

A COMPHREHENSIVE REVIEW ON VERTIGO

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ABSTRACT
Vertigo is a prevalent and often debilitating symptom characterized by the sensation of motion or spinning in the absence of actual movement. It affects a significant portion of the population and can stem from a wide range of underlying conditions involving the peripheral or central vestibular systems. This comprehensive review explores the pathophysiology, classification, diagnostic approaches, and management strategies for vertigo. Emphasis is placed on differentiating between peripheral causes, such as benign paroxysmal positional vertigo (BPPV), Ménière’s disease, and vestibular neuritis, and central causes, including stroke and multiple sclerosis. The review also examines current diagnostic tools, such as the Dix-Hallpike maneuver, videonystagmography (VNG), and MRI imaging. Therapeutic options, including vestibular rehabilitation, pharmacologic treatment, and surgical interventions, are discussed with a focus on evidence-based practices. The review aims to provide clinicians and researchers with an updated and holistic understanding of vertigo to facilitate accurate diagnosis and effective patient management.

KEYWORDS: Vertigo, Vestibular System, Benign Paroxysmal Positional Vertigo (BPPV), Ménière’s Disease, Vestibular Neuritis, Dizziness, Vestibular Rehabilitation.

INTRODUCTION
Vertigo is a complex and frequently encountered clinical symptom characterized by the illusion of motion, typically described by patients as a spinning, tilting, or swaying sensation, often accompanied by imbalance, nausea, or even vomiting. It significantly impacts the quality of life and daily functioning of affected individuals and is a common reason for medical consultations, especially in neurology, otolaryngology, and primary care settings. While vertigo is commonly mistaken for dizziness, it is a more specific term that denotes a false sense of rotational movement, distinguishing it from other types of dizziness such as presyncope, disequilibrium, or nonspecific lightheadedness.^[1]

The etiology of vertigo is broad and diverse, encompassing disorders of the peripheral vestibular system—primarily located within the inner ear—as well as central nervous system pathologies that affect the brainstem and cerebellum. Common peripheral causes include benign paroxysmal positional vertigo (BPPV), Ménière’s disease, vestibular neuritis, and labyrinthitis, whereas central causes involve more serious conditions like brainstem strokes, multiple sclerosis, and tumors of

the cerebellopontine angle.^[2] Differentiating between peripheral and central vertigo is critical due to differences in prognosis, urgency, and treatment approach.

Advancements in diagnostic methodologies—such as videonystagmography (VNG), vestibular evoked myogenic potentials (VEMPs), and imaging techniques like magnetic resonance imaging (MRI)—have significantly improved the ability to localize and identify the underlying cause of vertigo. Moreover, developments in vestibular rehabilitation therapy and pharmacological interventions have enhanced treatment outcomes and symptom control for many patients.^[3]

Despite the high prevalence and clinical significance of vertigo, it remains a diagnostic and therapeutic challenge due to its multifactorial nature and the subjective variability in symptom presentation. Misdiagnosis is not uncommon, often leading to inappropriate management and prolonged patient distress. Therefore, a comprehensive understanding of the pathophysiology, clinical evaluation, diagnostic techniques, and evidence-based treatment options is essential for healthcare providers involved in the care of patients with vertigo.

This review aims to provide an in-depth exploration of the various dimensions of vertigo, encompassing its classification, etiologies, diagnostic pathways, and management strategies. It also highlights recent advances in clinical practice and research that contribute to a more accurate diagnosis and effective therapeutic approach.^[4] By integrating current knowledge across disciplines, this review seeks to serve as a valuable resource for clinicians, researchers, and medical students interested in the comprehensive care of patients with vertigo.

LITERATURE REVIEW

Grillo et al. (2024) conducted a systematic review and meta-analysis assessing the effectiveness of telerehabilitation for patients experiencing dizziness. Their findings suggest that remote vestibular rehabilitation can be as effective as traditional in-person therapy, offering a viable alternative, especially in situations where access to healthcare facilities is limited.

Bumantari and Dewi (2024) explored the connection between nutrition and vertigo, highlighting how dietary factors may influence vestibular health. Their systematic review emphasizes the need for further research into nutritional interventions as potential adjunct therapies for vertigo management.

Pan et al. (2024) performed a bibliometric analysis to investigate the relationship between vestibular disorders, vertigo, and cognitive impairment in the elderly population. The study underscores the growing interest in understanding how vestibular dysfunctions may contribute to cognitive decline in older adults.

Swain (2023) revisited the underlying mechanisms of BPPV, discussing recent insights into its pathophysiology. The review provides a comprehensive overview of the current understanding of BPPV, aiding clinicians in diagnosis and treatment planning.

Casani et al. (2023) presented a narrative review based on a single-center clinical experience, categorizing patients with vertigo into acute, episodic, and chronic imbalance groups. Their findings highlight the importance of thorough clinical evaluation in differentiating between various vertigo presentations.

A 2022 narrative review emphasized the increasing recognition of vestibular migraine (VM) as a common cause of episodic vertigo. The study discussed the challenges in diagnosing VM and the need for targeted treatment strategies.

Castillo-Bustamante et al. (2022) highlighted the prevalence and challenges of diagnosing vertigo in adolescents. The review pointed out the lack of comprehensive epidemiological data in this age group and the need for age-specific diagnostic criteria.

Korres et al. (2022) conducted a systematic review to determine the prevalence of dizziness and vertigo among COVID-19 patients. Their findings suggest that vertigo can be a neurological manifestation of COVID-19, warranting attention in clinical assessments.

Pham et al. (2022) introduced "Look and Diagnose" (LAD), a hybrid deep learning system designed to assist in diagnosing BPPV. The system analyzes eye movements during positional tests, achieving high accuracy in classifying BPPV subtypes, thus supporting clinicians in diagnosis.

Ersoy et al. (2023) proposed the I-BaR system, integrating virtual reality and robotic platforms to enhance balance rehabilitation. This framework aims to provide individualized therapy, improving outcomes for patients with balance disorders.

RESULTS AND DISCUSSION

Recent literature continues to emphasize the critical distinction between peripheral and central vertigo. Peripheral vertigo, accounting for nearly 80% of vertigo cases, is commonly associated with disorders of the inner ear, such as benign paroxysmal positional vertigo (BPPV), Ménière's disease, and vestibular neuritis. Central vertigo, while less common, is linked to serious neurological conditions such as cerebellar stroke, multiple sclerosis, and vestibular migraine.^[5]

Studies over the past decade consistently report that BPPV is the most frequent cause of vertigo. A 2023 systematic review confirmed BPPV as the leading etiology in patients over 60, with a strong link to otolith dysfunction. Meanwhile, vestibular migraine is increasingly recognized, especially among younger adults and women, suggesting a shift in diagnostic attention toward central mechanisms.

Diagnostic Strategies and Tools

The review of diagnostic methodologies reveals a significant evolution from reliance on clinical history and bedside examination to more advanced diagnostic modalities. Traditional maneuvers like the **Dix-Hallpike test** and **head impulse test** remain highly effective in diagnosing BPPV and vestibular hypofunction, respectively.

However, the integration of **videonystagmography (VNG)**, **vestibular evoked myogenic potentials (VEMPs)**, and **magnetic resonance imaging (MRI)** has enhanced diagnostic accuracy, especially for central vertigo. A 2024 meta-analysis highlighted that combining clinical evaluation with VNG increased diagnostic sensitivity by over 25% in complex cases.^[6]

Artificial intelligence and machine learning are also beginning to play a role. Recent studies report early success in using algorithm-based systems to differentiate

between vertigo types based on symptom clusters, eye movement patterns, and imaging data.

Treatment Modalities and Management Approaches

Management strategies for vertigo have diversified and become more tailored. For **BPPV**, repositioning maneuvers such as the **Epley** and **Semont** techniques remain first-line treatments and show >90% efficacy when properly administered.

In contrast, treatment for **Ménière's disease** has progressed from symptomatic management (diuretics, low-salt diet) to intratympanic steroid injections and, in refractory cases, endolymphatic sac surgery. Vestibular migraine is primarily managed with migraine prophylaxis and lifestyle modification, though the lack of randomized controlled trials limits the development of specific guidelines.

Vestibular rehabilitation therapy (VRT) has become a cornerstone for chronic and persistent vertigo. A 2023 randomized trial showed that patients undergoing customized VRT exhibited significantly improved balance and reduced recurrence rates compared to those receiving pharmacotherapy alone.

Most recently, **telerehabilitation** has emerged as a viable option. A 2024 study found that remote vestibular therapy programs produced outcomes comparable to in-person therapy, especially for patients with mobility issues or in rural settings.^[7]

Psychosocial and Cognitive Implications

Several recent studies underscore the impact of vertigo beyond physical symptoms. Patients with chronic vertigo are at increased risk for **anxiety, depression, and social withdrawal**. Cognitive impairments, particularly in the elderly, are also receiving attention. A 2024 bibliometric review revealed increasing publications linking vestibular dysfunction to **cognitive decline**, especially in domains of spatial memory and executive function.

These findings suggest a need for a **multidisciplinary treatment approach**, integrating neurology, otolaryngology, psychiatry, and physiotherapy, especially in older adults or patients with recurrent episodes.

Gaps and Future Directions

Despite significant advancements, challenges remain in vertigo diagnosis and management: **Underdiagnosis of central causes**, particularly vestibular migraine and cerebellar stroke. **Limited public awareness**, often delaying presentation and diagnosis. **Insufficient integration of psychological evaluation** in chronic vertigo patients. **Lack of standardized protocols** for telerehabilitation and cognitive screening.^[8]

Future research should focus on Longitudinal studies examining vertigo's long-term cognitive effects. Development of portable, AI-assisted diagnostic tools.

Exploration of nutritional and metabolic contributors to vestibular disorders.

The evolving landscape of vertigo research reflects a transition from symptom-based management to a more **integrated, multidisciplinary, and evidence-based approach**. Accurate classification, timely diagnosis, and personalized management are critical to improving outcomes and quality of life for affected individuals. Continued research, particularly in emerging areas like digital diagnostics and vestibular-cognitive relationships, will further refine the clinical management of vertigo in years to come.

Heterogeneity of Sources: The studies reviewed vary widely in design, population demographics, diagnostic criteria, and outcome measures. This heterogeneity makes direct comparisons between studies challenging and may influence the generalizability of conclusions.

Limited High-Quality Randomized Controlled Trials:

Although observational studies and case series are abundant, there remains a relative lack of high-quality randomized controlled trials (RCTs), particularly in areas such as vestibular migraine, telerehabilitation, and long-term management strategies. This limits the strength of evidence supporting certain treatment recommendations.^[9]

Publication Bias: As with many review articles, there is a potential for publication bias, where positive results are more likely to be published than negative or null findings. This may skew the perceived effectiveness of certain diagnostic or treatment methods.

Language and Accessibility Restrictions: This review primarily includes studies published in English and those available through open-access or academic databases. Important findings published in other languages or in inaccessible journals may have been unintentionally excluded.

Emerging Technologies Not Fully Validated: Many recent advancements in vertigo diagnostics, such as AI-assisted analysis and wearable vestibular devices, are still in early stages. Their inclusion in the review reflects potential rather than fully validated clinical application, and further research is required to confirm their utility.

Limited Data on Long-Term Outcomes: There is a scarcity of long-term follow-up studies for many vertigo treatments, especially newer approaches like virtual rehabilitation and vestibular implants. This limits the ability to assess the durability and safety of these interventions over time.

Population-Specific Gaps: Some patient populations—such as children, individuals in low-resource settings, and those with cognitive impairments—are underrepresented in current research, making it difficult

to generalize findings to these groups.^[10] While the review captures the current landscape of vertigo research and clinical practice, these limitations underscore the need for more standardized, inclusive, and methodologically rigorous studies. Future work should aim to address these gaps to better inform clinical guidelines and patient care.

CONCLUSION

Vertigo remains one of the most common yet complex clinical symptoms encountered across multiple medical disciplines. Its multifactorial etiology—ranging from benign peripheral causes like BPPV to more serious central nervous system disorders such as vestibular migraine and cerebellar stroke—necessitates a careful and systematic approach to diagnosis and management. Over the past decade, significant advancements have been made in understanding the pathophysiology of vertigo, refining diagnostic tools, and developing more effective treatment strategies, including vestibular rehabilitation and telerehabilitation.

This review has highlighted the importance of distinguishing between peripheral and central causes, utilizing both clinical and technological tools for accurate diagnosis, and adopting personalized, evidence-based management approaches. It also emphasized the growing recognition of vertigo's impact on cognitive and psychological health, particularly in the elderly, and the need for integrated, multidisciplinary care.

Despite these advances, several gaps remain, including limited high-quality clinical trials, underrepresentation of certain patient populations, and the need for standardized treatment protocols. Addressing these limitations through continued research and innovation will be crucial in improving long-term outcomes and quality of life for individuals affected by vertigo.

In conclusion, a comprehensive, patient-centered approach that integrates current clinical knowledge, technological advancements, and interdisciplinary collaboration offers the best path forward in the effective management of vertigo. Continued education, research, and awareness are essential to reduce misdiagnosis, enhance therapeutic outcomes, and provide holistic care for this often-debilitating condition.

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