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A Narrative Review: Redefining Meniere's Disease Diagnosis in the Era of Precision Medicine

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ABSTRACT
Ménière's disease (MD) is a chronic inner ear disorder marked by recurrent vertigo, tinnitus, aural fullness, and sensorineural hearing loss. It represents 7–8% of vertigo cases in outpatient settings and often leads to significant disability. The absence of a gold standard diagnostic test remains a challenge for accurate and timely diagnosis. A narrative review was conducted in line with Scale for the Quality Assessment of Narrative Review Articles (SANRA) guidelines. Literature searches were performed in PubMed, ScienceDirect, and Google Scholar using the terms ("Meniere's Disease" OR "Vertigo" OR "Auditory") AND ("diagnostic examination" OR "diagnostic test"), limited to the last 10 years. Eligible studies were human research evaluating diagnostic methods for MD, available in full text. Nine studies met inclusion criteria: three observational cohort, four retrospective study, two prospective study, one structured review. Diagnostic methods assessed included audiometry, Vestibular Evoked Myogenic Potentials (VEMP), Electrocochleography (ECochG), Video Head Impulse Test (vHIT), and hydrops-sensitive Magnetic Resonance Imaging (MRI). Among these, MRI emerged as the most promising technique for early and reliable diagnosis. MD is a multidimensional condition involving auditory, vestibular, and neuropsychological systems. Hydrops MRI holds strong potential as a future diagnostic standard, but further multicenter validation is required before its widespread clinical adoption.

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INTRODUCTION

Ménière's Disease (MD) is one of the most complex inner ear disorders because the symptoms that appear vary from patient to patient. The main symptoms include recurrent vertigo attacks, ringing in the ears (tinnitus), a feeling of fullness in the ear, and variable sensorineural hearing loss. MD accounts for only about 7.2 to 7.5% of all vertigo cases seen in outpatient clinics, but this condition often causes significant impairment and disrupts sufferers' daily routines (Young et al., 2022). The prevalence of MD varies worldwide. Reported incidence ranges from 3.5 to 513 per 100,000 individuals, with a female to male ratio of approximately 1.89:1.

The clinical signs of MD can vary among individuals. It is noted that the majority of patients experience sudden vertigo lasting between 20 minutes and 12 hours, often

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accompanied by ringing and hearing loss in the low to mid frequencies. This diversity of symptoms presents a diagnostic challenge because the symptoms experienced by patients resemble vestibular migraines or other inner ear disorders (Young et al., 2022). MD has long been associated with the theory that endolymphatic hydrops, or endolymphatic hydrops, is an accumulation of endolymph. This accumulation is believed to cause rupture of Reissner's membrane, resulting in a mixture of potassium-rich endolymph with perilymph, resulting in abnormal depolarization of the vestibular nerve. A recent alternative theory posits a mechanism for endolymph drainage through physiological valves such as the valve of Bast. This theory suggests that accumulated endolymph can periodically drain into other compartments before eventually reaccumulating. Understanding the function of the endolymphatic sac is becoming clearer, as evidenced by the success of surgical interventions involving endolymphatic duct decompression or blockage in patients who do not respond to conservative therapy (Young et al., 2022).

Radiological data can provide further insight into how the disease progresses. Visible endolymphatic sac hypoplasia can predict the likelihood of MD progressing from unilateral to bilateral. Their study found that approximately 69% of patients with bilateral hypoplasia progressed to bilateral MD within 12 years. Patients with bilateral MD also frequently experience chronic vestibulopathy, characterized by oscillopsia, severe balance difficulties, and cognitive and emotional problems. This condition can result in severe hearing loss, ranging from complete deafness to complete deafness, significantly impairing the patient's quality of life. This highlights the importance of imaging in determining prognosis and long-term management strategies (Bächinger et al., 2021).

Molecular mechanisms provide deeper insights into the symptoms experienced by patients. Proteins that function in the tectorial membrane and the stereociliary connections of hair cells in the inner ear play a crucial role in the development of MD symptoms. Local detachment of this membrane can cause irregular depolarization of the hair cells, explaining why patients may experience sudden attacks of vertigo and changes in tinnitus levels. Immunological factors also need to be considered. Proinflammatory cytokines are thought to induce persistent inflammation in the inner ear. This can exacerbate endolymphatic fluid accumulation and disrupt ionic balance. These findings suggest an interplay between immune, environmental, and genetic elements in shaping the highly variable disease phenotype (Frejo & Lopez-Escamez, 2023).

Comorbidities also explain the diversity of pathogenesis, with significant associations between MD and migraines, autoimmune conditions, and allergies. Migraine rates in individuals with MD are even twice as high compared to the general population. This phenomenon raises the possibility of overlapping pathophysiological pathways, such as dysregulation of calcium ions and other ion channels. Variations in clinical phenotypes make MD a heterogeneous disease (Frejo & Lopez-Escamez, 2023). Although most cases occur sporadically, the presence of familial cases and the identification of recurrent genes in patients suggests a strong genetic basis (Fisch et al., 2024).

To date, the diagnosis of MD still relies on clinical criteria established by the Bárány Society and the American Academy of Otolaryngology–Head and Neck Surgery. A history of

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episodic vertigo accompanied by auricular symptoms and audiometric evidence are essential for the diagnosis (Young et al., 2022). However, the lack of a single, specific biomarker often requires a combination of various vestibular and audiometric examinations.

METHOD

Search Strategy

This study employed a narrative review approach, or the Scale for the Quality Assessment of Narrative Review Articles (SANRA), to analyze Ménière's Disease (MD). This method was chosen because of its ability to integrate various scientific journals published to date. SANRA was used as a guideline for writing this article to ensure the quality of the manuscript for publication.

The literature search was conducted through leading journal databases, including PubMed, Scopus, ScienceDirect, and Google Scholar. Keywords used in various combinations included ("Ménière's Disease" OR "Vertigo" OR "Auditory") AND ("Diagnostic examination" OR "Diagnostic test"). The search timeframe was set to the last 10 years to ensure the freshness of the information and reviews, thus maintaining the relevance and quality of the literature.

Inclusion and Exclusion Criteria

In developing this narrative review, inclusion criteria for literature sources were designed to ensure a comprehensive and evidence-based review. Top priority was given to recent clinical guidelines from authoritative institutions (AAO-HNS and Barany Society), systematic reviews, and randomized clinical trials addressing Ménière's disease diagnostic methods. Relevant observational studies and case reports were also considered, specifically evaluating the accuracy and utility of the diagnostic modalities under review. Topics covered included clinical symptoms, diagnostic criteria, and ancillary examinations. The study population was limited to human patients with a definitive or probable diagnosis of Ménière's disease based on the 1995/2015 AAO-HNS criteria or other recognized international criteria. Sources were selected from English-language articles published within the last 10-15 years. Topically, this narrative review focused on sources discussing variations in Ménière's disease patient conditions, diagnostic criteria and methods, and their impact on patient quality of life. Only articles available in full text and published in accredited journals were included. On the other hand, exclusion criteria included non-human studies (such as animal or in vitro studies), articles focusing on therapy without discussing diagnosis, individual case reports or series with very limited patient numbers, literature not readily accessible in full text, and publications unrelated to diagnostic aspects (such as those addressing only epidemiology or quality of life). Furthermore, articles with weak methodology, such as the lack of clear diagnostic criteria or analyzable examination data, were also removed from the review.

Study Selection Process

In a literature search using a predetermined search strategy, we identified nine medical articles that met the title, inclusion criteria, and exclusion criteria. Data relevant to the study title were extracted from articles that met the criteria to develop a first draft. As a final step to ensure the quality of the research articles, an independent evaluation was conducted using

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SANRA guidelines before the manuscript was finalized, resulting in a total score of 9 out of 12 points, indicating good quality.

RESULTS AND DISCCUSION

Table 1. Comparison of Meniere's Disease Diagnosis Methods

Title	Author	Year	Study Design	Evaluation Of Examination Results
Electrochleography in Cochlear Implant Users with Residual Acoustic Hearing	Jeong-Seo Kim	2020	Observational post-operative cohort (retrospective/prospective)	Electrocochleography (ECoG) has proven feasible for providing real-time intraoperative feedback and monitoring postoperative hearing preservation in cochlear implant (CI) patients with residual hearing. ECoG is a diagnostic tool for Meniere's disease/endolymphatic hydrops, characterized by enlarged summating potentials (SP) and an increased SP/Action Potential (AP) ratio due to increased endolymphatic volume.
Optimizing staging of Meniere's disease: integrating electrocochleography with vestibular tests	Huang, et al	2025		Study results indicate that combining electrocochleography (ECochleography) with vestibular examination provides higher sensitivity (98.5% total positivity) compared to traditional audiometry-based testing. Abnormalities in ECochG were detected in 54.5%, Cervical Vestibular Evoked Myogenic Potential (cVEMP) in 75.8%, Ocular Vestibular-Evoked Myogenic Potential (oVEMP) in 69.7%, CT in 66.7%, and Video Head Impulse Test (vHIT) in 24.2%. The new staging system identified more cases in the early phase (stages I–II = 66.7%) compared to the previous system, which was dominated by stage III (54.5%). The Random Forest model demonstrated robustness of this method (90% accuracy, F1-score 0.90). These results demonstrate that multimodal testing is more appropriate within the precision medicine paradigm, enabling earlier detection, more precise patient stratification, and personalized treatment based on cochlear and vestibular function profiles.

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Title	Author	Year	Study Design	Evaluation Of Examination Results
Assessment of Inter-Frequency Amplitude Ratio (1000/500 Hz) in cVEMP and oVEMP for the Dlagnosis of Meniere's Disease	Sacha Drabkin, et al	2024	Observational cohort analytic research	Researchers found no evidence that the 1000/500 Hz amplitude ratio of Cervical Vestibular Evoked Myogenic Potential (cVEMP) and Ocular Vestibular-Evoked Myogenic Potential (oVEMP) tests is an effective diagnostic method for distinguishing between Ménière's disease-affected and healthy ears. The finding that age influences the Inter-Frequency Amplitude Ratio (IFAR) value is an important finding, indicating that using IFAR without considering patient age, especially in the elderly, risks misdiagnosis. The naturally occurring increase in IFAR due to aging can be mistaken for Meniere's disease.
Evaluation of vestibular evoked myogenic potentials (VEMP) and electrocochleography for the diagnosis of Ménière's disease.	Lamounier, et al	2017	Retrospective study	The study findings indicate that both tests have high specificity (84.6–100%), making them effective in eliminating the diagnosis of Meniere's disease. However, their sensitivity is low to moderate, with Vestibular-Evoked Myogenic Potential (VEMP) 62.5–63.6% and Electrocochleography (ECochG) 37.5–63.6%, with VEMP showing slightly higher sensitivity than ECochG. Concordance between the two tests was moderate in the right ear ($\kappa = 0.54$) but weak in the left ear ($\kappa = 0.07$), suggesting that VEMP and ECochG evaluate different labyrinthine structures (saccule and cochlea). A significant finding was the presence of VEMP changes even in the asymptomatic ear, which may indicate subclinical saccular hydrops, supporting the role of VEMP in early identification before classic symptoms appear.
A longitudinal study investigating the effects of noise exposure on	Samuel Couth, et al	2024	Prospective study	This study found that noise exposure in young adults with normal hearing did not provide strong evidence of cochlear synaptopathy. Outer hair cell function

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Title	Author	Year	Study Design	Evaluation Of Examination Results
behavioural, electrophysiological and self-report measures of hearing in musicians with normal audiometric thresholds				was consistently lower in individuals with high noise exposure, but did not change significantly over time. In contrast, there were significant improvements in objective test results such as Auditory Brainstem Response (ABR) wave amplitude and Speech Perception in Noise Test (SPiN) comprehension. Extended High Frequency Hearing (EHF) tended to decline over time, but was more related to age than noise exposure. Meanwhile, subjective reports of tinnitus, sound hypersensitivity, and difficulty hearing in noisy environments were present in only a small proportion of participants and fluctuated without a consistent pattern.
Functional Audiometric Dissociation in Ménière's Disease: Exploring the Mismatch Between Pure-Tone Thresholds and Speech Recognition	Lorente, et al	2025	Longitudinal study (prospective).	In ears with Ménière's disease, functional audiometric dissociation occurred. Although Pure-Tone Audiometry (PTA) values were similar to those of controls, patients had higher Speech Recognition Threshold (SRT) and lower Rmax, indicating impaired speech processing not reflected in pure-tone thresholds. The PTA–SRT correlation remained strong, but the PTA's ability to predict functional impairment decreased (AUC 0.78 compared to >0.95 in controls), particularly at low frequencies (250–1000 Hz) most affected by endolymphatic hydrops. This confirms that PTA alone is insufficient for diagnosis and staging, necessitating the integration of suprathreshold tests (SRT/Rmax), vestibular testing, and MRI in a multimodal approach more in line with the precision medicine paradigm.
Defining diagnostic thresholds for dissociation between caloric	Cheon et al.	2025		In Ménière's Disease (MD) patients, a dissociation between abnormal caloric test results (Canal Paresis (CP) > 25%) and normal vHIT (Video-Head Impulse

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Title	Author	Year	Study Design	Evaluation Of Examination Results
test and vHIT in Ménière's disease				Test) was found in 56.9%, higher than VS (25.0%) and Benign Paroxysmal Positional Vertigo (BPPV) (9.4%). This dissociation pattern differentiated MD from BPPV (Decreased Otoacoustic Response/DOR = 12.74) but was less effective in differentiating MD from Vestibular Schwannoma (VS) (DOR = 3.96).
The dissociation between pathological caloric testing and a normal video head impulse test helps differentiate between Menière's disease, vestibular migraine, and other vestibular disorders: a confirmatory study in a large cohort of 2,101 patients	Mavrodiev, et al	2024		A total of 58.9% of MD patients showed a dissociation between normal vHIT results (gain ≥0.7) and pathological caloric testing (asymmetry > 25% or bilateral canal paresis). This dissociation has a high specificity (83.5%) and a Positive Predictive Value (PPV) of 82.6% in differentiating MD from Vestibular Migraine (VM), making it a potential diagnostic marker in patients with atypical clinical presentations. Compared with caloric testing alone, the combination of these two examinations provides a higher specificity and can serve as a rule-out tool for MD in the differential diagnosis of vestibular disorders.
Magnetic Resonance Imaging of Endolymphatic Hydrops in Meniere's Disease: A comparison of The Diagnostic Value of Multiple Scoring Methods	Heng Xiao et al.	2022	Observational, cross-sectional retrospective cohort	Gd-enhanced Magnetic Resonance Imaging (MRI) has a very high effectiveness, with an Intraclass Correlation Coefficient (ICC) of 0.98 and Kappa > 0.94. Of the three scoring systems, the Inner Ear Structure Assignment Method (IESAM) demonstrated the best diagnostic value. Sensitivity: 86.65 (identifying true positives), Specificity: 97.9% (identifying correctly true negatives), and Area Under the Curve (UCA): 0.94.

Comparison of MD Diagnostic Methods

The Bárány Society and the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNSF) guidelines serve as the primary international reference for the

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diagnosis of Ménière's Disease (MD). These standards provide a consistent diagnostic framework for global clinical practice. The definite MD category is defined as vertigo lasting 20 minutes to 12 hours, accompanied by audiometrically confirmed sensorineural hearing loss and additional aural symptoms. The possible MD category includes situations with clear clinical signs but without comprehensive audiometric verification. This grouping system supports the distinction between vestibular migraine and other vestibular disorders, although it has limitations in early case detection (Young et al., 2022). Low-frequency audiogram patterns are considered appropriate for inclusion as an additional criterion because they often precede vertigo symptoms. This recommendation aligns with the finding that some patients with early MD experience only unilateral tinnitus and low-frequency hearing loss without vertigo symptoms (Alsarhan, 2021).

Tonal audiometry and speech audiometry are still considered crucial for recording fluctuating patterns of sensorineural loss (especially low-frequency loss), an important characteristic because this pattern of loss often precedes vertigo in MD. Audiograms can show upsloping (worse hearing at low frequencies), which progresses to flattening in advanced stages. Audiometry is still frequently used for initial screening because it is easily accessible, inexpensive, non-invasive, and can be used to monitor disease progression. Unfortunately, audiometry only assesses cochlear function and cannot yet confirm the presence of endolymphatic hydrops (EH), making it more useful for monitoring than establishing an effective diagnosis (Piera Lorente et al., 2025).

Electrocochleography (ECochG) is used to measure the electrical activity of the cochlea and auditory nerve, particularly the ratio of summating potential (SP) to action potential (AP), which can be increased in patients with endolymphatic hydrops, a pathological hallmark of MD. While ECochG can be useful as a complementary method, its sensitivity and specificity are limited (Alsarhan, 2021). Its use would be more beneficial when combined with other examinations such as Vestibular-Evoked Myogenic Potential (VEMP) or MRI, as its role as a single method is still not recommended for routine diagnosis (Alsarhan, 2021).

Vestibular Evoked Myogenic Potentials (VEMPs) (cVEMP/oVEMP) also play a significant role because they describe vestibular function related to otolith involvement, which is sometimes not visible in audiometry, with varying sensitivity reports. The sound used to elicit VEMPs is air-conducted sound, or Air Conduction (AC). Sound stimuli selectively activate the otolith organs, with the saccule as the primary organ responsible for the Cervical Vestibular Evoked Myogenic Potential (cVEMP) and the utricle for the Ocular Vestibular-Evoked Myogenic Potential (oVEMP). Bone conduction (BC) vibrations activate the saccule and utricle bilaterally, making them useful for assessing bilateral otolith function or in conditions of conductive hearing loss. Objectively, VEMPs are capable of detecting Meniere's Disease in its early stages with the presence of saccular and utricular dysfunction. However, there is no standardization, with significant variability in recording parameters and interpretation criteria leading to inconsistent results and complicating interclinical comparisons. VEMP testing is also not specific for Meniere's disease because abnormal VEMP patterns are closely associated with vestibular hydrops, making VEMP more suitable as a supporting examination.

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VEMP is not yet considered a substitute for MRI visualization of endolymphatic hydrops (Liu et al., 2024).

The caloric test assesses lateral semicircular canal function at low frequencies by applying thermal stimulation, while the Video Head Impulse Test (vHIT) assesses the vestibulo-ocular reflex at high frequencies. A dissociation pattern is often found in MD, i.e., abnormal caloric results but a normal vHIT, which is considered relatively specific for diagnosis. Although safe and noninvasive, this test can cause discomfort (nausea/vertigo on the caloric test), has limited sensitivity, and results are inconsistent in the early stages (Melville et al., 2024).

MRI hydrops is considered the most superior biomarker for detecting Meniere's disease due to its ability to directly detect endolymphatic hydrops even before symptoms or preclinical symptoms in some MD patients. MRI with specialized sequences (e.g., delayed post-contrast 3D FLAIR or intratympanic gadolinium) allows direct visualization of endolymphatic hydrops, providing objective evidence supporting the diagnosis of MD and differentiating it from other diseases. In patients with Meniere's disease, MRI can directly detect endolymphatic hydrops, with a sensitivity of 86.6% and a specificity of 97.9% in a study of 97 patients with confirmed Meniere's disease (Xiao et al., 2022). MRI with gadolinium demonstrated endolymphatic hydrops in 93.7% of symptomatic ears, with a specificity of 81.3%, making it superior to a single vestibular test, which often yields inconsistent results (Xiao et al., 2022). Identification of endolymphatic sac hypoplasia on MRI can predict bilateral progression, so the use of imaging can strengthen the diagnosis and aid risk stratification (Bächinger et al., 2021). This examination can also help differentiate MD from other vestibular disorders when the clinical picture is ambiguous. However, its limitations include the possibility of hydrops in asymptomatic individuals, its disproportionate clinical severity, and the need for specialized procedures with high costs and potential risks from contrast (Xiao et al., 2022).

Effective diagnostic technology, both in terms of sensitivity and specificity, adds a new dimension to global standards. The Bárány Society guidelines do not currently list MRI as a standard diagnostic tool due to limited availability and cost. MRI scans using the latest methods are a viable diagnostic option in referral centers. However, MRI hydrops needs to be reevaluated and considered a candidate gold standard for the best early screening for MD.

Narrative Synthesis

According to the Scale for the Quality Assessment of Narrative Review Articles (SANRA), Ménière's Disease (MD) is a multifactorial disease, with genetic, immunological, radiological, and environmental factors interacting. This complexity can influence the diagnostic method chosen. Immunological mechanisms support the multifactorial framework of MD. MD patients experience elevated levels of pro-inflammatory cytokines such as TNF-α, IL-1β, and IL-6. These findings support the hypothesis that long-term inflammation in the endolymphatic sac causes vertigo, tinnitus, and hearing loss. Histopathology samples from MD patients show infiltration of immune cells, including T cells and macrophages (Yuan et al., 2025). Radiological aspects provide additional information about the disease course. Endolymphatic sac hypoplasia can show bilateral progression on MRI. By identifying radiological factors, risk can be classified and interventions can be prioritized for patients with

a high likelihood of developing chronic vestibulopathy (Bächinger et al., 2021). Endolymphatic hydrops can be identified directly through gadolinium-enhanced MRI (Scarpa et al., 2020).

The importance of narrative synthesis lies in the concept of establishing a diagnosis. A major challenge lies in integrating scientific evidence into clinical guidelines. The Bárány Society and AAO-HNSF guidelines have not fully accommodated modern diagnostic advances. It was emphasized that MRI hydrops and intratympanic therapy, while proven effective, are still of limited use (Basura et al., (2020). The narrative synthesis emphasized the need for updated evidence-based guidelines.

The link between research and clinical practice is at the heart of the SANRA analysis. Genetic screening should be considered as part of the evaluation of at-risk patients (Fisch et al., 2024). Cytokines can be used as a predictor of progression (Yuan et al., 2025). Integrating these two aspects with modern radiology will create a new paradigm based on precision medicine. Socioeconomic implications also need to be included in the synthesis. Bilateral MD has been reported to result in work disability, lost productivity, and high healthcare costs (Liu et al., 2024). Psychological distress exacerbates the economic burden on patients. The narrative analysis suggests that early intervention can reduce the long-term socioeconomic burden (Young et al., 2022).

Future research prospects emphasize multidisciplinary collaboration. Modern radiology can be used as an imaging biomarker to validate new therapies (Bächinger et al., 2025). al., 2021). MRI scanning with the latest methods is a viable diagnostic option in referral centers. However, MRI hydrops needs to be reevaluated and considered as a gold standard candidate for the best early screening for MD. The narrative synthesis also underscores the importance of further research on innovative combinations of radiology with genetic profiling, immunological biomarkers, and broader radiological findings to evaluate the most accurate and specific tests for MD.

CONCLUSION

Ménière's disease is a chronic, multifactorial inner ear disorder involving genetic, immunological, radiological, and environmental factors. Prevalence varies between countries, affecting middle-aged women more frequently, and often progresses bilaterally, with serious impacts on hearing, balance, and quality of life. Early symptoms of unilateral tinnitus and low-frequency hearing loss are crucial for early detection, but limited clinical criteria often delay diagnosis. Advances in diagnostic technology such as audiometry, electrocochleography, video head impulse testing, and MRI for hydrops may provide greater accuracy and aid risk stratification. Some literature suggests MRI for hydrops as the most effective examination for establishing an accurate, early diagnosis of MD that does not overlap with other diagnoses. However, due to limited costs and facilities in each healthcare facility, MRI for hydrops has not yet been established as the gold standard. A diagnostic approach based on genetic profiling, immunological biomarkers, and broader radiological findings is needed to evaluate the most accurate and specific examination for MD. With the existence of a gold standard for early MD screening, it is hoped that it will be able to reduce the number of patients diagnosed with advanced MD and that early management can be carried out, thereby increasing the

effectiveness of therapy, reducing the burden of disability, and improving the quality of life of patients in a sustainable manner.

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