

Tinnitus

Diagnosis and treatment of this elusive symptom

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More than 37 million Americans experience tinnitus, and adults age 40 to 70 are most often affected.^{1,2} Tinnitus is a symptom, not a disease, and as such has many different causes. Tinnitus is classified as vibratory and nonvibratory and is further subdivided into objective and subjective categories. The evaluation of tinnitus always begins with a thorough history and physical examination, with further testing performed when indicated. Many medical and nonmedical treatments exist, with varying degrees of success and safety. Once the physician determines that the patient does not have a life-threatening or obviously treatable underlying condition, the patient should be counseled, reassured that the tinnitus is not a life-threatening disease, and offered appropriate treatment. The degree to which the tinnitus bothers the patient will help determine the extent of treatment necessary.

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Tinnitus is a symptom, not a disease, and refers to internal auditory perceptions that are not caused by external sounds. Patients commonly describe these perceptions as ringing, buzzing, roaring, chirping, or sounds of steam escaping. Tinnitus is a distinct condition and must be differentiated from auditory hallucinations, which are perceptions of more com-

plex sounds such as voices or music. Most patients with tinnitus perceive the internal sounds only while in a quiet environment so they do not seek medical attention for it.

Tinnitus affects over 37 million Americans.¹ Almost 10 million experience severe or troubling symptoms that significantly interfere with the quality and productivity of their lives, prompting them to seek medical help for the condition.¹ Men and women age 40 to 70 are most often affected.² Twenty-five percent of older patients with no apparent predisposing cause (ie, history of noise exposure, use of ototoxic or nonsteroidal anti-inflammatory drugs [NSAIDs], or primary ear disease such as otosclerosis) exhibit tinnitus.³ Consequences of tinnitus may range in severity from complaints of mild irritation to severe depression and suicidal ideation.

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Classification

Many tinnitus classification systems exist, but the most specific and practical describes two primary categories: vibratory and nonvibratory.⁴ Vibratory tinnitus is characterized by the ability to hear “real” sounds, such as a venous hum or bruit, the patient’s own pulse, or muscular spasms, that are often mechanical in nature, and arise near or within the ear. Vibratory tinnitus is not necessarily caused by dysfunction of the auditory nerve, but instead results from mechanical sounds of muscle contractions, changes in the surface tension of mucus in the eustachian tube, bruits in the vascular system, or other causes.⁴

When the examiner also hears these sounds, the tinnitus is classified as objective and can be attributed to a disorder that produces a real noise, such as a humming murmur. Subjective tinnitus is heard only by the patient and may also be vibratory in nature but not loud enough for the examiner to hear. Subjective tinnitus is more common than objective tinnitus among all age groups, including older adults.

Nonvibratory tinnitus is attributed to neural activity in the central or peripheral auditory system. It does not have a mechanical cause, and thus is always classified as subjective. Subcategories of nonvibratory tinnitus include central (ie, arising from the temporal lobe, auditory nerve, and brain stem) and peripheral (ie, arising from the external auditory canal, middle ear, or cochlea) causes.¹

Vibratory tinnitus. Compared with nonvibratory tinnitus, vibratory tinnitus will most likely have a recognizable and treatable cause. Vascular disorders and neuromuscular pathologic states can produce the mechanical energy necessary to stimulate the auditory system in this manner. Vascular disorders causing subjective or objective vibratory tinnitus include arteriovenous malformations, severe anemia (ie, severe enough to produce hemodynamic symptoms, such as high-output anemias), thyrotoxicosis, aberrant vessels, middle ear inflammation, vascular neoplasms such as glomus tumors, benign intracranial hypertension, and partial stenoses of cervical vessels, intracranial vessels, or both. These conditions generally cause pulsatile tinnitus, which is the most common form of vibratory tinnitus and is synchronous with the heartbeat. Venous anomalies usually present with a constant, humming murmur, and the tinnitus often lessens or abates with compression of the involved vessels.

Neuromuscular conditions causing vibratory tinnitus include clonic contractions of the tensor veli palatini, levator veli palatini, tensor tympani, or stapedius muscles. Multiple sclerosis, psychogenic problems, cerebrovascular disorders, and intracranial neoplasms can cause these neuromuscular conditions. These problems generally manifest as clicking noises that occur at a rate faster than the patient's pulse and may be heard by the examiner.² The clicking caused by myoclonus of the tensor veli palatini is attributed to the eustachian tube opening, whereas clonus of the tensor tympani and stapedius causes tympanic membrane and ossicular chain motion. Thus, the examiner may see movement of the palate or tympanic membrane.

A patulous eustachian tube may cause subjective or objective vibratory tinnitus. The tinnitus occurs when the eustachian tube abnormally remains open, causing auditory perceptions of respiration from nasopharyngeal air turbulence. Patients often have an ab-



Older patients who exhibit tinnitus commonly describe the sound perceptions as ringing, buzzing, roaring, chirping, or sounds of steam escaping. Consequences may range in severity from mild irritation to severe depression and suicidal ideation.

Illustration for Geriatrics by Alexandra Baker

normal awareness of their own voices, also known as autophony. Losing a significant amount of weight or taking estrogens may contribute to this condition. The examiner may visualize movement of the tympanic membrane that coincides with respiration. Low-

ering the head to a dependent position below the level of the heart for several minutes may temporarily stop the symptoms of a patulous eustachian tube by causing local venous engorgement and closure of the tube.¹

Nonvibratory tinnitus. Peripheral non-

Table 1 Office examination and testing for tinnitus

Examination specifics

- Measure blood pressure in both arms
- Examine external ear for congenital abnormalities
- Examine tympanic membrane for fluid, cerumen impaction, or retrotympanic mass
- Evaluate for TMJ
- Test cranial nerve
- Observe patient for nystagmus
- Perform tuning fork testing
- Have audiogram and tympanometry performed

Testing specifics*

If patient history suggests a medical or metabolic problem, testing may evaluate:

- Complete blood cell count
- Chemistries, including blood glucose/fasting blood glucose levels
- Thyroid function
- Thyroid-stimulating hormone level
- Lipid profile
- Presence of syphilis (if history of exposure or if suspicious)
- Erythrocyte sedimentation rate
- Lyme titer

*Not all tinnitus patients will need every test; history and examination should guide testing

Source: Prepared for Geriatrics by Courtney A. Noell, MD, and William L. Meyerhoff, MD, PhD

vibratory tinnitus is usually detected in one or both ears, whereas central nonvibratory tinnitus is often described as occurring “in the head,” or in a general location. Most nonvibratory tinnitus is associated with hearing loss at the cochlear level. The tone of the tinnitus often corresponds with the frequency of the hearing loss, and the perceived loudness of the tinnitus is usually 0 to 20 decibels (dB) above the hearing threshold. Because this type of tinnitus is always subjective, diagnosis and management are more complex. In most cases, the character of the nonvibratory tinnitus makes it difficult to determine the origin.

Many conditions and causal factors are associated with subjective nonvibratory tinnitus, including noise-induced hearing loss, presbycusis, hypertension, atherosclerosis, cerumen impaction, cochlear or labyrinthine infection or inflammation, and neoplasms, all of which occur with some frequency in the geriatric population.

Multiple pharmacologic agents may also cause subjective nonvibratory tinnitus, including aminoglycosides, aspirin, loop diuretics, and NSAIDs. Approximately 5% of patients with subjective nonvibratory tinnitus have a history of significant head trauma. The tinnitus may develop immediately after or within weeks of the traumatic event.⁵ Although such head trauma is typically not caused by falls, it is useful to inquire about falls during the initial assessment.

Noise-induced hearing loss is common and usually involves a ≥ 30 dB hearing loss at high frequencies (4,000 to 6,000 hertz [Hz]). Presbycusis, the sensorineural hearing loss associated with aging, and familial progressive high frequency sensorineural hearing loss, typically occur bilaterally. All three of these conditions are associated with a high-pitched ringing subjective nonvibratory tinnitus. Hypertension and atherosclerosis are associated with changes in the microvasculature of the CNS that

can lead to high-pitched subjective nonvibratory tinnitus that may fluctuate with blood pressure. Cerumen impaction may cause a low-pitched, intermittent subjective nonvibratory tinnitus in the ear that is impacted, with conductive hearing loss. Once the obstructing cerumen is removed, the hearing loss and tinnitus should disappear.⁵

Patient evaluation

Because tinnitus is a symptom and not a disease, a thorough evaluation must begin with a complete, directed history and physical examination. Ask about the type of sound perceived by the patient, the pitch (high or low), pattern (pulsatile, steady, clicking), location (unilateral, bilateral, general), intensity, association with certain situations or physical stimuli, effect of surrounding noise, age of onset, progression, and duration. Associated audiovestibular symptoms, including aural fullness, vertigo, and hearing loss, should be noted. The most important goal of the interview is determining how the sound affects the patient; in other words, the level of the patient’s irritation with the tinnitus.

Specifically, one should inquire about use of ototoxic medications such as aspirin, quinine, or aminoglycoside antibiotics. Information regarding previous head trauma, noise exposure, ear discharge, ear surgery, severe ear infections, and family history are also important. Associated medical conditions such as obesity (which causes tinnitus via benign intracranial hypertension), hypertension, anemia, atherosclerosis, diabetes, and hyperthyroidism may be relevant. Basic laboratory tests, including complete blood cell count, measurement of sedimentation rate, and measurement of lipid, electrolyte, blood glucose, and thyroid function levels, can help identify treatable conditions. Recommendations for examination and testing are provided in table 1.

A complete otoneurologic exam must be performed, including an otoscopic exam and auscultation around

the ear and neck. Presence of a pulsatile or dark purple mass in the middle ear space could indicate a vascular tumor; a bruit may signify an arteriovenous malformation, vascular tumor, or atherosclerosis. Cranial nerve testing, observation for nystagmus, and tuning fork testing for unilateral, conductive, or sensorineural hearing loss and abnormalities of the cranial nerves, can be conducted in the office setting. Tympanometry conducted by a technician or an audiologist can help identify a patulous eustachian tube or myoclonus of the middle ear or palate muscles.

Audiometry is especially important for evaluating subjective tinnitus, as it measures the presence and extent of hearing loss. Many patients do not realize that they have a high-frequency hearing loss at or near the pitch of the tinnitus. Hearing loss associated with tinnitus should be evaluated in the same manner as any other hearing loss. Unilateral sensorineural hearing loss and tinnitus should prompt investigation for an acoustic neuroma. Early diagnosis and treatment of an acoustic neuroma are critical for preserving hearing and facial nerve function. Evaluation of tonal matching (ie, matching defined-frequency tones to the tone of the patient's tinnitus) and the ability of the tinnitus to be masked can be done, as well as measuring discomfort with loud noises at standard frequencies from 1,000 to 8,000 Hz. These evaluations can help determine whether a masking device can be used.

Radiologic evaluations

Not all patients with tinnitus require a radiologic study. For example, patients who have nonpulsatile tinnitus without an abnormal tympanic membrane or other associated symptoms or signs do not typically require imaging. If necessary, however, patients can be referred to an otolaryngologist for an evaluation tailored to the specific type of tinnitus and other associated symptoms. An imaging algorithm for patients with tinnitus is provided in the figure on page 33.

If a patient presents with objective pulsatile tinnitus and a normal tympanic membrane, cerebral angiography may be recommended to investigate a possible dural arteriovenous fistula, carotid stenosis, or aneurysm. For a patient with subjective pulsatile tinnitus and a normal tympanic membrane, a high-resolution head CT with a special "acoustic protocol" as described by Willinsky⁶ is indicated to rule out Paget's disease or increased intracranial pressure. The acoustic protocol refers to high-resolution CT imaging of the posterior fossa and supratentorial structures, examining the petrous part of the temporal bone in detail with 1.5 mm thick slices using bone and standard soft-tissue algorithms. Sismanis⁷ recommends head MRI with arteriography (MRA) for patients with subjective pulsatile tinnitus to better differentiate benign intracranial hypertension (BIH) from vascular anomalies. Other signs suggestive of BIH are papilledema, obesity, and high CSF pressure upon lumbar puncture.

In a patient with subjective pulsatile tinnitus and a mass seen behind the tympanic membrane, high resolution CT using posterior fossa and petrous protocols is recommended to identify a cholesterol granuloma, aberrant carotid artery, persistent stapedia artery, or a large/superiorly located jugular bulb. If results from this study indicate a glomus tumor, further evaluation should be performed using angiography alone or MRI/MRA. If a retrotympanic mass is identified on physical examination and the patient has nonvibratory subjective tinnitus, a high resolution CT is recommended to evaluate for cholesteroloma or inflammatory/infectious middle ear processes unless the nature and extent of the process is obvious from the examination.⁶

If the patient has nonvibratory tinnitus and a normal tympanic membrane, the selection of a radiologic study may depend on the type of hearing loss. If the hearing loss is unilateral or asymmetric, MRI with gadolinium enhance-

ment of the cerebellopontine angle may be required to rule out acoustic neuroma depending on specific audiometric data, usually determined by the otolaryngologist. Labyrinthitis can cause sudden onset hearing loss, vertigo, and tinnitus, and may appear on an enhanced MRI as labyrinthine enhancement. If the hearing loss is bilateral and a cochlear abnormality is suspected, a high resolution CT of the temporal bones is recommended to rule out bony abnormalities such as otosclerosis or Paget's disease.⁶

Treatment options

Incomplete understanding of the origin of most cases of tinnitus often precludes definitive diagnosis and treatment, but some types can be treated with good results. All underlying medical and otologic conditions causing tinnitus must be treated. If possible, depending on the patient's condition, eliminate all tinnitus-producing med-

All underlying medical and otologic conditions causing tinnitus must be treated

ications, such as aspirin and NSAIDs. If a lesion is suspected that can be treated surgically, refer the patient to an otolaryngologist. Many patients whose tinnitus is caused by otosclerosis may greatly improve following stapedectomy although results are inconsistent. If the cause is a glomus tumor or acoustic neuroma, excision of the tumor may alleviate the tinnitus. Surgical treatments are available for severe cases of Meniere's disease and can improve vertigo and tinnitus associated with the disease.

When a complete evaluation fails to identify a definitive cause of tinnitus

Tinnitus

and has ruled out tumors and other life-threatening conditions, reassuring the patient that the symptoms can be managed is paramount. Patients may experience significant anxiety knowing that they have to live with the tinnitus and wondering how it will affect their hearing, but they should be reassured that tinnitus does not cause deafness. Understanding that they do not have a serious life-threatening condition may be enough to quell the irritation they experience. Most patients consider their tinnitus mild and compensate well in

Hearing aids are still the most common technological aid used to relieve tinnitus

their daily lives without any further treatment. Patients with tinnitus should avoid certain foods and medications, especially stimulants such as caffeinated coffee, tea, and cola, and medications such as aspirin and NSAIDs. Meniere's disease often improves with a low-salt diet. If the tinnitus is most bothersome in a quiet environment, such as when the patient is attempting to sleep, recommend that the patient mask the sound by tuning an FM radio to a location between frequencies and play white noise at a volume sufficient to eliminate or reduce the tinnitus.

Pharmacologic therapies. Medical treatments for tinnitus are abundant, although sometimes questionable and with varying degrees of efficacy. None of the treatments can cure tinnitus, but they might reduce its severity in some patients. Dobie performed a review of randomized clinical trials of tinnitus and found that overall, nonspecific support and counseling are helpful for patients with tinnitus, and tricyclic antidepressants may be useful in severe

cases. Nevertheless most current medical and other treatments cannot be considered well-established in reducing tinnitus in excess of placebo effect for the long-term.⁸

Most therapies are directed at increasing vascular flow to the cochlea or relieving patient anxieties. Papaverine HCl (a smooth muscle relaxant) was once the drug of choice for increasing blood flow, but experience has shown little actual success in patients with tinnitus. Other vasodilators that have been used include adrenergics, antiadrenergics, anticholinesterase agents, and cholinolytics.⁹ Supplementation with vitamins A, C, B₁₂, and nicotinic acid have been advocated as well as zinc and copper for their beneficial effects on the vascular system and general well-being. Nevertheless, megadoses of these vitamins and minerals are unlikely to significantly improve tinnitus and can cause serious problems in older patients with pre-existing medical conditions.

Tranquilizers are prescribed to relieve anxiety associated with tinnitus, and in some cases may help relieve the loudness of the sounds. Benzodiazepines are the most common drug class used, with one study citing greater benefits with alprazolam than placebo.¹⁰ Dobie cautioned that this study should be replicated to include evaluation of the impact of tinnitus on the patient, and evaluation of the long-term effects of alprazolam on tinnitus with special attention to the problem of dependency.⁸

Antidepressants are often prescribed for tinnitus patients in order to relieve depression, which often accompanies disabling tinnitus. In addition to their independent analgesic effects, tricyclics have been used to relieve depression and thus minimize associated tinnitus. Studies have shown the most improvements from tricyclics in tinnitus patients who have sleep disturbances and in those who do not have musculoskeletal problems. A review of randomized clinical trials concluded that tricyclic antidepressants are probably helpful in severe cases of tinnitus; however, tricyclics may accentuate tinnitus in other cases.⁸ Use

of the newer antidepressants for tinnitus requires further investigation.

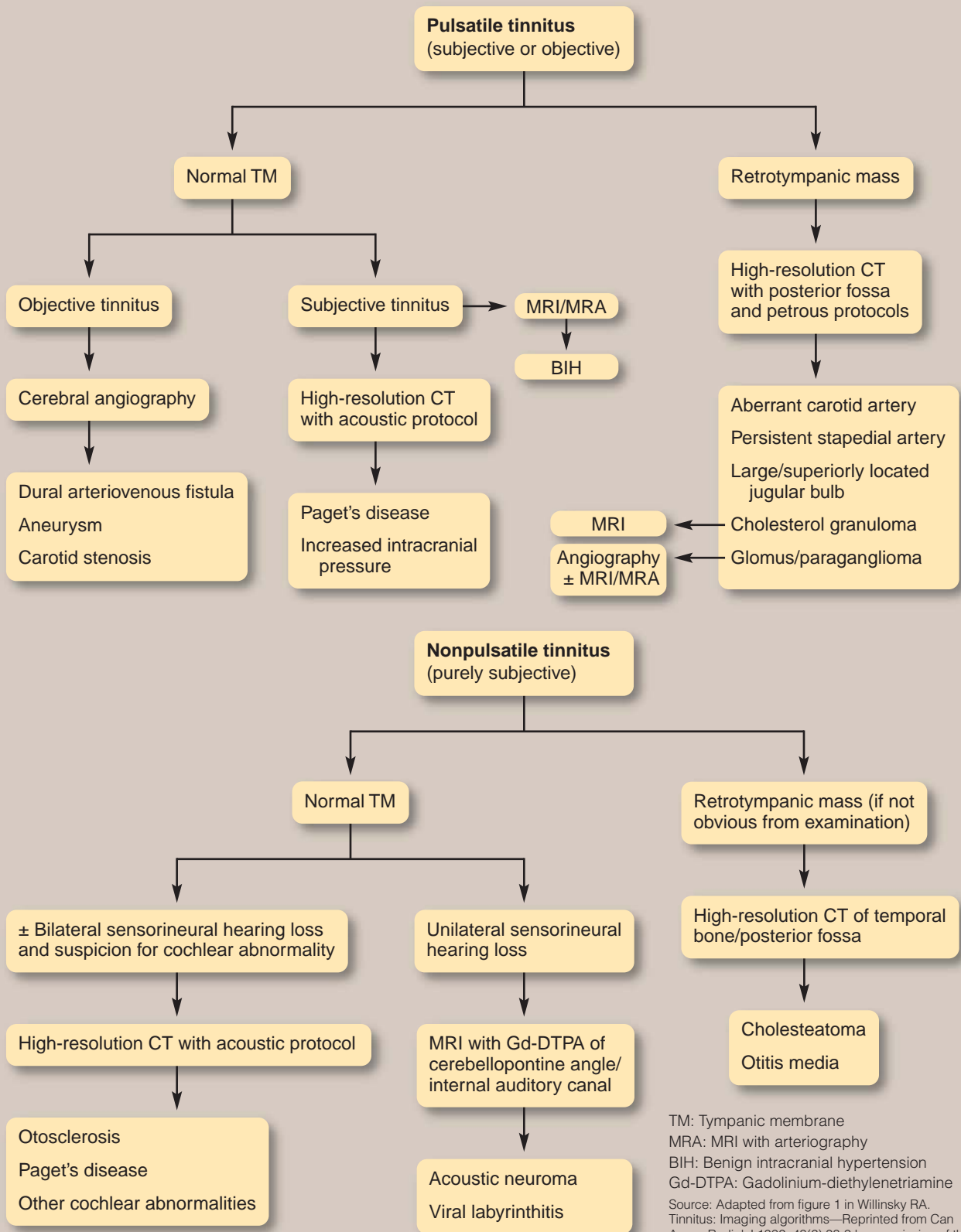
Nonpharmacologic therapies. Alternative treatment with ginkgo biloba has been used to relieve tinnitus, but only a few randomized clinical trials have provided information regarding its effectiveness. One review of randomized controlled clinical trials found that ginkgo biloba may be better than placebo for managing symptoms of tinnitus, but recommended further studies to determine optimum dosage and patient selection.¹¹ There is no agreement about the appropriate dose needed to provide relief of tinnitus. The effects of ginkgo biloba are thought to include anti-ischemic properties, free radical scavenging, and metabolic actions as well as increases to microcirculatory blood flow.

Masking, which utilizes one tone or type of noise, such as white noise, to cover up the tinnitus, has been a primary method of treatment for patients with severe tinnitus since 1976.¹² The simplest, most cost-effective method is to have the patient set an FM radio dial between stations to generate broad-spectrum static. The static is often enough to mask the tinnitus in the period prior to sleep. If the patient has hearing loss, a hearing aid can be used to introduce masking simply by amplifying environmental noise. Despite many advances in technology, hearing aids are still the most common technological aid used to relieve tinnitus. Special tinnitus masking devices deliver a constant or varied signal at a specified frequency (either low or high) that is tailored to the perceived frequency of the tinnitus. The volume can be adjusted to produce the smallest amount of noise needed to mask the tinnitus. A tinnitus instrument (a masker and hearing aid in one device) combines frequency-specific amplification and masking to manage tinnitus in patients with significant hearing loss.

In many patients, tinnitus remains suppressed for some time after the masking has been discontinued. If this occurs, it is an indication that future masking efforts will likely be success-

Figure. Imaging algorithm for patients with tinnitus

Radiologic evaluations



TM: Tympanic membrane
 MRA: MRI with arteriography
 BIH: Benign intracranial hypertension
 Gd-DTPA: Gadolinium-diethylenetriamine
 Source: Adapted from figure 1 in Willinsky RA.
 Tinnitus: Imaging algorithms—Reprinted from Can
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Table 2 American Tinnitus Association contact information

<p>Address</p> <p>American Tinnitus Association P.O. Box 5 Portland, OR 97207-0005</p> <p>Telephone</p> <p>Toll Free in U.S. (800) 634-8978 (503) 248-9985</p>	<p>Fax</p> <p>(503) 248-0024</p> <p>Website</p> <p>www.ata.org</p> <p>Email</p> <p>tinnitus@ata.org</p>
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ful. Masking will not help patients who have little to no residual hearing in the frequency range of the tinnitus. Overall, masking devices may improve tinnitus in only 10 to 15% of patients.¹ Patients seem to improve enough that the tinnitus is not noticeable and does not disrupt their daily lives.

Biofeedback has been used to manage psychological reactions to tinnitus. This treatment teaches patients to control their states of relaxation to reduce the stress experienced with tinnitus. Biofeedback does not directly treat the symptom of tinnitus. Thus, successful use of this modality does not necessarily reduce the magnitude of tinnitus, but it does reduce patient stress.


Tinnitus retraining therapy, as described by Jastreboff and colleagues,¹³ uses habituation to retrain patients so that they become at least relatively unaware of the tinnitus. After a thorough audiologic and tinnitus assessment, the patient receives directive counseling and begins wearing a low-level, broadband noise generator in both ears. This protocol is designed to facilitate habituation to the tinnitus rather than to mask the sounds, which is forbidden during therapy. The rationale is based on a neurophysiologic model of tinnitus that postulates that several nonauditory systems and all auditory pathways play important roles in tinnitus. The level of tinnitus annoyance is determined predominantly by the nonauditory systems. Thus, if patients can be habituated to a noise, its presence will no longer cause annoyance and they will not be aware of the noise unless they focus on it. Following therapy, 83% of patients exhibited significant

improvement in tinnitus symptoms as measured by changes in the effect of tinnitus on their daily lives, level of tinnitus-induced annoyance, and answers to a questionnaire, compared with 18% of patients who improved following counseling alone.¹³

If the patient needs more help than the physician or audiologist can provide, counseling and support groups may be able to provide needed assistance. The American Tinnitus Association has current information on research and management options for tinnitus, and can provide support group information as well. Patients and healthcare professionals may find useful information on the website, www.ata.org, as well as links to other sites of interest. Contact information for the American Tinnitus Association is provided in table 2.

Conclusion

Because tinnitus is a nonspecific symptom that affects patients differently, a thorough evaluation should include a complete history, physical examination, and other appropriate testing. Identifying the effect of tinnitus on the patient is an integral part of the evaluation. Referral to an otolaryngologist facilitates the evaluation, treatment, and counseling process for patients with severe tinnitus. Once the life-threatening and treatable causes have been identified and treated, the main-

stay of management is explanation and reassurance. Despite ongoing research, no one approach to tinnitus has been able to provide a cure. 

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