risk of these disorders in people with vestibular vertigo compared with the general U.S. population. A study in Germany including patients seen at a specialized dizziness clinic used a structured clinical interview for major mental disorders (Structured Clinical Interview for DSM-IV [Diagnostic and Statistical Manual of Mental Disorders IV] Axis I Disorders [SCID-1]) to examine the prevalence of psychiatric disorders. Of the sample, 49% had a diagnosed psychiatric disorder, led by anxiety-phobic disorder, somatoform disorder, and affective disorder. There is some evidence that the prevalence of psychiatric disorders depends on the type of vestibular dysfunction, that is, there was greater prevalence in episodic vestibular disorders such as VM or Meniere’s disease.

Regarding the impact of anxiety and depression on recovery, Herdman et al examined many factors associated with outcomes in a cohort of 209 individuals with unilateral vestibular hypofunction who underwent customized VR. Having anxiety or depression was associated with a longer amount of time that symptoms interfered with life activities but did not affect improvement in other outcome measures typically associated with VR, such as symptom severity, Dynamic Gait Index, or Activities-Specific Balance Confidence. A retrospective analysis of individuals receiving VR examined outcomes based on affect using the Positive and Negative Affect Scale, a proxy measure for anxiety and depression. Of the sample, 19% had an abnormal affect. The amount of improvement was about the same in both groups, but the abnormal affect group had worse scores overall.

**Fear of Movement**
Fear of movement in response to injury is rooted in the literature on chronic low back pain, whereby fear of inducing or increasing pain could lead to a maladaptive avoidance response of restricting movements and activities. In contrast, the confrontation response leads to increased movement and return to activities. Vlaeyen et al developed a more complete model by considering not just fear of pain but also fear of movements and activities that may cause pain. In addition, they added the concept of catastrophization, which was a strong predictor of fear of movement. In their model of acute injury leading to pain, individuals who are less fearful and have lower catastrophization are more likely to confront the pain and recover. On the other hand, individuals who are more likely to catastrophize and are more fearful will demonstrate avoidance behaviors, leading to more disability, disuse, and a reinforcement of the pain experience.

The many similarities between chronic pain and chronic dizziness make the application of these concepts to vestibular disorders appropriate. In the acute stage of a vestibular disorder, head movement is likely to cause or increase dizziness. In a patient with less fear of movement leading to re-injury and lower catastrophization, head movement exercises will promote vestibular compensation through VOR gain adaptation. However, a patient who expects more harm to come from movement will restrict the movements and activities that are needed for their recovery. Therefore, on theoretical grounds, it appears that fear of movement may interfere with recovery during VR. For example, the uncertainty of when the dizziness will begin and end may result in anxiety in patients with Meniere’s disease. The uncertainty may then lead to less motivation to perform their home exercise program. Motivational interviewing may benefit the patient who is either afraid of exercising or does not think that movement will help them to recover.

Several groups have explored using cognitive-behavioral therapy (CBT) in concert with VR to combat some of the anxiety and avoidance components of the disorder.
caveat to these studies is that little detail is provided about the VR component. Two of the studies provided evidence of greater improvement in the Dizziness Handicap Inventory and Vertigo Symptom Scale scores in the treatment group compared with a wait-list control group. However, no change in anxiety or depression was observed. The third study added CBT to a general self-administered vestibular exercise program (i.e., not supervised by a physical therapist) for the treatment of individuals with phobic postural vertigo. A significant improvement in the Vertigo Handicap Questionnaire was found in the CBT + VR group compared with the VR only group.

Fear of Falling
Fear of falling is a significant contributor to mobility limitations, especially in older adults. It is also an important concern for people with vestibular disorders. Honaker and Kretschmer conducted a qualitative study to examine how fear of falling changed after VR in individuals with vestibular and balance disorders who had a history of falling. In this sample, fear of falling resulted in restricting the performance of activities of daily living. VR improved their fear of falling, as indicated by an increase in Activities-Specific Balance Confidence scores. Future research should continue this line of inquiry to examine outcomes in individuals with and without a fear of falling.

Cognitive Impairment
The impact of cognitive impairment on VR outcomes is not well understood, but a recent report suggests that patients with bilateral vestibular loss have attention impairments. Although cognitive impairment may not alter the physiology of vestibular compensation, it could impact recovery if it interferes with a person's ability to comply with exercises and recall what he/she has previously learned in therapy (so-called carry-over effect). Micarelli et al investigated posturography and self-report outcomes in older adults with unilateral vestibular hypofunction who had mild cognitive impairment (MCI) or Alzheimer's disease (AD). Individuals with MCI and AD had increased posturography measures, reduced Dynamic Gait Index scores, and worse Dizziness Handicap Inventory and Activities-Specific Balance Confidence scores compared with a control group of older adults without cognitive impairment. Furthermore, the group with AD had worse performance and self-reported outcomes compared with the MCI group. While this investigation did not directly look into the outcomes following VR, it suggested worse long-term function in people with cognitive impairment.

Sleep
Impaired sleep function can have a profound impact on health outcomes. There are several reports of an association between disordered sleep and vestibular disorders. A large nationally representative cross-sectional survey found an association between having vestibular vertigo and too little or too much sleep duration, but it is not clear if sleep interfered with recovery. Additionally, impaired sleep function was found to a higher degree in individuals with chronic subjective dizziness and phobic postural vertigo compared with those with other vestibular diagnoses.

Sugaya et al investigated the effect of VR on sleep quality, dizziness handicap, and health-related quality of life in people with chronic dizziness. VR had a beneficial effect on these outcomes. Importantly, it was discovered that individuals who continued to have sleep disturbance had greater dizziness handicaps and anxiety compared with those without sleep disturbance.

Vestibular Suppressants
The most commonly prescribed medications for patients with dizziness of presumed vestibular origin are vestibular suppressants. Table 2, adapted from Hain et al, lists common vestibular suppressants, their pharmacological class, typical dosages, and typical adverse reactions and unwanted side effects. Many vestibular suppressants also may provide relief from nausea or anxiety. When patients take vestibular suppressants during vestibular rehabilitative therapy, it could theoretically diminish central

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<tr>
<th>Drug (brand name)</th>
<th>Pharmacological class</th>
<th>Dose</th>
<th>Adverse reactions</th>
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<tbody>
<tr>
<td>Meclizine (Antivert, Bonine)</td>
<td>Antihistamine, anticholinergic</td>
<td>12.5–50 mg orally every 4–6 h</td>
<td>Sedation</td>
</tr>
<tr>
<td>Dimenhydrinate (Dramamine)</td>
<td>Antihistamine, anticholinergic</td>
<td>50 mg orally every 4–6 h</td>
<td>Sedation</td>
</tr>
<tr>
<td>Promethazine (Phenergan)</td>
<td>Phenothiazine</td>
<td>25 mg orally or rectally every 6–12 h</td>
<td>Extrapyramidal reactions, Drowsiness, Restlessness</td>
</tr>
<tr>
<td>Clonazepam (Klonopin)</td>
<td>Benzodiazepine</td>
<td>0.25–0.5 mg orally twice daily</td>
<td>Mild sedation, Drug dependency</td>
</tr>
<tr>
<td>Diazepam (Valium)</td>
<td>Benzodiazepine</td>
<td>1–2 mg twice daily; 2–10 mg (one dose)</td>
<td>Sedation, Respiratory depression, Drug dependency</td>
</tr>
<tr>
<td>Lorazepam (Ativan)</td>
<td>Benzodiazepine</td>
<td>0.25–0.5 mg orally twice daily</td>
<td>Mild sedation, Drug dependency</td>
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compensation. Hence, the negative effect on vestibular compensation needs to be weighed against the benefits.

**Ototoxic Medications**

Several aminoglycoside antibiotics, for example, gentamicin, are known to be vestibulotoxic medications. Some chemotherapeutic agents such as cisplatin are also vestibulotoxic medications. In some patients, vestibulotoxic medications can cause irreversible bilateral reduced vestibular function. The presence of bilateral vestibular loss must be recognized so that appropriate treatments can be initiated.

**Polypharmacy**

Polypharmacy generally refers to the use of five or more medications. It is especially important to review each patient’s medication list looking for medications that can lead to dizziness and disequilibrium. Vestibular suppressant medications should be reduced or discontinued if possible. Disease-specific pharmacotherapy depends upon the accuracy of diagnosis.

**Conclusion**

Patients with unilateral disorders, inclusive of BPPV, have the best outcomes. Patients with bilateral vestibular loss and those with central disorders improve after undergoing VR but not as much as patients with unilateral vestibular loss. There are multiple factors that can negatively affect recovery in patients with vestibular disorders, including age, physical activity level, congenital disorders, onset of symptoms, musculoskeletal disorders, visual deficits, sensory loss, anxiety and/or depression, fear of movement, fear of falling, cognitive impairment, sleep disorders, and medication. Early recognition of these factors and attempts to mitigate their effect on patient recovery could potentially improve patient outcomes and facilitate faster recovery after a vestibular insult.

Conflict of Interest

None.

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