International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

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ARTICLE TITLE	LIVING WITH MENIERE'S DISEASE: HOW TO MANAGE THIS CHALLENGING BALANCE AND HEARING DISORDER
ARTICLE INFO	Agnieszka Floriańczyk, Ewa Romanowicz, Aleksandra Kołdyj, Agnieszka Ozdarska, Adrian Krzysztof Biernat, Marcin Lampart, Anna Rupińska, Katarzyna Kozon, Kamila Krzewska. (2025) Living with Meniere's Disease: How to Manage This Challenging Balance and Hearing Disorder. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.3479
DOI	https://doi.org/10.31435/ijitss.3(47).2025.3479
RECEIVED	02 June 2025
ACCEPTED	12 July 2025
PUBLISHED	18 July 2025
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LIVING WITH MENIERE'S DISEASE: HOW TO MANAGE THIS CHALLENGING BALANCE AND HEARING DISORDER

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ABSTRACT

Meniere's disease is a chronic inner ear disorder characterized by recurrent vertigo, fluctuating hearing loss, tinnitus, and aural fullness. Despite extensive research, its aetiology remains unclear, complicating treatment. This review summarizes current therapeutic strategies for Meniere's disease, spanning non-pharmacological, pharmacological, intratympanic, and surgical interventions. Lifestyle modifications, such as salt restriction and increased water intake, offer initial symptom control, though evidence remains limited. Pharmacological therapies, including diuretics, betahistine, and piracetam, provide varying degrees of vertigo relief, with inconsistent outcomes for hearing and tinnitus. Intratympanic treatments—steroids and gentamicin—are effective for refractory cases; steroids offer hearing preservation, while gentamicin achieves superior vertigo control at the risk of ototoxicity. Surgical options, including endolymphatic sac shunt surgery, semicircular canal plugging, vestibular neurectomy, and labyrinthectomy, are reserved for intractable cases, with selection guided by disease severity and hearing status. Emerging therapies, such as vestibular rehabilitation and *Coriolus versicolor* supplementation, show potential in improving vestibular compensation and reducing oxidative stress and inflammation. While current treatments primarily aim to manage symptoms rather than resolving the underlying disorder, ongoing research may lead to more targeted and disease-modifying therapies.

KEYWORDS

Meniere's Disease, Balance Disorder, Hearing Disorder, Intratympanic Treatment

CITATION

Agnieszka Floriańczyk, Ewa Romanowicz, Aleksandra Kołdyj, Agnieszka Ozdarska, Adrian Krzysztof Biernat, Marcin Lampart, Anna Rupińska, Katarzyna Kozon, Kamila Krzewska. (2025) Living with Meniere's Disease: How to Manage This Challenging Balance and Hearing Disorder. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.3479

Introduction.

Meniere's disease is a chronic inner ear disorder characterized by recurrent vertigo, fluctuating sensorineural hearing loss, tinnitus, and aural fullness (Kim & Cheon, 2020). Its prevalence is estimated at 190 per 100,000 individuals, affecting females twice as often as males, with an average age of onset between 40 and 60 years (Harris & Alexander, 2010). The exact cause of Meniere's disease remains unknown, though proposed mechanisms include genetic factors, autoimmunity, anatomical abnormalities and endolymphatic hydrops due to impaired lymphatic absorption or drainage (Tong et al., 2025). MD significantly impacts patients' quality of life, often leading to psychological distress and functional impairment (Yardley et al., 2003). Diagnosis is based on clinical history and audiological findings, following internationally recognized criteria (Lopez-Escamez et al., 2015). Given the unknown aetiology of the disease and the lack of a definitive cure, therapy focuses on alleviating symptoms, reducing disability, and slowing disease progression (Yaz et al., 2020). Treatment is stepwise, beginning with lifestyle and pharmacological interventions, progressing to intratympanic therapies, and ultimately to surgical options if conservative measures fail (Tong et al., 2025; Wu et al., 2019). This review aims to provide an overview of the available therapeutic options for Meniere's disease.

Methodology

This review discusses the range of medical and surgical treatments available for managing Meniere's disease. A comprehensive literature search was conducted using the PubMed database with the following search terms: (Meniere [Title]) AND ((Treatment [Title]) OR (Management [Title])). The search included full-text studies published in English within the last 20 years, focusing on the pharmacological and surgical management of Meniere's disease. Titles and abstracts were manually reviewed to assess the relevance of the studies and their alignment with the review's objectives. The selected studies were then qualitatively analysed and summarized to provide an overview of the findings. As this review was not designed as a meta-analysis, no statistical methods were applied.

Management of Meniere's disease

1. Non-pharmacological treatment

Non-pharmacological treatment methods include dietary modifications, such as reducing the intake of table salt, alcohol and caffeine. However, these recommendations could be deemed quite general, as there is a lack of high-quality studies that precisely define the suggested amounts of these substances (Sbeih et al., 2018). Some clinicians have proposed monitoring 24-hour urine osmolality as a means of evaluating patients' adherence to dietary recommendations. However, the scientific rationale for relying on specific urinary or serum biomarkers in this context remains unclear (Sbeih et al., 2018). Similarly, although patients with Meniere's disease are frequently advised to avoid alcohol and caffeine, the evidence supporting these recommendations is limited. Furthermore, caffeine avoidance may be particularly challenging for individuals with comorbid migraine, as it is a common ingredient in many over-the-counter migraine medications (Sbeih et al., 2018). Another common recommendation is maintaining adequate water intake. Naganuma et al. (Naganuma et al., 2006) found that increasing daily water intake to 35 mL/kg significantly reduced vertigo episodes and improved low-frequency hearing in patients with Meniere's disease who were unresponsive to conventional therapy. Compared to a historical control group, patients undergoing water therapy showed better hearing outcomes and lower plasma vasopressin levels, suggesting that adequate hydration may be an effective, low-cost treatment option. These findings highlight the potential benefits of individualized lifestyle adjustments, though further well-designed studies are needed to establish clear guidelines and optimize non-pharmacological management strategies for Meniere's disease.

2. Pharmacological treatment

Pharmacological treatment serves as a second-line intervention in Meniere's disease, typically used in patients who continue to experience symptoms despite lifestyle modifications (Molnár et al., 2021). Commonly used medications include diuretics, betahistine, and piracetam (Molnár et al., 2021; Sbeih et al., 2018).

2.1 Diuretics

Diuretics are widely used in the treatment of Meniere's disease, although their efficacy remains a subject of debate in the literature (Sbeih et al., 2018). Burgess et al. (Burgess & Kundu, 2009) in their review found no high-quality evidence evaluating the effectiveness of diuretics in Meniere's disease. They concluded, however, that the low dose diuretics used for Meniere's disease are generally well tolerated and cost-effective. Other studies have found diuretics to have a significant effect on vertigo and no effect on hearing and tinnitus (van Deelen, 1986). Further high-quality research is warranted to more rigorously evaluate the efficacy of diuretics in the management of Meniere's disease.

2.2 Betahistine

Betahistine is another conservative treatment option for Meniere's disease. It is an H3 receptor antagonist that has been shown to enhance cochlear blood flow and possibly plays a role in facilitating central vestibular compensation (Sbeih et al., 2018). Molnar et al. (Molnár et al., 2021) found its use to significantly reduce the frequency and duration of vertigo and dizziness episodes, though it had no significant effect on the intensity of symptoms. While the average effective dose was 87.5 ± 27.2 mg/day, no clear correlation was found between dosage and symptom control. Nauta et al (Nauta, 2014) also determined a beneficial effect of betahistine in vestibular vertigo in Meniere's disease. However, the most recent long-term, multicenter, double-blind, randomized, placebo-controlled, dose-finding trial indicated that the current evidence remains inconclusive regarding the efficacy of betahistine in preventing vertigo attacks associated with Meniere's disease when compared to placebo (Adrion et al., 2016). Similarly, additional well-designed, high-quality studies are necessary to more thoroughly assess the therapeutic efficacy of betahistine in the treatment of Meniere's disease.

2.3 Piracetam

Piracetam may be used in combination therapy with betahistine in patients with Meniere's disease experiencing vertigo episodes, potentially offering advantages over betahistine monotherapy (Molnár et al., 2021). It might be a beneficial addition to a conventional conservative treatment in patients with particularly severe vestibular symptoms; however, further research on this topic is necessary (Molnár et al., 2021).

3. Intratympanic treatment

Patients who continue to experience persistent symptoms despite pharmacological therapy may be offered intratympanic treatment, which includes non-ablative steroid injections and ablative gentamicin injections (Wu et al., 2019).

3.1 Steroids

Steroid injection is a non-ablative and safe treatment for refractory Meniere's disease. Although the exact mechanism of intratympanic steroid injection in Meniere's disease remains unclear, its therapeutic benefits may stem from its influence on ion homeostasis, fluid regulation, and immune modulation (MacArthur et al., 2015). Animal and human studies suggest that steroids, particularly methylprednisolone, upregulate genes related to ion balance and inflammatory response, and may act through aquaporin pathways to alleviate endolymphatic hydrops (B. Liu et al., 2016; MacArthur et al., 2015). Garduno-Anaya et al. (Garduño-Anaya et al., 2005) found that dexamethasone at 4 g/L injected into the ear transtympanically shows 82% of complete control of vertigo over placebo (57%) and results in subjective improvement in tinnitus (48%), hearing loss (35%), and aural fullness (48%) in the dexamethasone group compared with 20%, 10%, and 20% respectively in the control group. Attrache et al. (Attrache et al., 2016) confirm that a 6-month intratympanic steroid treatment results in a significant reduction in vertigo spells, with 70.8% of patients achieving a ≥60% reduction in vertigo frequency. Tinnitus loudness also improved slightly but significantly in this study, while hearing levels remained unchanged across all tested frequencies. Complete remission of vertigo was achieved by 20.8 % of patients within 8 months. Some research suggests that methylprednisolone may be more effective than dexamethasone for vertigo control due to its higher inner ear penetration and greater biological activity, although not all the studies confirm this conclusion (Cao et al., 2019; Lee et al., 2021). These findings support the use of intratympanic steroids as an effective and safe therapeutic option for patients with refractory Meniere's disease, though further research is needed to clarify the optimal agent, dosage, and long-term efficacy (Yaz et al., 2020).

3.2 Gentamicin

Intratympanic gentamicin is, on the other hand, a destructive treatment method for refractory Meniere's disease (Ballard et al., 2019). It demonstrates strong efficacy in reducing vertigo symptoms but carries the risk of damaging vestibular function and deteriorating hearing (Webster et al., 2023). Intratympanic gentamicin treatment has shown to control vertigo in 75% to 100% of patients with unilateral Meniere's disease and is therefore one of the most effective treatments for vertigo symptoms (H. Liu et al., 2017; Shlamkovitch et al., 2018; Tong et al., 2025). There may be a genetic basis for the varying susceptibility to this treatment in controlling vertigo across the population (Huang et al., 2019). Intratympanic gentamicin injections selectively damage the vestibular apparatus in the affected ear, with the expectation that the central vestibular system will adapt and compensate for the resulting unilateral dysfunction—provided the opposite ear maintains normal function (Webster et al., 2023). However, about 20% of the patients exhibit insufficient central compensation, resulting in persistent vestibular symptoms (Tong et al., 2025). It is also associated with hearing deterioration in up to 20% of cases (Pullens & van Benthem, 2011). Hearing loss appears to be more pronounced in the low-frequency range (Sam et al., 2016). Nevertheless, Schlamkovitch et al. (Shlamkovitch et al., 2018) report that hearing tests conducted approximately two months post-treatment with low concentration gentamicin showed a statistically significant 5 dB improvement at 1000 Hz and a 5 dB deterioration at 8000 Hz in the treated ear compared to the healthy ear. Patients who received the drug using a titration regimen—typically involving lower doses—experienced smaller declines in hearing and word recognition scores compared to those treated with a fixed-dose regimen, who showed greater deterioration. Multivariate analysis revealed no significant differences in hearing outcomes between the treated and untreated ears. Liu et al. (H. Liu et al., 2017) also found that 78% of the patients treated with intratympanic gentamicin showed no significant change in hearing, 16.2% experienced improvement, and only 5.4% demonstrated deterioration in pure tone audiometry. These studies suggest that this treatment is largely effective for vertigo control, with minimal and frequency-specific impact on hearing, which might be even further reduced by using a titration regimen when administering intratympanic gentamicin injections.

3.3 Comparison of steroid and gentamicin intratympanic injections

Several studies and meta-analyses have compared the efficacy and safety of intratympanic gentamicin and intratympanic steroids in the treatment of refractory Meniere's disease. A meta-analysis by Lee et al. (Lee et al., 2021) revealed a statistically significant advantage of gentamicin over dexamethasone for vertigo control, but not over methylprednisolone. Hearing outcomes favoured steroids, suggesting better hearing preservation. Additionally, gentamicin demonstrated significantly greater improvement in tinnitus and aural fullness compared to steroids at both 6- and 12-months post-treatment. Patel et al. (Patel et al., 2016) also found no significant difference between intratympanic gentamicin and methylprednisolone in controlling vertigo in patients with Meniere's disease, with both treatments reducing vertigo attacks by over 85% in the final 6 months compared to baseline. Both drugs also significantly improved scores on vestibular symptom questionnaires, with most symptom relief occurring within two months and remaining stable over 24 months. Hearing outcomes were similar between groups, though methylprednisolone showed a trend toward better speech discrimination. There was no significant difference in the number of follow-up injections or non-responders between treatments. Overall, both therapies were effective and well tolerated. A systematic review by Yaz et al. (Yaz et al., 2020) determined that gentamicin injections generate a slightly greater reduction in vertigo symptoms in some studies, particularly over longer follow-up periods, although both treatments significantly improved subjective symptoms. Steroids was associated with better hearing preservation, while gentamicin posed a higher risk of temporary hearing deterioration and post-injection vertigo and vomiting. No major differences in complication rates were observed overall. Both intratympanic gentamicin and steroid injections are effective and safe options for patients with refractory Meniere's disease, though treatment choice may depend on individual patient factors such as laterality and hearing status.

4. Surgical treatment

Although approximately 80% of patients with Meniere's disease benefit from lifestyle modifications and pharmacological or intratympanic therapies, the remaining 20% require surgical intervention (X. Li et al., 2021). Operative treatments include non-ablative procedures such as endolymphatic sac surgery and lateral semicircular canal plugging, as well as ablative approaches like vestibular neurectomy and labyrinthectomy (Bento et al., 2017; X. Li et al., 2021; Perkins et al., 2018; Véleine et al., 2022). The former pose minimal risk to hearing, while the latter are reserved for patients with non-serviceable hearing due to the higher likelihood of cochlear damage (Bento et al., 2017; X. Li et al., 2021; Perkins et al., 2018; Véleine et al., 2022).

4.1 Endolymphatic sac shunt surgery

Endolymphatic sac shunt surgery is a non-ablative procedure based on the hypothesis that decompression of the mastoid bone reduces endolymphatic pressure and facilitates expansion of the endolymphatic sac, thereby decreasing the frequency of vertigo episodes. Insertion of a Silastic tube into the lumen of the sac may further increase its internal diameter, thereby enhancing its function and facilitating endolymphatic drainage (Bento et al., 2017). Effectiveness of endolymphatic sac shunt surgery in controlling vertigo is however controversial, with reported success rates ranging from 44% to 94% of patients. Accurate assessment of therapeutic benefit is challenging due to the variable natural course of the disease. (Albu et al., 2015; Bento et al., 2017). Approximately 70% to 88% of patients maintain or improve their hearing after the procedure, while 12% to 30%—mainly with unilateral disease—experience worsening, often to severe hearing loss (Albu et al., 2015; Bento et al., 2017). Despite some risk of hearing deterioration, the overall hearing preservation profile of endolymphatic drainage is relatively favourable. Given its potential to reduce vertigo, it remains a suitable option for patients with refractory Meniere's disease who are not eligible for more invasive or destructive procedures.

4.2 Lateral semicircular canal plugging

Plugging surgery is another non-ablative approach based on the concept that blocking a semicircular canal can stop the flow of endolymph, which in turn prevents displacement of the cupula. By doing so, it halts the activation of sensory receptor cells in the canal, effectively reducing or eliminating vertigo attacks in Meniere's disease (X. Li et al., 2021). Vertigo control achieved 2 years after surgery ranges from 75% to 98.7% (Charpiot et al., n.d.; Zhang et al., 2016, 2020). The most serious complication arising from this intervention is hearing loss, which affects 20–30% of patients at two-year follow-up, though the underlying cause remains unclear (X. Li et al., 2021; Zhang et al., 2016, 2020). Li et al. (X. Li et al., 2021) monitored intraoperative auditory brainstem responses and found that semicircular canal plugging itself causes minimal hearing damage. They suggested that serous

fibrous labyrinthitis may be a contributing factor to postoperative hearing deterioration. Despite the risk of hearing loss in a subset of patients, semicircular canal plugging offers a high rate of vertigo control and represents a viable option for those with intractable symptoms and serviceable hearing.

4.3 Vestibular neurectomy

Vestibular neurectomy is an ablative and highly invasive surgical treatment of Meniere's disease. It involves sectioning of the vestibular portion of the eighth cranial nerve, effectively eliminating the transmission of balance signals from the affected inner ear to the brain (C. S. Li & Lai, 2008). This procedure offers high rates of vertigo control and hearing preservation—both often exceeding 90%—and is considered one of the most effective options for patients with intractable vertigo and serviceable hearing (C. S. Li & Lai, 2008). However, it is a technically complex intracranial procedure associated with potentially serious, though rare, complications such as cerebrospinal fluid leakage, facial nerve injury, and persistent postoperative headaches (Véleine et al., 2022; Zhang et al., 2020). It requires a high level of surgical expertise and is generally reserved for patients who have failed less invasive treatments and are deemed suitable surgical candidates (Wu et al., 2019).

4.4 Labyrinthectomy

Another ablative surgical treatment is labyrinthectomy, reserved as a treatment of last resort (Zhang et al., 2020). The procedure removes or destroys the entire vestibular labyrinth, permanently eliminating vestibular input from the affected ear (Roberts & Slattery, 2016). It provides excellent vertigo control but at the cost of complete hearing loss in the treated ear (Hansen et al., 2013; Perkins et al., 2018). As such, it is primarily indicated in patients with profound or non-functional hearing who continue to experience disabling vertigo despite conservative or medical treatments (Zhang et al., 2020). This procedure may be performed via a transmastoid approach and is sometimes combined with cochlear implantation in selected cases (Hansen et al., 2013; Perkins et al., 2018). Despite its destructive nature, labyrinthectomy remains a valuable option in end-stage or unilateral Meniere's disease, offering lasting relief from vertigo and improved quality of life (Zhang et al., 2020).

5. Other strategies

In addition to pharmacological and surgical approaches, several complementary strategies have been explored for managing Meniere's disease. These include non-invasive therapies aimed at enhancing vestibular compensation and emerging nutraceutical interventions targeting underlying pathophysiological mechanisms such as oxidative stress and inflammation. The following section highlights two such approaches—vestibular rehabilitation therapy and nutritional mushroom supplementation—that show promise in improving patient outcomes and quality of life.

5.1 Vestibular rehabilitation therapy

Vestibular rehabilitation therapy is a widely used, exercise-based treatment for managing persistent dizziness and vertigo in patients with vestibular dysfunction, particularly those with unilateral peripheral involvement. It facilitates vestibular compensation by improving coordination between visual, vestibular, and proprioceptive systems, thereby enhancing balance, gaze stability, and quality of life(Tong et al., 2025). Vestibular rehabilitation therapy includes five core components: gaze stability exercises, balance and gait training, habituation exercises, motor endurance training, and central vestibular training(Tong et al., 2025). Moderate to strong evidence supports its safety and effectiveness, especially for unilateral vestibular disorders (Mcdonnell & Hillier, 2015). Additionally, studies suggest that these beneficial effects of vestibular rehabilitation are also seen in patients with Meniere's disease, especially those previously treated with intratympanic gentamicin (Perez et al., 2006). More high-quality, long-term randomized controlled trials are required to establish the sustained efficacy of this therapy in patients with Meniere's disease. Notably, Tong et al. (Tong et al., 2025) are currently conducting such a trial to address this gap in the evidence base.

5.2 Nutritional mushroom treatment

Mushroom supplementation, particularly with species such as *Coriolus versicolor,* has emerged as a promising dietary strategy for reducing oxidative stress by activating Nrf2-dependent antioxidant and stress resilience pathways (Xia et al., 2022). These pathways are implicated in various diseases, including Meniere's disease, and their activation by *Coriolus versicolor* suggests that this mushroom may represent a promising

new therapeutic approach for managing Meniere's disease by addressing the underlying redox imbalance (Xia et al., 2022). Di Paola et al. (Paola et al., 2024) demonstrated that *Coriolus versicolor* supplementation in patients with Meniere's disease leads to significant improvements in psycho-emotional status, tinnitus severity, and speech discrimination, although no changes were observed in tonal audiometry. Biochemical analyses revealed upregulation of Nrf2-dependent antioxidant pathways and stress-response proteins, including Hsp70 and HO-1, alongside increased levels of glutathione and improved redox balance. *Coriolus* also reduced markers of protein and lipid oxidation, such as protein carbonyls and HNE, and restored mitochondrial respiratory complex activities impaired in Meniere's disease. Additionally, supplementation increased anti-inflammatory eicosanoids and decreased pro-inflammatory markers, highlighting its systemic anti-inflammatory and neuroprotective potential. These findings support *Coriolus versicolor* as a promising adjunctive therapy for mitigating oxidative stress and inflammation in Meniere's disease pathogenesis, although further studies are required to confirm this conclusion.

Conclusions

Meniere's disease remains a complex and debilitating inner ear disorder with no definitive cure. Its management requires a personalized, stepwise approach aimed at controlling vertigo, preserving hearing, and improving overall quality of life. Non-pharmacological measures such as dietary modifications and adequate hydration may offer symptomatic relief, though evidence supporting these interventions is limited. Pharmacological treatments—including diuretics, betahistine, and piracetam—play a role in symptom control but require further validation through high-quality studies. Intratympanic therapies provide effective options for refractory cases, with gentamicin offering superior vertigo control at the expense of potential hearing loss, while steroids provide a safer alternative with favourable hearing preservation. Surgical interventions, though invasive, remain essential for patients with severe, intractable disease, and must be tailored to the patient's hearing status and overall health. Adjunctive therapies such as vestibular rehabilitation and emerging nutraceuticals like *Coriolus versicolor* supplementation represent promising avenues for enhancing vestibular compensation and mitigating oxidative stress and inflammation. Continued research into the underlying pathophysiology and novel treatment modalities hold promise for more targeted and effective management options in the future.

REFERENCES

1. Adrion, C., Fischer, C. S., Wagner, J., Gürkov, R., Mansmann, U., & Strupp, M. (2016). Efficacy and safety of betahistine treatment in patients with Meniere's disease: Primary results of a long term, multicentre, double blind, randomised, placebo controlled, dose defining trial (BEMED trial). *The BMJ*, *352*. https://doi.org/10.1136/bmj.h6816
2. Albu, S., Babighian, G., Amadori, M., & Trabalzini, F. (2015). Endolymphatic sac surgery versus tenotomy of the stapedius and tensor tympani muscles in the management of patients with unilateral definite Meniere's disease. *European Archives of Oto-Rhino-Laryngology*, *272*(12), 3645–3650. https://doi.org/10.1007/S00405-014-3428-1<SPAN
3. Attrache, N. A. Al, Krstulovic, C., Guillen, V. P., Pérez, C. M., & Garrigues, H. P. (2016). Response over time of vertigo spells to intratympanic dexamethasone treatment in meniere's disease patients. *Journal of International Advanced Otology*, *12*(1), 92–97. https://doi.org/10.5152/IAO.2016.2177
4. Ballard, D. P., Sukato, D. C., Timashpolsky, A., Babu, S. C., Rosenfeld, R. M., & Hanson, M. (2019). Quality-of-Life Outcomes following Surgical Treatment of Ménière's Disease: A Systematic Review and Meta-analysis. *Otolaryngology - Head and Neck Surgery (United States)*, *160*(2), 232–238. https://doi.org/10.1177/0194599818803612
5. Bento, R. F., Cisneros, J. C., & De Oliveira Fonseca, A. C. (2017). Endolymphatic sac drainage for the treatment of Ménière's disease. *Journal of Laryngology and Otology*, *131*(2), 144–149. https://doi.org/10.1017/S0022215116009713
6. Burgess, A., & Kundu, S. (2009). Diuretics for Ménière's disease or syndrome. In *Cochrane Database of Systematic Reviews* (Issue 4). https://doi.org/10.1002/14651858.CD003599.pub2
7. Cao, Z., Yue, F., Huang, W., Rajenderkumar, D., & Zhao, F. (2019). Different medications for the treatment of Ménière's disease by intratympanic injection: A systematic review and network meta-analysis. *Clinical Otolaryngology*, *44*(4), 619–627. https://doi.org/10.1111/coa.13350
8. Charpiot, A., Rohmer, D., & Gentine, A. (n.d.). *Lateral Semicircular Canal Plugging in Severe Ménière's Disease: A Clinical Prospective Study About 28 Patients*.

9. Garduño-Anaya, M. A., De Toledo, H. C., Hinojosa-González, R., Pane-Pianese, C., & Ríos-Castañeda, L. C. (2005). Dexamethasone inner ear perfusion by intratympanic injection in unilateral Ménière's disease: A two-year prospective, placebo-controlled, double-blind, randomized trial. *Otolaryngology - Head and Neck Surgery*, *133*(2), 285–294. https://doi.org/10.1016/j.otohns.2005.05.010
10. Hansen, M. R., Gantz, B. J., & Dunn, C. (2013). Outcomes after cochlear implantation for patients with single-sided deafness, including those with recalcitrant méniére's Disease. *Otology and Neurotology*, *34*(9), 1681–1687. https://doi.org/10.1097/MAO.0000000000000102
11. Harris, J. P., & Alexander, T. H. (2010). Current-day prevalence of ménière's syndrome. *Audiology and Neurotology*, *15*(5), 318–322. https://doi.org/10.1159/000286213
12. Huang, C.-J., Wan, T.-K., Fang, T.-Y., & Wang, P.-C. (2019). CASP9 genotype confers gentamicin susceptibility in intratympanic treatment of intractable vertigo caused by Ménière's disease. *Acta Oto-Laryngologica*, *139*(4), 336–339. https://doi.org/10.1080/00016489.2019.1575525<SPAN
13. Kim, M. H., & Cheon, C. (2020). Epidemiology and Seasonal Variation of Ménière's Disease: Data from a Population-Based Study. *Audiology and Neurotology*, *25*(4), 224–230. https://doi.org/10.1159/000506921
14. Lee, S. Y., Kim, Y. S., Jeong, B., Carandang, M., Koo, J. W., Oh, S. H., & Lee, J. H. (2021). Intratympanic steroid versus gentamicin for treatment of refractory Meniere's disease: A meta-analysis. *American Journal of Otolaryngology - Head and Neck Medicine and Surgery*, *42*(6). https://doi.org/10.1016/j.amjoto.2021.103086
15. Li, C. S., & Lai, J. T. (2008). Evaluation of retrosigmoid vestibular neurectomy for intractable vertigo in Ménière's disease: An interdisciplinary review. *Acta Neurochirurgica*, *150*(7), 655–661. https://doi.org/10.1007/s00701-007-1462-0
16. Li, X., Lv, Y., Wang, R., Chao, X., Fan, Z., Wang, H., & Zhang, D. (2021). Intraoperative auditory brainstem response monitoring during semicircular canal plugging surgery in treatment of Meniere's disease. *Acta Oto-Laryngologica*, *141*(1), 73–77. https://doi.org/10.1080/00016489.2020.1823015<SPAN
17. Liu, B., Leng, Y., Zhou, R., Liu, J., Liu, D., Zhang, S. L., & Kong, W. J. (2016). Intratympanic steroids injection is effective for the treatment of drop attacks with Ménière's disease and delayed endolymphatic hydrops A retrospective study. *Medicine (United States)*, *95*(52). https://doi.org/10.1097/MD.0000000000005767
18. Liu, H., Zhang, T., Wu, Q., Zhang, Y., & Dai, C. (2017). End-point indicators of low-dose intra-tympanic gentamicin in management of Ménière's disease. *Acta Oto-Laryngologica*, *137*(2), 136–143. https://doi.org/10.1080/00016489.2016.1224921
19. Lopez-Escamez, J. A., Carey, J., Chung, W. H., Goebel, J. A., Magnusson, M., Mandalà, M., Newman-Toker, D. E., Strupp, M., Suzuki, M., Trabalzini, F., & Bisdorff, A. (2015). Diagnostic criteria for Menière's disease. *Journal of Vestibular Research: Equilibrium and Orientation*, *25*(1), 1–7. https://doi.org/10.3233/VES-150549
20. MacArthur, C., Hausman, F., Kempton, B., & Trune, D. R. (2015). Intratympanic Steroid Treatments May Improve Hearing via Ion Homeostasis Alterations and Not Immune Suppression. *Otology and Neurotology*, *36*(6), 1089–1095. https://doi.org/10.1097/MAO.0000000000000725
21. Mcdonnell, M. N., & Hillier, S. L. (2015). Vestibular rehabilitation for unilateral peripheral vestibular dysfunction. In *Cochrane Database of Systematic Reviews* (Vol. 2015, Issue 1). John Wiley and Sons Ltd. https://doi.org/10.1002/14651858.CD005397.pub4
22. Molnár, A., Maihoub, S., Tamás, L., & Szirmai, Á. (2021). Conservative Treatment Possibilities of Ménière Disease, Involving Vertigo Diaries. *Ear, Nose & Throat Journal*, *100*(7), 536–542. https://doi.org/10.1177/0145561319881838<SPAN
23. Naganuma, H., Kawahara, K., Tokumasu, K., & Okamoto, M. (2006). Water may cure patients with Meniere disease. *Laryngoscope*, *116*(8), 1455–1460. https://doi.org/10.1097/01.mlg.0000225904.78569.0c
24. Nauta, J. J. P. (2014). Meta-analysis of clinical studies with betahistine in Méniè re's disease and vestibular vertigo. In *European Archives of Oto-Rhino-Laryngology* (Vol. 271, Issue 5, pp. 887–897). Springer Verlag. https://doi.org/10.1007/s00405-013-2596-8
25. Paola, R. Di, Siracusa, R., Fusco, R., Ontario, M., Cammilleri, G., Pantano, L., Scuto, M., Tomasello, M., Spanò, S., Salinaro, A. T., Abdelhameed, A. S., Ferrantelli, V., Arcidiacono, A., Fritsch, T., Lupo, G., Signorile, A., Maiolino, L., Cuzzocrea, S., & Calabrese, V. (2024). Redox Modulation of Meniere Disease by *Coriolus versicolor* Treatment, a Nutritional Mushroom Approach with Neuroprotective Potential. *Current Neuropharmacology*, *22*(12), 2079–2098. https://doi.org/10.2174/1570159X22666231206153936<SPAN
26. Patel, M., Agarwal, K., Arshad, Q., Hariri, M., Rea, P., Seemungal, B. M., Golding, J. F., Harcourt, J. P., & Bronstein, A. M. (2016). Intratympanic methylprednisolone versus gentamicin in patients with unilateral Ménière's disease: a randomised, double-blind, comparative effectiveness trial. *The Lancet*, *388*(10061), 2753–2762. https://doi.org/10.1016/S0140-6736(16)31461-1
27. Perez, N., Santandreu, E., Benitez, J., & Rey-Martinez, J. (2006). Improvement of postural control in patients with peripheral vestibulopathy. *European Archives of Oto-Rhino-Laryngology*, *263*(5), 414–420. https://doi.org/10.1007/s00405-005-1027-x

28. Perkins, E., Rooth, M., Dillon, M., & Brown, K. (2018). Simultaneous labyrinthectomy and cochlear implantation in unilateral meniere's disease. *Laryngoscope Investigative Otolaryngology*, *3*(3), 225–230. https://doi.org/10.1002/lio2.163
29. Pullens, B., & van Benthem, P. P. (2011). Intratympanic gentamicin for Ménière's disease or syndrome. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.cd008234.pub2
30. Roberts, D. S., & Slattery, W. H. (2016). Labyrinthectomy for Meniere's Disease. *Operative Techniques in Otolaryngology - Head and Neck Surgery*, *27*(4), 188–193. https://doi.org/10.1016/j.otot.2016.10.002
31. Sam, G., Chung, D. W., van der Hoeven, R., Verweij, S., & Becker, M. (2016). The effect of intratympanic gentamicin for treatment of Ménière's disease on lower frequency hearing. *International Journal of Clinical Pharmacy*, *38*(4), 780–783. https://doi.org/10.1007/S11096-016-0295-4
32. Sbeih, F., Christov, F., & Gluth, M. B. (2018). Newly Diagnosed Meniere's Disease: Clinical Course With Initiation of Noninvasive Treatment Including an Accounting of Vestibular Migraine. *Annals of Otology, Rhinology & Laryngology*, *127*(5), 331–337. https://doi.org/10.1177/0003489418763224<SPAN
33. Shlamkovitch, N., Lasry, R., Ephraim, E., Marom, T., & Gavriel, H. (2018). Low Concentration Intra-Tympanic Gentamicin Treatment for Menière's Disease: A Long-Term Follow Up. *Otology & Neurotology*, *39*(7), 903–907. https://doi.org/10.1097/MAO.0000000000001882<SPAN
34. Tong, Q., Zhou, Y., Wu, P., & Yu, H. (2025). Effect of vestibular rehabilitation treatment (VRT) on patients with unsteadiness after intratympanic gentamicin in Menière's disease: protocol for a randomised controlled trial. *BMJ Open*, *15*(2), e088722. https://doi.org/10.1136/BMJOPEN-2024-088722<SPAN
35. van Deelen. (1986). *Use of a Diuretic in the Treatment of Meniere's Disease*.
36. Véleine, Y., Brenet, E., Labrousse, M., Chays, A., Bazin, A., Kleiber, J. C., & Dubernard, X. (2022). Long-term efficacy of vestibular neurotomy in disabling Ménière's disease and Tumarkin drop attacks. *Journal of Neurosurgery*, *137*(4), 1034–1040. https://doi.org/10.3171/2021.10.JNS21145
37. Webster, K. E., Galbraith, K., Lee, A., Harrington-Benton, N. A., Judd, O., Kaski, D., Maarsingh, O. R., MacKeith, S., Ray, J., Van Vugt, V. A., & Burton, M. J. (2023). Intratympanic gentamicin for Ménière's disease. In *Cochrane Database of Systematic Reviews* (Vol. 2023, Issue 2). John Wiley and Sons Ltd. https://doi.org/10.1002/14651858.CD015246.pub2
38. Wu, V., Sykes, E. A., Beyea, M. M., Simpson, M. T. W., & Beyea, J. A. (2019). Approach to Ménière disease management. *Canadian Family Physician*, *65*(7), 463–467.
39. Xia, Y., Wang, D., Li, J., Chen, M., Wang, D., Jiang, Z., & Liu, B. (2022). Compounds purified from edible fungi fight against chronic inflammation through oxidative stress regulation. In *Frontiers in Pharmacology* (Vol. 13). Frontiers Media S.A. https://doi.org/10.3389/fphar.2022.974794
40. Yardley, L., Dibb Ã, Ã. B., OSBORNEy Ã, G., & D L E Y L, Y. R. (2003). Factors associated with quality of life in Menie Áre's disease. In *Clin. Otolaryngol* (Vol. 28).
41. Yaz, F., Ziylan, F., Smeeing, D. P. J., & Thomeer, H. G. X. M. (2020). Intratympanic Treatment in Menière's Disease, Efficacy of Aminoglycosides Versus Corticosteroids in Comparison Studies. *Otology & Neurotology*, *41*(1), 1–10. https://doi.org/10.1097/MAO.0000000000002451<SPAN
42. Zhang, D., Fan, Z., Han, Y., Lv, Y., Li, Y., & Wang, H. (2016). Triple semicircular canal plugging: a novel modality for the treatment of intractable Meniere's disease. *Acta Oto-Laryngologica*, *136*(12), 1230–1235. https://doi.org/10.1080/00016489.2016.1206966
43. Zhang, D., Lv, Y., Han, Y., Li, Y., Li, X., Wang, J., Song, Y., Kong, L., Jian, H., Fan, Z., & Wang, H. (2020). Long-term outcomes of triple semicircular canal plugging for the treatment of intractable Meniere's disease: A single center experience of 361 cases. *Journal of Vestibular Research*, *29*(6), 315–322. https://doi.org/10.3233/VES-190682<SPAN