



Clinical Predictors of Hearing Preservation in Ménière Disease

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Abstrak

Hasil pendengaran pada penyakit Ménière bersifat heterogen, mulai dari fluktuasi yang berkepanjangan hingga penurunan yang ireversibel dan keterlibatan bilateral. Karena tingkat pendengaran memengaruhi konseling dan perencanaan tindak lanjut, dokter memerlukan prediktor praktis yang tersedia dari anamnesis dan audiometri rutin. Tinjauan ini merangkum bukti yang dipublikasikan antara tahun 2016 dan 2025 tentang prediktor klinis yang terkait dengan pelestarian pendengaran pada penyakit Ménière. Di seluruh kohort kontemporer dan data metaanalitik, usia yang lebih tua dan durasi penyakit yang lebih lama berulang kali dikaitkan dengan pendengaran yang lebih buruk dan kemungkinan yang lebih rendah untuk mempertahankan ambang batas yang memadai. Audiometri dasar adalah prediktor yang paling dapat ditindaklanjuti, stadium awal dan kehilangan dominan frekuensi rendah menunjukkan probabilitas yang lebih besar untuk ambang batas yang stabil atau membaik dengan manajemen konservatif, sementara keterlibatan frekuensi yang lebih luas dan kehilangan frekuensi tinggi ini dikaitkan dengan perkembangan dan peningkatan risiko penyakit bilateral. Migrain komorbid dan fenotipe klinis spesifik pada saat onset juga telah dikaitkan dengan keterlibatan bilateral. Secara keseluruhan, usia, durasi penyakit, stadium awal, pola frekuensi kehilangan pendengaran, riwayat migrain, dan fenotipe onset membentuk kerangka kerja untuk stratifikasi risiko dan tindak lanjut pendengaran pada penyakit Ménière.

Kata Kunci : Audiometri, prediktor klinis, pendengaran, penyakit Ménière, prognosis

Abstract

Hearing outcomes in Ménière disease are heterogeneous, ranging from prolonged fluctuation to irreversible decline and bilateral involvement. Because hearing level influences counselling and follow up planning, clinicians need practical predictors that are available from history taking and routine audiometry. This review summarises evidence published between 2016 and 2025 on clinical predictors associated with hearing preservation in Ménière disease. Across contemporary cohorts and metaanalytic data, older age and longer disease duration are repeatedly associated with poorer hearing and a lower likelihood of maintaining serviceable thresholds. Baseline audiometry is the most actionable predictor, earlier stages and low frequency predominant loss show a greater probability of stable or improved thresholds with conservative management, while broader frequency involvement and early high frequency loss are linked to progression and increased risk of bilateral disease. Comorbid migraine and specific clinical phenotypes at onset have also been associated with bilateral involvement. Overall, age, disease duration, baseline stage, frequency pattern of loss, migraine history, and onset phenotypes form a framework for risk stratification and hearing follow up in Ménière disease.

Keywords : Audiometry, clinical predictors, hearing, Ménière disease, prognosis

Introduction

Ménière disease is a chronic inner ear disorder classically defined by recurrent spontaneous vertigo, fluctuating aural symptoms, and sensorineural hearing loss. Current clinical practice guidance emphasises that diagnosis relies primarily on clinical history



supported by audiometry, and that management aims not only to control vertigo but also to relieve or prevent progressive auditory disability (1).

Although vertigo is often the most disabling symptom at presentation, long term quality of life is strongly shaped by hearing trajectories, communication limitations, and the timing of hearing rehabilitation. International consensus recommendations explicitly link treatment escalation to hearing status, reserving hearing destructive options for cases with non serviceable hearing, while considering hearing sparing procedures when preservation is still realistic (2).

The auditory course of Ménière disease varies widely across individuals. Some patients remain in an early fluctuating stage for years, while others show relatively rapid deterioration or progression to bilateral disease. Recent reviews and phenotyping work highlight that Ménière disease is likely a clinical umbrella rather than a single biological entity, which partly explains the variability in hearing outcomes (3,4).

From a clinical standpoint, prediction is needed at two levels. First, clinicians need to estimate whether the affected ear is likely to maintain stable, serviceable hearing. Second, clinicians need to estimate the risk of contralateral involvement, because bilateral disease changes counselling, monitoring intensity, and the urgency of hearing preservation strategies. The aim of this review is to synthesise recent evidence on clinical predictors of hearing preservation in Ménière disease, with an emphasis on factors that are routinely available in outpatient practice.

Method

A. Searching Strategy

We conducted a literature review to identify contemporary evidence on predictors of hearing preservation in Ménière disease. We searched PubMed and cross referenced relevant articles from bibliographies and guideline documents. Search terms included combinations of Ménière disease, hearing outcome, hearing preservation, prognosis, predictors and audiometry. The search yielded 23 records; after title and abstract screening and full text assessment, 15 articles were included in the final synthesis.

B. Eligibility Criteria

Eligible publications were limited to the last ten years (2016 to 2025) and included clinical practice guidelines, consensus statements, longitudinal cohort studies, predictive modelling studies, and systematic reviews or metaanalyses reporting auditory outcomes or contralateral hearing loss over follow up. Studies focusing on non routine investigations

beyond bedside assessment and standard audiometry were not prioritised in order to maintain a clinically oriented scope.

C. Data Extraction

Data were synthesised qualitatively. Predictors were grouped into demographic, baseline audiometric profile, comorbidity and phenotypic features, and predictors of bilateral involvement. Because outcome definitions vary across studies, hearing preservation is discussed pragmatically as stable or improved thresholds over follow up, maintenance of serviceable hearing, or avoidance of contralateral sensorineural hearing loss.

Results

Demographic Predictors

Across recent observational studies, age and disease duration remain consistent correlates of hearing status. A large retrospective analysis describing symptom evolution reported that diagnosis is often delayed, and that auditory and balance related symptoms persist even as vertigo spells attenuate with longer duration (5). Longitudinal work also suggests that clinical subgroups may have different ages of onset, which may influence long term auditory disability (6).

An additional dimension is the age at onset, which has been incorporated into predictive models for contralateral involvement. In a multicentre model for bilateral sensorineural hearing loss, age of onset above the mid thirties contributed to a higher probability of developing contralateral loss when combined with audiometric and comorbidity variables (7).

While age and duration are not modifiable, they inform counselling and follow up intensity. Patients with older age or longstanding disease should be counselled that stable thresholds are less likely and that functional decline may occur even without dramatic changes in pure tone averages (8).

Baseline Audiometry and Clinical Stage

Baseline audiometry is central to prognostication because it captures both current cochlear reserve and the frequency distribution of the loss. The clinical practice guideline highlights audiometry as the key test to document hearing involvement and support diagnosis, and the same data are used pragmatically to stage hearing and track progression (1).

In a cohort managed with structured conservative measures and close follow up, most affected ears demonstrated stable or improved low frequency thresholds after one year,

although high frequency thresholds were less likely to improve (9). These findings support the clinical observation that earlier stage disease with low frequency predominant involvement often retains some reversibility, whereas broader frequency involvement may signal more advanced cochlear injury.

Clinical severity stratification also aligns with the probability of response to conservative care. A staging system integrating vertigo severity, subjective hearing loss, and comorbidity burden showed that patients without subjective hearing loss had the highest response rates to conservative treatment, while the presence of hearing loss and higher symptom burden were associated with poorer response (10). Although the outcome in that work focused on symptom response, the staging construct is clinically relevant because persistent symptoms often prompt escalation to interventions that may carry different hearing risks (2).

Audiometric Pattern and Risk of Bilateral Involvement

The frequency pattern on the first audiogram appears to carry prognostic information beyond stage alone. High frequency involvement early in the disease course has been linked to a higher risk of subsequent contralateral sensorineural hearing loss. In a multicentre retrospective longitudinal study, high frequency hearing loss on the first audiogram, migraine history, and age of onset were retained as clinical predictors in the final model for bilateral involvement (7).

Meta analytic evidence supports the clinical relevance of contralateral progression. A systematic review and meta analysis estimated long term risk of progression from unilateral to bilateral disease and highlighted that risk increases with longer observation, reinforcing the need for long follow up when counselling newly diagnosed patients (11).

Bilateral Ménière disease is not clinically uniform. A longitudinal study distinguishing synchronous versus metachronous bilateral debut suggested that timing patterns may reflect different disease behaviour, and that the chronology of symptom appearance can inform prognosis and monitoring (12). Phenotype based clustering has similarly identified clinical predictors such as migraine history and familial disease patterns that may delineate subgroups with different risks of bilateral involvement (6).

Beyond pure-tone thresholds, speech audiometry offers additional functional insight. Speech recognition performance can show a dissociation from pure-tone averages in Ménière disease, meaning that communication difficulty may be underestimated if monitoring relies only on threshold-based metrics (8). Longitudinal follow-up studies also

suggest that tracking speech recognition scores can reveal clinically meaningful changes over time and may complement pure-tone audiometry when defining hearing preservation in practice (13).

Comorbidity and Phenotypic Features

Migraine has emerged repeatedly as a relevant comorbidity in Ménière cohorts and may be linked to both diagnostic overlap and disease behaviour. The diagnostic boundary between vestibular migraine and Ménière disease can be challenging in practice, and recent reviews emphasise careful phenotyping and longitudinal observation when symptoms overlap (14). In prediction models for bilateral hearing loss, migraine history contributed to risk stratification, although effect sizes vary across datasets (7).

More broadly, subtyping frameworks propose that different clinical clusters may underlie different courses, including different probabilities of bilateral hearing loss. Recent work on subtyping argues that integrating clinical features, comorbidities, and the chronology of audiovestibular symptoms may be more informative than treating Ménière disease as a single homogeneous entity (4,6).

Table 1. Summary of Clinical Predictors Associated with Hearing Preservation and Bilateral Risk in Ménière disease

Predictor	Association with hearing preservation	Key supporting evidence
Older age or later age of onset	Generally associated with worse hearing status over time and lower probability of maintaining serviceable thresholds	Pyykkö et al. 2024; Moleon et al. 2022 (5,7)
Longer disease duration or delayed diagnosis	Associated with persistent auditory symptoms and progression risk; informs need for long term monitoring	Pyykkö et al. 2024; Hudson et al. 2025 (5,11)
Baseline audiometric stage (pure tone thresholds)	Earlier stages more likely to remain stable or improve with conservative management; later stages less likely	Basura et al. 2020; Zhang et al. 2022 (1,9)
Frequency pattern on first audiogram	Low frequency predominant loss suggests greater chance of shortterm stability; broad frequency involvement suggests progression risk	Zhang et al. 2022; Zhang et al. 2025 (9,15)
Early high frequency hearing loss	Associated with increased risk of later contralateral sensorineural hearing loss	Moleon et al. 2022; Hudson et al. 2025 (7,11)
Migraine history and phenotypic clustering	Associated with specific clinical subgroups and bilateral risk in several datasets; requires careful differential diagnosis	Moleon et al. 2022; Chen et al. 2023; Frejo et al. 2016 (6,7,14)

Discussion

The past decade of literature supports a pragmatic view that hearing prognosis in Ménière disease can be estimated using a small set of routinely available variables, even though the underlying biology remains heterogeneous. Age and duration are consistent correlates of hearing status, but their clinical value lies mainly in setting expectations and shaping follow up intensity rather than guiding specific interventions (3,4).

Baseline audiometry remains the strongest actionable element for hearing focused care. The guideline centred approach to diagnosis relies on documenting sensorineural loss, and the same audiogram provides the foundation for staging, monitoring, and counselling (1). Evidence from structured conservative management cohorts suggests that short term improvement is more common in low frequency ranges, whereas high frequency thresholds are more resistant to recovery, supporting the concept of early cochlear reserve in some patients (9). Clinicians should therefore interpret early low frequency fluctuation as potentially reversible, while broader patterns may indicate a transition toward more permanent injury.

The risk of bilateral involvement is a critical counselling point because it transforms the functional impact of the disorder. Meta analytic data confirm that contralateral progression is not rare over long follow up, and individual studies suggest that the chronology of bilateral debut may reflect different disease behaviour (11,12). Importantly, recent prediction modelling indicates that early high frequency involvement, age at onset, and migraine history can help stratify the probability of contralateral sensorineural hearing loss, although the predictive performance is moderate and should be applied cautiously (7). Phenotype based frameworks further argue that migraine and familial patterns may mark clinically meaningful subgroups (6,15).

From a functional standpoint, reliance on pure tone averages alone risks underestimating disability. Speech audiometry, particularly speech recognition or word recognition scores, can capture communication outcomes that may not align with pure-tone thresholds in Ménière disease and can therefore complement threshold-based monitoring when counselling patients (8,13). Clinical severity staging may also inform decision making indirectly by anticipating treatment escalation. Patients with a combination of severe vestibular symptoms, hearing loss, and high comorbidity burden are less likely to respond to conservative care, which can lead to consideration of intratympanic therapy or surgery (10). Consensus recommendations emphasise that hearing status should influence the choice

between hearing sparing and hearing destructive interventions, reinforcing the need to discuss hearing priorities early (2).

Several limitations constrain the strength of inferences. Outcome definitions vary, follow up duration is inconsistent, and many studies originate from tertiary centres with selected populations. Predictive models require external validation across health systems and should be paired with shared decision making.

Conclusion and Recommendation

Recent evidence from observational cohorts, predictive modelling studies, and meta-analyses supports a pragmatic set of clinical predictors that are readily obtainable in routine practice. Advancing age and longer disease duration are consistently associated with less favourable auditory trajectories. In contrast, baseline audiometric stage and the frequency profile of hearing loss, including predominantly low-frequency loss versus broader involvement or early high-frequency impairment, represent the most clinically actionable parameters for hearing preservation counselling. Evidence related to bilateral involvement further indicates that early high-frequency loss, a history of migraine, and distinct onset phenotypes are linked to a higher likelihood of contralateral progression. These findings underscore that Ménière disease should be conceptualised as a dynamic condition with a potential for bilateral evolution rather than a static unilateral disorder.

In clinical practice, recommendations include: (1) documenting baseline hearing stage and audiogram configuration at the time of diagnosis using standard pure-tone audiometry, with repeated assessments during follow-up; (2) tailoring monitoring intensity through risk stratification, whereby individuals with broad frequency involvement, early high-frequency loss, prolonged pre-diagnostic symptom duration, migraine history, or higher overall symptom burden merit closer follow-up and earlier counselling regarding bilateral risk and hearing rehabilitation planning; and (3) when treatment escalation is considered, selecting interventions in accordance with the patient's hearing-related priorities while explicitly discussing the comparative risks to hearing across available options, consistent with guideline and consensus principles.

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