

Ethan Zimmerman, MD;
Andrew Timboe, DO
Mike O'Callaghan Federal
Hospital, Nellis Air Force
Base, Nev

ethanzimmerman@
yahoo.com

The authors reported no
potential conflict of interest
relevant to this article.

Tinnitus: Steps to take, drugs to avoid

This algorithm will help you identify the source of your patient's tinnitus; a summary of the evidence for various treatments makes it clear which ones to avoid.

PRACTICE RECOMMENDATIONS

› Advise patients to wear earplugs or earmuffs to prevent hearing loss and tinnitus when exposed to excessively loud sounds (>80 dB). **C**

› Avoid prescribing benzodiazepines, antidepressants, or gabapentin for the treatment of tinnitus; little evidence supports routine use of these agents. **B**

› Consider referring patients for cognitive-behavioral therapy or tinnitus retraining therapy, each of which can reduce the bothersome nature of tinnitus. **B**

Strength of recommendation (SOR)

- A** Good-quality patient-oriented evidence
- B** Inconsistent or limited-quality patient-oriented evidence
- C** Consensus, usual practice, opinion, disease-oriented evidence, case series

CASE 1 ▶ Mr. L is a 47-year-old construction worker who comes to the clinic with a 3-month history of bothersome, constant, high-pitched ringing in his ears that is worse on his right side. He also reports mild hearing loss. Mr. L notes that he keeps a busy schedule, working weekends at a local shooting range. He is a 30-pack-year smoker and takes sumatriptan and nasal fluticasone spray as needed for migraines and allergies. On inspection, his ears appear normal.

CASE 2 ▶ Ms. B, age 68 years, seeks treatment for a constant pulsatile noise in her left ear, which has been bothering her for the past 5 months. She lives alone and says this noise is worse when the house is quiet. She takes chlorthalidone for hypertension and prophylactic aspirin. She indicates that she has no problems with her hearing. On exam, the noise synchronizes with her pulse.

If Mr. L and Ms. B were your patients, what would your next steps be?

An estimated 50 million people in the United States experience some form of tinnitus,¹ and the incidence is on the rise, which some have attributed to the increased use of personal music devices.^{2,3} Patients often describe tinnitus as a ringing noise, but it also can be perceived as buzzing, chirping, hissing, whistling, humming, or other sound. It is more often bilateral than unilateral⁴ and more often intermittent than continuous.¹

Tinnitus may be present in childhood, but the prevalence increases with age. Surveys show that approximately 25% of adults experience symptoms and one-fourth of these patients report that it interferes with daily activities.^{1,2} The prevalence peaks at 31% in patients between the ages of 60 and 69 years.¹

The severity of the condition ranges from causing patients to merely be aware of the noise to having substantial adverse effects

TABLE 1

Causes of tinnitus^{2,6,7}

Subjective	Objective
Otologic: noise-induced hearing loss, presbycusis, Meniere's disease, otosclerosis	Vascular: aortic/carotid stenosis, venous hum, arteriovenous fistula/malformation, vascular tumors, high-output cardiac state (eg, anemia)
Neurologic: multiple sclerosis, vestibular schwannoma (acoustic neuroma)	Neurologic: Palatal myoclonus, idiopathic stapedial muscle spasm
Ototoxic drugs (eg, gentamycin, furosemide)	Patulous eustachian tube
Metabolic: thyroid disorder, diabetes, zinc deficiency	
Mechanical: head/neck injury, temporomandibular joint disorder, infection, cerumen impaction	

on their quality of life. Because not all patients will report tinnitus symptoms, it is important to be aware of risk factors, which include advanced age, male sex, history of military service, and a work history that includes exposure to loud noise.^{1,2} Smoking and hypertension also are associated with higher rates of tinnitus, as is living in the southern United States.¹

A subjective, or objective case of tinnitus?

While subjective tinnitus consists of noises only the patient can hear, objective tinnitus refers to noises, including somatosounds such as turbulent blood flow or palatal myoclonus, that a physician could at least theoretically detect by auscultation or with an amplifying device. Objective tinnitus is less common than subjective tinnitus and more often has an identifiable and correctable source,⁵ though it may herald a serious underlying condition. When tinnitus is pulsatile or rhythmic, it may be the result of an arteriovenous fistula, arteriovenous malformation, cerebral aneurysm, arterial bruit, or other vascular lesion, such as a glomus tumor.⁶ Nonvascular conditions like palatal myoclonus present with clicking or low-pitched buzzing and may be a result of multiple sclerosis.⁷

The causes of both subjective and objective tinnitus are detailed in TABLE 1.^{2,6,7}

Tinnitus and hearing loss:

The connection

Most tinnitus is associated with hearing loss and probably results from a disruption in the

normal suppression of neuronal activity in the central nervous system.^{2,8}

Conductive hearing loss can be caused by cerumen impaction, otosclerosis, or cholesteatoma. Sensorineural hearing loss (SNHL), which is more common than conductive hearing loss, often is irreversible. The damage typically occurs in the stereocilia cells of the cochlea. These cells trigger the release of neurotransmitters that activate the eighth cranial nerve and cause abnormal excitation along the auditory pathway, giving the perception of sound in a quiet environment.²

Patients with SNHL usually have a history of prolonged exposure to loud noise (eg, heavy machinery, firearms, personal musical devices such as an iPod, or musical instruments) and often describe their tinnitus as a bilateral, high-pitched, continuous ringing. The other major category of SNHL that causes tinnitus is presbycusis—the hearing loss associated with aging—which has clinical features similar to noise-induced hearing loss.⁸

What to look for

Evaluation of tinnitus begins with a thorough history and physical exam (FIGURE 1).^{2,6,7,9} Key components of the exam include inspecting the ears, nose, and throat and evaluating cranial nerve function. Weber and Rinne tuning fork testing can help to confirm a conductive hearing loss. When evaluating a patient who reports pulsatile tinnitus, perform auscultation over vascular structures in the neck, temple, and around the ear.



When a patient reports pulsatile tinnitus, perform auscultation over vascular structures in the neck, temple, and around the ear.

CONTINUED

Up to 25% of patients with chronic tinnitus report an increase in severity over time. Thus, prevention efforts can be beneficial for patients who already have the condition.

Obtain targeted laboratory studies if there is a suggested metabolic etiology for tinnitus (TABLE 1).^{2,6,7} Handheld tympanometry that is flatlined or fluctuates with breathing can help support the diagnosis of a subtle middle ear effusion or patulous eustachian tube, respectively.

It is important to quantify how tinnitus affects a patient's mood, including irritability and concentration. Tinnitus can be measured on several scales, including the Tinnitus Functional Index (TFI),¹⁰ which is easily completed in the office. It has been validated to quantify the severity of symptoms and can be used to monitor a patient's progress. A copy of the TFI and its scoring instructions are available at <http://www.ohsu.edu/xd/health/services/ent/services/tinnitus-clinic/tinnitus-functional-index.cfm>.

■ **Refer most patients to audiology.** Patient's symptoms often correlate poorly with acoustic functioning.⁶ Unless you find simple, reversible causes of tinnitus on history and physical, a comprehensive audiologic evaluation is essential. Components of these evaluations include pure-tone thresholds, tympanometry, speech thresholds, and speech discrimination testing.⁷

■ **Image when necessary.** If audiometric testing indicates cochlear damage, imaging generally is unnecessary because SNHL has been confirmed.⁷ However, if a retrocochlear hearing deficit is detected, auditory brainstem response testing is useful to help locate the lesion. Gadolinium-enhanced magnetic resonance imaging of the internal auditory canals also can be performed to evaluate for central nervous system lesions.^{2,7} This will detect vestibular schwannoma, which is the most frequent cause of tinnitus apparent on imaging.¹¹

Pulsatility is the one true red flag feature of tinnitus and regardless of audiometry, patients with pulsatile tinnitus require imaging to rule out vascular lesions. The petrous carotid system is a common culprit; therefore, contrast-enhanced high-resolution computed tomography (CT) of the temporal bone is a reasonable initial study since it also will detect osseous abnormalities of the inner ear. However, angiography often is eventually necessary (conventional, magnetic resonance, or

CT) to exclude a dural arteriovenous fistula or malformation—the most common cause of objective, pulsatile tinnitus.¹¹ When tinnitus is pulsatile, unilateral, atypical in nature, or associated with deafness, imaging plus referral to a neurologist or otolaryngologist is advisable.⁶

Medications, and other factors to consider

Many different types of medications and substances can have ototoxic effects, mainly on the cochlear hair cells (TABLE 2).¹² The damage may be reversible or irreversible. When doing so would be clinically prudent, consider tapering a patient off a drug that may be causing tinnitus.⁷

■ **Other causes to consider.** Pain in the jaw or neck may be due to a temporomandibular joint disorder or a cervical spine problem like whiplash; these conditions are associated with tinnitus and vertigo.^{7,13} The combination of low-pitched tinnitus, vertigo, aural fullness, and hearing loss often signifies Meniere's disease—especially if symptoms are episodic.

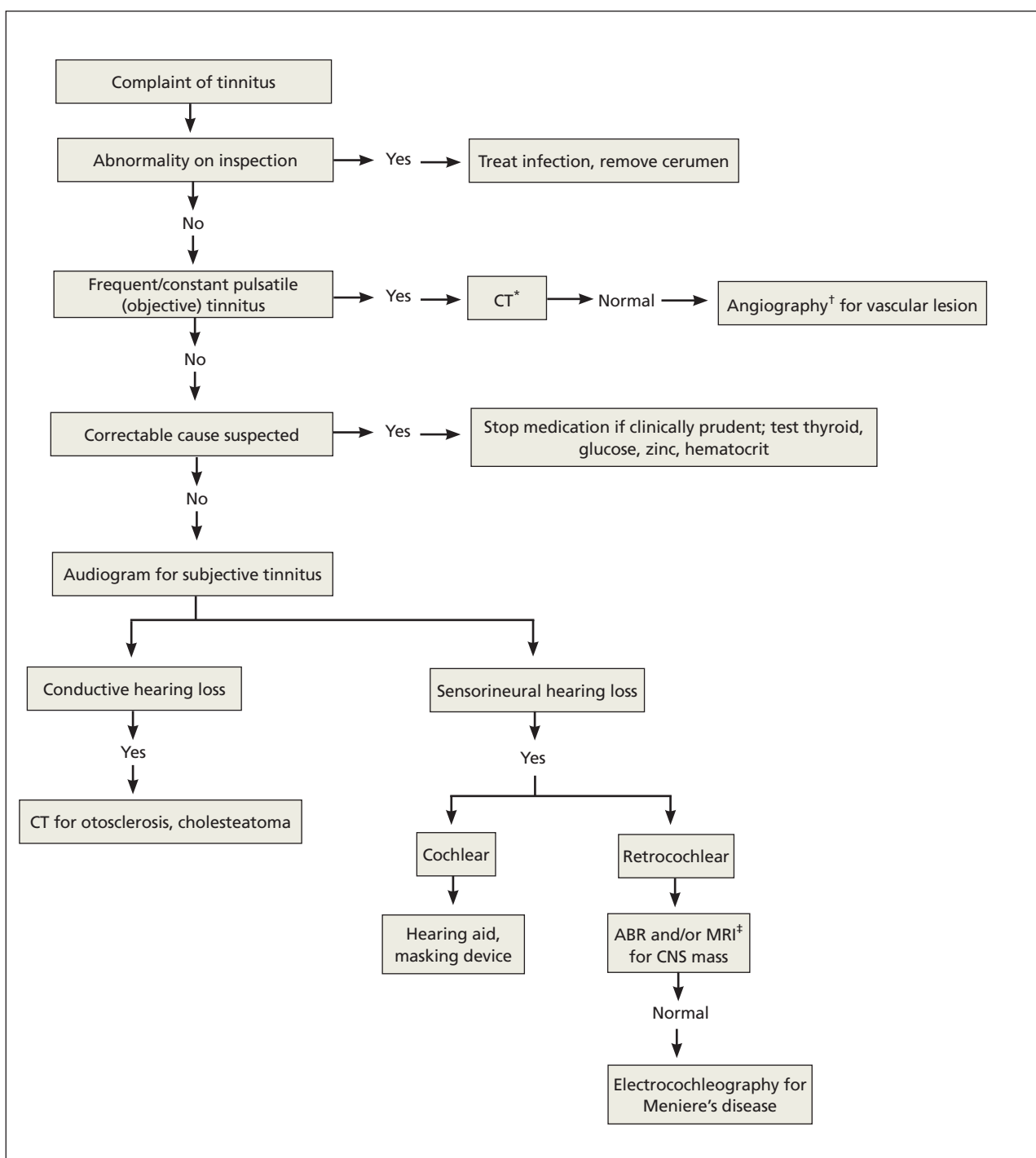
■ **Address mood disorders.** Although insomnia, anxiety, depression, and post-traumatic stress disorder generally are not considered causes, these conditions are associated with tinnitus and can exacerbate the condition. Tinnitus can trigger depression, and vice versa. Optimizing treatment for these common problems can significantly reduce suffering.^{6,7}

For most patients, you'll focus on prevention, rather than Tx

Treatment for tinnitus (which we'll describe in a bit) is necessary only for patients for whom the condition has substantially affected the quality of their life.² Greater emphasis should be placed on prevention.

Most tinnitus originates from the auditory system and is considered irreversible, but up to 25% of patients with chronic tinnitus report an increase in severity over time.¹⁴ Therefore, prevention can be beneficial not only for patients at risk of developing tinnitus, but also for those already affected by it. Prevention efforts should focus on protecting

FIGURE 1

Diagnostic algorithm for tinnitus^{2,6,7,9}

ABR, auditory brainstem response; CNS, central nervous system; CT, computed tomography; MRI, magnetic resonance imaging.

*High-resolution, contrast-enhanced computed tomography of temporal bone.

†Computed tomography, magnetic resonance, or conventional angiography.

‡Magnetic resonance imaging of head and internal auditory canal with gadolinium.

CONTINUED

>
 Recommend ear
 plugs or muffs
 for patients
 exposed to
 >80 dB and
 both forms of
 protection for
 those exposed
 to >95 dB.

TABLE 2
Drugs that can cause tinnitus¹²

Analgesics
Aspirin (typically only at high doses)
NSAIDs
Antibiotics
Aminoglycosides (eg, gentamycin)
Erythromycin
Vancomycin
Antineoplastics
Cisplatin
Mechlorethamine
Vincristine
Antimalarials
Chloroquine
Hydroxychloroquine
Quinine
Loop diuretics (eg, furosemide)
Valproate

NSAIDs, nonsteroidal anti-inflammatory drugs.

hearing by reducing noise levels and exposure time to certain noise thresholds.

The decibel (dB) scale is logarithmic; perception of sound loudness doubles every 10 dB. The sound of a vacuum cleaner is approximately 70 dB; the average human pain threshold is roughly 110 dB, which is the loudness of live rock music. Eardrum rupture occurs at approximately 150 dB—the equivalent of hearing a jet take off at 25 meters.

Talk to patients about hearing protection devices. The US Environmental Protection Agency monitors all hearing protection devices and assigns them a Noise Reduction Rating (NRR). The adequacy of single vs double hearing protection depends on the dB exposure level, duration of exposure, and NRR for the protective device(s). In general, recommend single hearing protection (ear plugs, which are inserted in the ear canal, or ear muffs, which fit around the ears) to patients exposed to >80 dB and dual hearing protection (ear plugs and muffs) to those ex-

posed to >95 dB. More guidance on single or dual hearing protection can be obtained from a local occupational health physician or from https://www.osha.gov/dts/osta/otm/noise/hcp/attenuation_estimation.html.

■ **There are drawbacks** to using certain forms of ear protection. Regular use can increase the likelihood of cerumen impaction or otitis externa, both of which can actually cause tinnitus. Proper training on how to use hearing protection devices and routine otologic examinations are advisable for patients who frequently use ear protection.

Techniques that can help patients to better cope

The most common therapies used to treat tinnitus are cognitive-behavioral therapy (CBT) and tinnitus retraining therapy (TRT). Both are techniques of habituation designed to change the way patients think about, and emotionally respond to, tinnitus.^{15,16}

■ **CBT** is administered by a skilled therapist and employs relaxation exercises, coping strategies, and deconditioning techniques.¹⁶ The goal of CBT is to reduce arousal levels and reverse negative thoughts about tinnitus.¹⁶ A recent Cochrane review found that although CBT does not subjectively reduce the loudness of tinnitus, it does significantly improve quality of life and depression caused by tinnitus.¹⁷ CBT's benefits also extend to other common comorbidities such as SNHL, insomnia, depression, and anxiety.¹⁶ Up to 75% of patients experience improvement in their score on the standardized Tinnitus Handicap Questionnaire one year after completing therapy.¹⁶

■ **TRT** combines counseling, education, and acoustic therapy—using soft music or a sound machine—to minimize the bothersome nature of the condition.¹⁵ TRT is delivered by a team of physicians, audiologists, and psychologists and requires commitment from patients because most therapies are performed at a specialized tinnitus center over the course of up to 2 years.¹⁵ Retrospective trials of TRT have generally been positive, finding that this approach minimizes the annoyance patients experience.¹⁵

■ **Even in the absence of a formal TRT protocol**, patients can take advantage of

acoustic therapy. Patients should be advised to add pleasant noise to quiet environments with soft music or sound machines. “Masking” devices are also an option. These commercially available sound generators fit in the ear and may lessen patients’ perception of tinnitus.^{2,18}

Evidence supporting medications is weak

Though many medications have been investigated for treating tinnitus, most have been studied in small clinical trials and none is FDA-approved for tinnitus.

■ **Acamprosate**, which is FDA-approved for maintaining alcohol abstinence in alcohol-dependent patients, is a relatively new tinnitus treatment option. In small randomized, double-blinded, placebo controlled trials, approximately 90% of patients treated with acamprosate experienced improvement in tinnitus severity and quality of life.¹⁹ Larger studies will be necessary to determine if frequent adverse effects (including depression, anxiety, diarrhea, and drowsiness) will hamper its usefulness.

■ **Benzodiazepines** (mainly alprazolam) tend to reduce tinnitus-associated anxiety and also may decrease tinnitus intensity via central suppression of the auditory pathway. However, because evidence is limited to small trials with methodological flaws, and because benzodiazepines have the potential for dependence, the risks and benefits of these agents must be weighed carefully.^{7,16}

■ **Lidocaine** has a long history of use for tinnitus, by both intravenous and intratympanic routes. Its benefits are unclear. In some trials, lidocaine was moderately effective in the short term, whereas in others, it appeared to make tinnitus worse.^{7,20}

■ **Oral misoprostol** also may be an option, according to a series of placebo-controlled trials.²⁰ But the benefit of this medication may be limited to the perception of loudness, and not other tinnitus measures, such as improved sleep and concentration.²⁰

■ **Antidepressants** can have a profound positive effect on tinnitus in patients with severe depression but do not have the same effect on patients who do not suffer from depression.²⁰ Anticonvulsants such as gabapentin have not been found to be effective for tinnitus.²¹

■ **Researchers are investigating** centrally acting agents, such as the *N*-methyl-D-aspartate antagonist neramexane, for the treatment of tinnitus. With safety and tolerability now established, neramexane is in European phase III trials.²²

The jury is out on alternative therapies

With data lacking for prescription medications, patients may look into complementary and alternative therapies. However, consistent evidence is lacking for these therapies, as well. Ginkgo biloba has been found to reduce tinnitus severity and loudness in limited studies,²³ although some preparations may be superior to others.¹⁴ In a double-blind, randomized controlled trial, melatonin decreased tinnitus intensity significantly, particularly for men and for patients with severe symptoms or a history of noise exposure.²⁴ Zinc supplements may improve tinnitus in patients with zinc deficiency.^{20,25} Acupuncture and electromagnetic stimulation have not proven efficacious in the treatment of tinnitus.²¹

Additional steps that your patient can take

A trial of a hearing aid is often worthwhile as a noninvasive, first-line intervention for patients with tinnitus and SNHL. Hearing aids reduce the perception of tinnitus by amplifying ambient sounds.⁸ Some hearing aids also incorporate masking devices and are used to treat tinnitus in patients with hearing loss. Cochlear implants also are an option for certain patients with confirmed severe SNHL. One study found that tinnitus intensity and awareness were reduced in up to 86% of patients who received cochlear implants.²⁶

The American Tinnitus Association also advises patients with tinnitus to eliminate potential aggravating factors, including salt, artificial sweeteners, sugar, alcohol, tobacco, and caffeine.²⁷

CASE 1 ▶ Mr. L was referred for audiometric testing, which revealed severe high-frequency SNHL that was worse in the right ear. His symptoms improved slightly following a trial of a combination hearing aid/masking device



Acupuncture and electromagnetic stimulation have not proven efficacious in the treatment of tinnitus.

and participation in TRT. He was counseled to quit smoking and use dual hearing protection for future high-noise exposure.

CASE 2 ▶ Ms. B had normal audiometric testing and was referred for angiography. This revealed a dural arteriovenous fistula that was categorized as type III (draining directly into subarachnoid veins) with a small adjacent an-

eurysm. She underwent a successful clipping of the draining vein to prevent future hemorrhage. Her tinnitus subsequently resolved. Her aspirin use was not modified because it was low dose. **JFP**

CORRESPONDENCE

Ethan Zimmerman, MD, Mike O'Callaghan Federal Hospital, 4700 Las Vegas Boulevard North, Nellis Air Force Base, NV 89191; ethanzimmerman@yahoo.com

References

1. Shargorodsky J, Curhan GC, Farwell WR. Prevalence and characteristics of tinnitus among US adults. *Am J Med.* 2010;123:711-718.
2. Folmer RL, Martin WH, Shi Y. Tinnitus: questions to reveal the cause, answers to provide relief. *J Fam Pract.* 2004;53:532-540.
3. Figueiredo RR, Azevedo AA, Oliveira PM, et al. Incidence of tinnitus in mp3 player users. *Braz J Otorhinolaryngol.* 2011;77:293-298.
4. Stouffer JL, Tyler RS. Characterization of tinnitus by tinnitus patients. *J Speech Hear Disord.* 1990;55:439-453.
5. Heller AJ. Classification and epidemiology of tinnitus. *Otolaryngol Clin North Am.* 2003;36:239-248.
6. Crummer RW, Hassan GA. Diagnostic approach to tinnitus. *Am Fam Physician.* 2004;69:120-126.
7. Lockwood AH, Salvi RJ, Burkard RF. Tinnitus. *N Engl J Med.* 2002;347:904-910.
8. Bauer CA. Tinnitus and hyperacusis. In: Flint PW, Haughey BH, Lund VJ, et al, eds. *Cummings Otolaryngology: Head and Neck Surgery.* 5th ed. Philadelphia: Mosby Elsevier; 2010: 2131-2139.
9. ACR Appropriateness Criteria®: vertigo and hearing loss. American College of Radiology Web site. Available at: <http://www.acr.org/-/media/ACR/Documents/AppCriteria/Diagnostic/HearingLossVertigo.pdf>. Accessed January 7, 2014.
10. Meikle MB, Henry JA, Griest SE, et al. The tinnitus functional index: development of a new clinical measure for chronic, intrusive tinnitus. *Ear Hear.* 2012;33:153-176.
11. Kang M, Escott E. Imaging of tinnitus. *Otolaryngol Clin North Am.* 2008;41:179-193.
12. Seligmann H, Podoshin L, Ben-David J, et al. Drug-induced tinnitus and other hearing disorders. *Drug Saf.* 1996;14:198-212.
13. Bernhardt O, Mundt T, Welk A, et al. Signs and symptoms of temporomandibular disorders and the incidence of tinnitus. *J Oral Rehabil.* 2011;38:891-901.
14. von Boetticher A. Ginkgo biloba extract in the treatment of tinnitus: a systematic review. *Neuropsychiatr Dis Treat.* 2011;7:441-447.
15. Bauer CA, Brozoski TJ. Effect of tinnitus retraining therapy on the loudness and annoyance of tinnitus: a controlled trial. *Ear Hear.* 2011;32:145-155.
16. Fioretti A, Eibenstein A, Fusetti M. New trends in tinnitus management. *Open Neurol J.* 2011;5:12-17.
17. Martinez-Devesa P, Perera R, Theodoulou M, et al. Cognitive behavioural therapy for tinnitus. *Cochrane Database Syst Rev.* 2010;(9):CD005233.
18. Hobson J, Chisholm E, El Refaie A. Sound therapy (masking) in the management of tinnitus in adults. *Cochrane Database Syst Rev.* 2010;(12):CD006371.
19. Sharma DK, Kaur S, Singh J, et al. Role of acamprosate in sensorineural tinnitus. *Indian J Pharmacol.* 2012;44:93-96.
20. Salvi R, Lobarinas E, Sun W. Pharmacological treatments for tinnitus: new and old. *Drugs Future.* 2009;34:381-400.
21. Savage J, Waddell A. Tinnitus. *Clin Evid (Online).* 2012;pii:0506.
22. Suckfüll M, Althaus M, Ellers-Lenz B, et al. A randomized, double-blind, placebo-controlled clinical trial to evaluate the efficacy and safety of neramexane in patients with moderate to severe subjective tinnitus. *BMC Ear Nose Throat Disord.* 2011;11:1.
23. Ernst E, Stevinson C. Ginkgo biloba for tinnitus: a review. *Clin Otolaryngol.* 1999;24:164-167.
24. Hurtuk A, Dome C, Holloman CH, et al. Melatonin: can it stop the ringing? *Ann Otol Rhinol Laryngol.* 2011;120:433-440.
25. Arda HN, Tuncel U, Akdogan O, et al. The role of zinc in the treatment of tinnitus. *Otol Neurotol.* 2003;24:86-89.
26. Quaranta N, Wagstaff S, Baguley DM. Tinnitus and cochlear implantation. *Int J Audiol.* 2004;43:245-251.
27. Management tips. American Tinnitus Association Web site. Available at: <http://www.ata.org/for-patients/tips>. Accessed January 13, 2014.

Was there a patient who changed the way you practice medicine?

We'd like to hear about your experience! In 750 words or less, tell us your story. Describe the patient, the challenges of his or her care, and the events that made you reevaluate how you practice family medicine.

Send your entry to mostrowski@frontlinemedcom.com by March 15.

The winning entry will be published in the May issue of the journal as part of our 40th anniversary celebration. Second- and third-place winners will be published online.



Do you have a winning entry? Find out by submitting your story today!

