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What is **vestibular** weakness?

Patients with this balance disorder require an interprofessional team to promote safety and quality of life.

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The vestibular system is responsible for crucial sensory and motor functions related to perceived self-motion, head position, and spatial orientation. Vestibular weakness (VW) occurs when there's hypofunction or absent function of the vestibular system due to disease processes or drug toxicity, affecting the labyrinth or vestibular nerves in one or both ears.

This article presents an overview of the vestibular system and information about VW, including signs and symptoms, diagnostic tests, and management strategies to promote patient safety.

The vestibular system

The inner ear is called the labyrinth, which contains structures for hearing and balance. The bony labyrinth is a complex system of intricate tunnels within the cranium that contains the organ of Corti, which produces nerve impulses in response to sound vibrations, and the vestibular system, which includes the utricle, saccule, and semicircular canals that are responsible for balance (see *Path taken by sound waves reaching the inner ear* and *Anatomy of the inner ear*). Each tunnel is lined with a membrane, with a space between the cranium and the membrane containing two fluids: endolymph and perilymph. Endolymph saturates the hair cells of the acoustic and vestibular systems. It's stored and absorbed in the endolymphatic sac (ELS) that lies between the dura mater and the petrous bone in the inner ear. The ELS plays a role in immune function and adjusts the pressure of endolymph. Endolymphatic hypertension or hydrops (dilatation) can be caused by conditions such as Meniere disease, congenital defects, and tertiary syphilis.

Whereas endolymph is an intracellular fluid that's abundant in potassium and low in sodium, the composition of perilymph is similar to extracellular fluid, with a high sodium content. Found in the tympanic and vestibular ducts, perilymph is a clear fluid that encases and protects the endolymph within the bony labyrinth. One of the most important functions of perilymph is to transmit sound waves to endolymph.

An imbalance in the amount of endolymph and perilymph may lead to vestibular symptoms. For example, the thin membrane separating endolymph and perilymph may rupture, causing these two chemically incompatible fluids to mix and leading to vertigo by increasing the vestibular nerve firing rate.

The utricle and saccule together house the otolith organs. Otoliths sense head

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March/April 2021 Nursing made Incredibly Easy! 37

position as it increases in velocity while moving forward in a straight line and relative to gravity. Semicircular canals sense head rotation or turning motion. Otoliths and the semicircular canals initiate postural reflexes that join muscles in the body to maintain an upright position. In a similar fashion, the vestibulo-ocular reflex (VOR) stabilizes retinal images when a person's head is turning. For example, when the head is turning in one direction and at a certain velocity, the person's eyes must turn at the same velocity in the opposite direction. The VOR arc, which includes the semicircular canals and otoliths, vestibular oculomotor nuclei, and extraocular muscles, works together during head movement under cerebellar modulation control.

The vestibulocochlear nerve (eighth cranial nerve) is responsible for hearing and balance and has two components. The superior vestibular nerve innervates the semicircular canals and the inferior vestibular nerve innervates the saccule. Fibers from both nerves lead to the vestibular ganglion, which has a portion for each nerve. Both nerves join into a single fiber that leads to the brainstem (see *A closer look at the vestibulocochlear nerve*).

Signs and symptoms

VW can be either bilateral or unilateral. Bilateral VW occurs when a disease or drug affects the functioning of the vestibular system, vestibulocochlear nerve, and the VOR. The prevalence of bilateral VW in the US is 28 per 100,000 adults. Patients experience imbalance, spatial disorientation, and mild-to-severe oscillopsia-an illusion that the environment is moving or oscillating when the head is turning, caused by a loss of the VOR. Patients may experience blurry vision; vision in which objects appear to bounce, jump, or vibrate; vertigo; tinnitus; hearing problems; nausea; vomiting; and trouble walking, especially in the dark (see Picturing oscillopsia).



38 Nursing made Incredibly Easy! March/April 2021

An imbalance may be exacerbated by visual stimuli in busy or crowded public places with bright lights. Shopping in a crowded aisle in a grocery store may cause the patient to have blurry vision and increasing imbalance. Driving a car, particularly at night, may be a challenge because headlights from oncoming cars may trigger blurry vision. The glare from the headlights may be mildly uncomfortable for the patient or severely impair his or her ability to continue driving safely. Driving through tunnels or on narrow roads may trigger visual symptoms and imbalance. Patients may have difficulty reading street signs or identifying the characteristics of a person's face as they walk by them. They may find that it's easier to focus on nearby objects, whereas distant objects may be difficult to visualize clearly.

Patients may have difficulty with accurate gravity perception, especially walking in dimly lit rooms or in the dark, on uneven surfaces, or when moving the head frequently. Patients may place one foot in front of the other in the dark and realize that the surface of the ground is closer or farther away than they thought. BP, pulse, and respiration may increase, and the patient may experience orthostatic hypotension. Fatigue and difficulty concentrating are common symptoms. Severely impaired patients may have trouble establishing postural stability. Patients may also experience a disruption of social activities and performing activities of daily living and are at a high risk for accidents and falls.

Bilateral VW may develop subsequent to systemic diseases affecting the labyrinth, including, but not limited to, autoimmune inner ear disease, bilateral Meniere disease, meningitis, vasculitis, Cogan syndrome, antiphospholipid syndrome, congenital malformations, vestibular schwannoma, infections, and trauma. However, bilateral VW is most often caused by ototoxicity from aminoglycoside antibiotics, which include gentamicin,





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March/April 2021 Nursing made Incredibly Easy! 39

streptomycin, and tobramycin. Gentamicin and streptomycin are especially toxic to the vestibular system.

Unilateral VW occurs in 14% to 20% of patients with inner ear pathologies. Symptoms are similar to bilateral VW but may be milder because the normal contralateral ear is compensating for disease in the affected ear. Common symptoms include nausea, vomiting, imbalance, dizziness, and vertigo when the head is turning. Unilateral VW may occur suddenly or gradually, depending on the underlying pathology. Vestibular neuritis, labyrinthitis, Meniere disease that's predominantly unilateral, vestibular schwannoma, viral

Picturing oscillopsia

Oscillopsia is an illusion that the environment is moving and may be manifested in varying degrees of severity from blurry vision to blurry vision in which images oscillate, jump, or bounce.



and bacterial infections, and blood clots are known to cause inner ear damage. Aggressive treatment for Meniere disease may cause unilateral VW. For example, transtympanic infusion of gentamicin may be utilized to chemically weaken or destroy the vestibular nerves in Meniere disease to control intractable vertigo.

Diagnostic tests

Chair rotational testing provides a reliable, quantifiable measure of the stability of the VOR. Patients are seated in a computerized rotational chair that's in the middle of a small, darkened room. Patients wear infrared goggles as the computer measures eye movement while the chair rotates.

Electronystagmography (ENG) measures how well the inner ear, eyes, and brain communicate to ensure normal balance and is helpful in the diagnosis of VW to differentiate between balance symptoms related to the inner ear or brain. In ENG, electrodes are placed on the patient's face and eyes to obtain measurements of the electrical impulses of eye movement and the presence of nystagmus-rapid and uncontrolled movement of the eyes in a horizontal, vertical, or rotational direction that may be caused by inner ear diseases, multiple sclerosis, stroke, head injury, substance use, or alcohol consumption. Nystagmus may accompany oscillopsia and is a defining feature of vertigo.

ENG may be accompanied by videonystagmography (VNG), which is used to sense eye movement through video cameras by recording the patient's ability to follow objects with his or her eyes and the vestibular system's response.

A caloric test often accompanies ENG and VNG. In a caloric test, cool or warm water is introduced into both inner ears one at a time, which should cause nystagmus by irritating the vestibulocochlear nerve. Evoking nystagmus means that the vestibular system is functioning to some degree in the ear being tested.

40 Nursing made Incredibly Easy! March/April 2021

The head impulse test (HIT), sometimes called the head thrust test, is a simple and quick way to assess the VOR. To perform the HIT, the healthcare provider and patient face each other in a seated position. The healthcare provider holds the patient's head and the patient is instructed to fix his or her gaze on an object. For example, the fixed gaze may be on the healthcare provider's nose or shoulder or a clock on the wall. The healthcare provider rapidly turns the patient's head from one side to the other, assessing if he or she has corrective eye movements.

Testing visual acuity with the Snellen eye chart during an optometric or ophthalmic exam may be useful as a diagnostic tool. However, this test requires the patient's head to be completely still. Symptoms of VW, such as oscillopsia, nystagmus, nausea, vomiting, dizziness, and vertigo, are unlikely during a routine exam because they're generally elicited with head movement. For example, a patient who has a history of oscillopsia may state that his or her vision is completely clear during the exam and then experience blurry or glared vision while shopping in a busy grocery store on the same day.

Audiometric studies and imaging studies of the brain should be included in the diagnostic evaluation. Audiometric studies may indicate an impairment in hearing and speech discrimination, whereas imaging studies, such as a computed tomography (CT) scan, may indicate tumor, infection, or stroke.

Management strategies

Both bilateral and unilateral VW are treated with vestibular rehabilitation therapy, which is an exercise program to improve gaze and posture stability, decrease the frequency of vertigo, and enhance the achievement of activities of daily living. Vestibular exercises may include those targeting visual, inner ear, and postural problems. A physical

Signs and symptoms

Bilateral VW

- Imbalance
- Spatial disorientation
- Mild-to-severe oscillopsia
- Vertigo
- Nausea
- Vomiting
- Trouble walking

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- Auditory symptoms
- Neurologic symptoms
- Unilateral VW
- NauseaVomiting
- Imbalance
- Dizziness
- Vertigo

therapist will assess the patient's responses to customize the exercise plan. For example, the physical therapist assesses the patient's eye movement while in a sitting or standing position, his or her ability to move the head from side to side and shrug the shoulders, and the ability to stand while placing an object on the floor and then picking it up.

In bilateral VW, treatment is often longer and difficult because of a lack of bilateral inner ear vestibular function. Physical therapists may have to rely on other reflexes to sense head motion, such as the cervico-ocular reflex. In unilateral VW, treatment is geared toward promoting central composition by relying on the contralateral ear with normal vestibular function.

The nurse plays an important role in the interprofessional team managing patients with VW. Perform a comprehensive health history interview and head-totoe assessment. Assess the patient's ability to stand and gait while supporting him or her to prevent falls. Evaluate comorbidities; for example, differentiate balance symptoms caused by osteoarthritis from those associated with inner ear pathology in the same patient. Correlate the findings from the head-to-toe assessment with any diagnostic lab and imaging studies. Evaluate the patient's medication history, including the use of medications or supplements to treat nausea, vomiting, or vertigo. Evaluate the patient's risk of falls using a fall risk assessment tool. Encourage the patient to wear a medical-alert



consider this

Your patient is a 78-year-old female with diabetes mellitus, hypertension, and rheumatoid arthritis. She regularly takes metformin, bisoprolol, and azathioprine. She's prone to infection because of her weakened immune system from the aging process, comorbidities, and receiving azathioprine for rheumatoid arthritis, which is a powerful steroid-sparing immunosuppressant medication. She has an occasional urinary tract infection, which is managed effectively with broad-spectrum antibiotics.

She's currently recovering from right lower lobe pneumonia after being treated successfully with gentamicin, an aminoglycoside medication. She received I.V. infusions in the hospital over a 5-day period. Gentamicin peak and trough levels while in the hospital were within normal ranges. After discharge from the hospital, her physician decided to continue daily infusions of gentamicin at home by a home healthcare nurse.

The patient started to have tinnitus and hearing difficulty in both ears after three infusions (3 days). She states, "I feel like I'm off balance and my vision is a little blurry." The physician diagnoses her with gentamicin otoxicity. Gentamicin is principally cleared from the body through renal filtration. Older adults are at an increased risk for aminoglycoside toxicity because their urinary creatinine clearance may be reduced.

The following interventions are included in the patient's care plan:

• Discontinue gentamicin because a CT scan of the chest shows resolution of the pneumonia.

- Assessment of the patient's hearing by an otolaryngologist because the physician determined that there's a slight bilateral hearing loss compared with a year earlier.
- A walker is ordered to prevent the patient from falling because she notes minor difficulty walking, especially in darkened rooms in her house. She states, "I only have blurred vision when I'm walking or driving in the car. I can see fine when I'm sitting still and reading."
- Patient teaching includes instructing the patient to maintain sufficient lighting in her home, remove loose rugs, and avoid driving or being a passenger in a motor vehicle until her balance problem resolves. The patient's daughter decides that it's best for her to live with her mother to ensure safety for the time being. Her daughter says, "I don't want her to fall."
- Vestibular rehabilitation with a physical therapist is ordered three times a week for 1 month.
- Assessment by the home healthcare nurse of the patient's gait and visual acuity with each visit. The nurse also conducts a head-to-toe assessment at each visit.

After 1 month, the patient's symptoms improve and within 2 months she's symptom free, ambulating normally without a walker. Her lungs are clear upon auscultation and the rate and depth of respirations are normal. Her hemoglobin A1C is 6.1, serum creatinine 0.9, and estimated glomerular filtration rate 76 and her rheumatoid arthritis is in remission.

bracelet stating that he or she has VW and may also be receiving medications for dizziness and vertigo that may impair mental alertness. Lastly, provide emotional support, letting the patient share his or her fears.

The following are priority patient teaching points for VW:

• Ensure optimal lighting in the home, keep the floor clear of loose rugs, and remove clutter.

- Install handrails in the house as indicated.
- Wear rubber-soled shoes that fit comfortably.
- Ensure that the bathtub and bathroom have nonskid mats.
- Secure all electrical cords.
- Use assistive devices to ambulate as indicated.
- Avoid alcohol and smoking and eat a well-balanced diet.

• Review medication purposes and adverse reactions that may cause balance problems.

• Avoid driving a motor vehicle during the night or when visual symptoms are present.

• Avoid crowded public places that are visually stimulating to prevent oscillopsia and imbalance.

• Ambulate cautiously to ensure accurate interpretation of depth perception while walking and turning the body slowly in a different direction.

• Always keep antivertigo or dizziness rescue medications with you and wear a medical-alert bracelet.

• Have balance, hearing, and vision checked regularly. Hearing deficits can add to the morbidity of balance disorders and cause anxiety and discomfort.

• Join a support group for people coping with balance disorders.

42 Nursing made Incredibly Easy! March/April 2021

A safety framework

Nurses play a crucial role in collaboration with physical therapists and physicians to develop a unique care plan for the patient with VW, using safety as a framework to protect the patient from accidents and falls and improve quality of life.

REFERENCES

Batuecas-Caletrio A, Trinidad-Ruiz G, Rey-Martinez J, Matino-Soler E, Martin Sanz E, Fernandez NP. Oscillopsia in bilateral vestibular hypofunction: not only gain but saccades too. *Ear Hear.* 2020;41(2):323-329.

Bilateral vestibulopathy. In: Albernaz PLM, e Maia FZ, Carmona S, Cal RVR, Zalazar G, eds. *The New Neurotology: A Comprehensive Clinical Guide*. Cham, Switzerland: Springer; 2019:175-180.

Bojrab DI II, Lai W, Bojrab DI. Electronystagmography and videonystagmography. In: Babu S, Schutt CA, Bojrab DI, eds. *Diagnosis and Treatment of Vestibular Disorders*. Cham, Switzerland: Springer; 2019:45-65.

Cohen HS. A review on screening tests for vestibular disorders. J Neurophysiol. 2019;122(1):81-92.

Hain TC, Cherchi M, Yacovino DA. Bilateral vestibular weakness. *Front Neurol.* 2018;9:344.

Hall CD, Herdman SJ, Whitney SL, et al. Vestibular rehabilitation for peripheral vestibular hypofunction: an evidence-based clinical practice guideline. *J Neurol Phys Ther.* 2016;40(2):124-155.

Lewis SL. Dementia and delirium. In: Lewis SL, Bucher L, Heitkemper MM, Harding MM, Kwong J, Roberts D, eds. Medical-Surgical Nursing: Assessment and Management of Clinical Problems. 10th ed. Saint Louis, MO: Mosby; 2016:1411-1412.

McCarty-Walsh E, Bojrab DI. The vestibulo-ocular reflex and head impulse testing. In: Babu S, Schutt CA, Bojrab DI, eds. *Diagnosis and Treatment of Vestibular Disorders*. Cham, Switzerland: Springer; 2019:67-74.

National Dizzy and Balance Center. Unilateral vestibular loss. 2018. www.nationaldizzyandbalancecenter.com/ unilateral-vestibular-loss.

National Institute on Aging. Balance problems and aging. 2017. www.nia.nih.gov/health/balance-problems-and-disorders.

National Institute on Deafness and Other Communication Disorders. Balance disorders. 2018. www.nidcd.nih.gov/ health/balance-disorders.

Renga V. Clinical evaluation of patients with vestibular dysfunction. *Neurol Res Int.* 2019;2019:3931548.

Schwann ZG, Babu S, Schutt CA. Bilateral vestibular hypofunction. In: Babu S, Schutt CA, Bojrab DI, eds. *Diagnosis and Treatment of Vestibular Disorders*. Cham, Switzerland: Springer; 2019:291-300.

van de Berg R, van Tilburg M, Kingma H. Bilateral vestibular hypofunction: challenges in establishing the diagnosis in adults. ORL J Otorhinolaryngol Relat Spec. 2015;77(4):197-218.

Vestibular Disorders Association. https://vestibular.org.

Yetişer S. Intratympanic gentamicin for intractable Meniere's disease: a review and analysis of audiovestibular impact. *Int Arch Otorhinolaryngol.* 2018;22(2):190-194.

Zaleski-King AC, Lai W, Sweeney AD. Anatomy and physiology of the vestibular system. In: Babu S, Schutt CA, Bojrab DI, eds. *Diagnosis and Treatment of Vestibular Disorders*. Cham, Switzerland: Springer; 2019:3-16.

Zalewski CK, McCaslin DL, Carlson ML. Rotary chair testing. In: Babu S, Schutt CA, Bojrab DI, eds. *Diagnosis and Treatment of Vestibular Disorders*. Cham, Switzerland: Springer; 2019:75-98.

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