

Research advances understanding of tinnitus, lifts hopes of better treatments

By Judith Nemes



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Tinnitus research has made great strides in the past decade, offering new options for successful management of this sometimes debilitating condition and raising hopes of improved treatments in the near future. Scientists are beginning to gain a better understanding of the causes of tinnitus, which is a big first step toward improving management of the disorder.

Already, some new treatments are gaining wider visibility—and respectability—as they demonstrate positive results. And significant progress is being made in imaging techniques and animal studies that hold the promise of better treatments to come. There is even a possibility of pharmacological approaches in the next 5 to 10 years, according to researchers working in this discipline. Other more experimental studies also are ongoing.

Meanwhile, tinnitus authorities say, some long-established multi-pronged approaches are continuing to provide measurable relief to individuals who had been incapacitated by the tormenting ringing and buzzing noises they experienced.

“There’s no surgery or medication or pill that’s shown conclusively to cure tinnitus,” states Richard Tyler, PhD, a professor in the Department of Otolaryngology and the Department of Speech Pathology and Audiology at the University of Iowa in Iowa City. “Tinnitus is a symptom, and it likely has many causes and many treatments that could work. While some things may work for some individuals, one of the biggest challenges is identifying who will benefit and figuring out how to treat them effectively.”

AUDIOLOGISTS URGED TO GET TRAINING

Despite progress on the treatment front, there is a dearth of audiologists who have taken specialized training in this area and who actively seek out patients with tinnitus. David P. Fagerlie, CEO of the American Tinnitus Association (ATA), estimates that only about 10% of audiologists in the U.S. are trained appropriately to treat people with tinnitus. There are many reasons why more audiologists aren’t caring for patients with tinnitus, including inadequate reimbursement and a lack of confidence that they can actually help such individuals. But, says Fagerlie, there are significant opportunities for audiologists and other hearing care professionals to expand their practices in this area.



David Fagerlie

“With appropriate training, audiologists could change the world in tinnitus,” he contends. “They are the best suited professionals to deal with this problem because they are interested in the whole hearing system from neurology to the workings of the little bones in the ear. We know that a high percentage of people with chronic tinnitus also have hearing loss and many of the counseling skills audiologists use in aural rehabilitation can be applied to people with tinnitus.”

There are training programs all over the country for audiologists wishing to gain expertise in caring for tinnitus patients, says James W. Hall III, PhD, associate chair and clinical professor in the Department of Communicative Disorders at the University of Florida, Gainesville. Hall conducts full-day tinnitus workshops for audiologists, as well as 3-hour seminars that teach the skills required to handle most tinnitus cases.



James W. Hall III

Hall contends, "If the average tinnitus patient were managed properly by the first professional they saw, most patients wouldn't have such severe problems with it." He adds, "Audiologists who see these patients early on can help them immeasurably."

INCIDENCE HIGH AND RISING

Currently, about 50 million Americans have tinnitus and an estimated 10 to 12 million of them suffer enough to seek treatment for the condition, according to a study by researchers at Gallaudet University, Washington, DC. What's more, the number of Americans suffering from tinnitus is expected to grow significantly in the years ahead. American military personnel returning home from duty in Iraq and Afghanistan are being diagnosed with tinnitus more often than any other medical condition, reports Fagerlie, adding that those figures are expected to rise in the years to come.

On the home front as well, more and more younger Americans are expected to experience symptoms of tinnitus and other forms of noise-induced damage, in part because of the constant use of iPods and other MP3 players. A recent study by the Centers for Disease Control and Prevention found that one of every eight children between the ages of 6 and 19 suffers from noise-induced hearing damage.

Thus, now more than ever, audiologists are needed to help treat patients with tinnitus, says Fagerlie. "Training is important because there is a state of the art, which has been developed over time, and there are techniques that need to be known," the ATA leader says. "There are directive counseling, sound therapies, and electrical stimulation. But you can't just give someone a device with sound in it and send them home. There are also new treatments worth looking at."

Traditionally, three general types of treatments have been most commonly used: masking, hearing aids, and sound therapy combined with counseling. While those management plans still are widely used, this article will focus on some of the newer therapies being introduced. It will also examine studies under way that are paving the way to better results down the road for patients who cannot simply ignore the incessant buzzing noise in their heads.

PET SCAN IMAGING, ANIMAL STUDIES BEAR FRUIT

In the mid-1990s, researchers at the University of Buffalo, NY, began a series of studies using imaging techniques that have helped change our understanding of the mechanics of tinnitus and potential treatment options for it. Two of the researchers, Richard Salvi, PhD, and Alan Lockwood, used positron emissions tomography, or PET scans, to demonstrate that tinnitus originated in the brain. Previously, it was generally believed that the condition originated in the ear, says Salvi, who is a professor in the Department of Communicative Disorders and Sciences at the University of Buffalo and director of the Center for Hearing and Deafness. Lockwood is a professor in the Departments of Neurology and Nuclear Medicine, also at Buffalo.

By using radioactive water as a marker of blood flow and neural

activity in the brain, the researchers measured higher levels of brain activity when study participants with tinnitus said they were experiencing louder buzzing noises when they clenched their jaw, Salvi explains. They found a change in activity in the auditory cortex of the brain, which suggested that the tinnitus originated in the brain, not the ear. These patients all had diminished hearing because of injury or age.

Salvi and his colleagues discovered that when the brain's auditory cortex receives weaker signals from the cochlea, it boosts the volume to try to get stronger signals. It's believed that the brain's effort to turn up the volume of these signals also increases the volume of the buzzing or ringing noise in the background, which Salvi refers to as "neural static."

Using these same imaging techniques, the research team found that tinnitus triggered higher activity of blood flow to the limbic area of the brain, which controls emotions.

"Our study documented a connection between the phantom sound and emotional activity," says Salvi. "There never had been any data to support this theory before."

Other studies using imaging techniques followed, and have continued to provide hard evidence that tinnitus activity can be tracked to the brain. That has led the researchers to postulate that certain drugs might be used to reduce the high level of blood flow or neural activity to parts of the brain that trigger tinnitus.

To that end, Salvi and colleagues have for the past 5 years been pursuing animal research and potential drug therapies to treat tinnitus. With funding from ATA, the Tinnitus Research Consortium, and, more recently, the National Institutes of Health, researchers at the University of Buffalo have been working with rats to determine if a handful of experimental drugs and compounds can reduce noise-induced tinnitus. Using electrodes, they are trying to measure the neural activity in the animals' auditory cortices to see if the drugs reverse the effects of tinnitus.

The next step, says Salvi, is to test a series of drugs to find what works. In theory, if the drugs are effective, they should change the chemical activity in the brain to reduce the tormenting sounds of tinnitus.

Salvi is conducting separate studies to explore ways to modulate ion channels in the brain, which regulate the excitability of neurons. He hopes to find a medication that may reduce tinnitus that is caused by this brain process.

These are all building blocks, says Salvi, since any studies attempting to change brain activity now can be measured using the imaging tools the Buffalo researchers developed a decade ago. He adds, "I'm extremely optimistic that in the next 5 to 10 years we may see major breakthroughs in understanding tinnitus and even in pharmacological treatment."

COMPANY OFFERS A NEW SOUND THERAPY

Tinnitus sufferers don't have to wait another decade for some of the treatment options that have been developed. Various forms of sound therapy have been around for many years. Some of these generate white noise to mix with the tinnitus and make it less noticeable.

One of the newer sound therapy approaches that is becoming better known involves a medical device and a 6-to-8-month program that together are designed to provide immediate relief

from the incessant buzzing of tinnitus, as well as longer term desensitization so those suffering from the disorder can learn to live with it more comfortably.

The device is manufactured by Neuromonics, Inc., of Bethlehem, PA. Teri Sinopoli, an audiologist and the company's director of clinical services, explains that the combination of the device with the educational and counseling program is intended to address the three components that together produce the problems most commonly experienced by tinnitus sufferers.

These are: (1) audiological (hearing loss often triggers tinnitus), (2) neurological (how the brain responds), and (3) psychological (how people react to tinnitus).

Here is Sinopoli's explanation of how the Neuromonics program works: The pocket-sized device emits a high-frequency (up to 12,500 Hz) acoustic stimulus that's customized and spectrally modified based on a patient's individual hearing profile. In the first phase of the treatment, which typically lasts for 2 months, an embedded neural stimulus (akin to the sound of a shower) is added to relaxing music, which covers up the tinnitus completely so patients get immediate relief from the constant ringing noises. Patients are told to wear the device for 2 to 4 hours a day, during the time when their tinnitus is most bothersome.

In the second phase, the embedded neural stimulus is removed and the patient continues to listen to the acoustic stimulus, which is customized music. While the music covers the tinnitus during the peaks, the ringing sound (the tinnitus) is audible to the patient during the troughs, says Sinopoli. She says, "The patient hears the tinnitus intermittently, becoming desensitized to it and learning how to dismiss it even though they hear it on occasion."

The high-frequency stimulation from the device produces an engrossing and enriching acoustic environment for the brain, thereby promoting neural plastic changes that counteract the effects of hearing loss on the tonotopic order in the auditory cortex, Sinopoli explains. She adds, "By stimulating the brain, we're trying to get it back to its normal pitch order."

She says that the relaxing music helps keep the patient calm, which helps address the psychological element of the disorder. The counseling component also is very important because as the patient becomes educated about the tinnitus he or she can learn not to be fearful of it, Sinopoli says.

The Food and Drug Administration cleared the product as a Class II medical device in 2005. In the past year, says Sinopoli, Neuromonics has observed a significant increase in the number of audiologists recommending the product to patients. So far, about 200 clinicians in the U.S. have been trained to provide the treatment. The company reports that 91% of the participants in



The Oasis device from Neuromonics

its clinical trials saw a reduction of at least 40% in their tinnitus disturbance and, on average, patients reported their condition improved by about 65%.

Patients report generally good results after using the device for several months, says Christina T. Stocking, AuD, a clinical assistant professor in the University of Buffalo's Department of Communicative Disorders and Sciences. As of last November, Stocking had six patients wearing the Neuromonics device, called Oasis. Some achieved almost total relief, she says, one reported some improvement in his tinnitus disturbance, and one said he enjoyed the relaxation part, but didn't observe any major benefits from wearing the device.



Christina Stocking

"It's not for everyone," says Stocking, who adds that because of the high cost of the treatment the people who are most severely affected by tinnitus are the ones most likely to try it. While individual clinics set their own charges, Sinopoli says that the price of the device and the counseling typically ranges from about \$3500 to \$5500.

IDENTIFYING SUB-GROUPS IS A CHALLENGE

One of the most significant stumbling blocks to finding a cure for tinnitus is the difficulty of identifying the specific sub-group an individual patient belongs to so a particular medication can be tested for efficacy, says Richard Tyler of the University of Iowa, one of America's leading tinnitus experts. For example, he says, some patients experience tinnitus constantly and find it very distressing, while others report their tinnitus varies in quality and in loudness or say their tinnitus is worse in noisy situations than in quiet.



Richard Tyler

There is a wide range of treatments that produce varying degrees of results in patients with tinnitus, but finding solid data to support the efficacy of particular remedies is no easy task. As Tyler explains, researchers trying to conduct controlled studies face the challenge of finding a sufficient number of subjects who all have tinnitus with the same underlying cause or same set of symptoms. For example, some sufferers report that taking ginkgo biloba or zinc has reduced their tinnitus. But if there are 100 people in a study and only 20 of them are helped by the treatment being tested, the findings are not scientifically significant, he says.

He adds, "Some people jump from one cure to another in the hopes of finding one that works for them. But the problem of sub-groups makes it tough to design a well-controlled investigation to see if a particular treatment works."

In the meantime, audiologists caring for patients with tinnitus should always begin with an intensive questionnaire to determine which part of the patient's life is most negatively affected by the disorder, he says. Since the disorder is manifested in so many different ways, the clinician can customize the treatment plan and try certain therapies that are considered most efficacious for that particular sub-set of patients, he notes. "There's

no one-size-fits-all treatment protocol,” says Tyler.

TINNITUS AND POST-TRAUMATIC STRESS DISORDER

More and more U.S. soldiers returning from Iraq and Afghanistan are seeking treatment for tinnitus. And, many of these patients also have been diagnosed with post-traumatic stress disorder, or



Marc Fagelson

PTSD, according to Marc Fagelson, AuD, director of the tinnitus clinic at the James H. Quillen Mountain Home VA Medical Center in Johnson City, TN. In a study to be published in the *American Journal of Audiology*, Fagelson reports data he has collected about how many patients with tinnitus share many of the same behavioral manifestations as accompany PTSD.

For example, Fagelson finds that many patients with both tinnitus and PTSD are startled by sudden noises, and he believes similar neural mechanisms are stimulated by both conditions. There is a fear and threat response that many people feel with tinnitus and PTSD because the limbic system is engaged in both disorders, he says. And patients with both conditions report being frustrated by their inability to control how they behave in some situations.

“When something happens around them, they don’t like the way they respond to it,” Fagelson says. Some patients with PTSD, for instance, have an urge to dive under a table when they hear a sudden noise, or they are uneasy in social situations because they don’t feel in control of how they will react to certain external stimuli.

He believes there may be management approaches used for treating control issues that arise with PTSD patients that could be effective with tinnitus sufferers. He notes that the pharmacological agents used for the two disorders are very similar. For example, SSRIs and benzodiazepenes are used to reduce symptoms associated with anxiety and hypervigilance for both. Also, sleep medications (often Xanax) are prescribed for both disorders. The counseling that most PTSD patients receive, either individually or in groups, is also similar to that offered tinnitus patients.

While Fagelson reports achieving considerable success with his tinnitus patients, he says there aren’t enough specialists at VA tinnitus centers to handle the growing demand. At his clinic, he says there is a nearly 1-year waiting list for new tinnitus patients.

That’s not surprising considering that, the American Tinnitus Association reports, only about 10 to 15 centers in the VA’s national healthcare system have audiologists with special training in tinnitus. A spokesman at the VA confirmed that figure, but added that while there aren’t tinnitus specialists at all VA hearing clinics, many audiologists at the clinics can provide veterans with basic care for their tinnitus problems.

EXPERIMENTAL STUDIES EXPLORE OTHER AVENUES

Currently, experimental tinnitus treatments and research studies are under way in the U.S. and around the globe. Tyler and colleagues at Iowa are involved in several clinical trials, including two on counseling and sound therapy, one using zinc as a treatment, and another that uses electrical stimulation to suppress tinnitus. Researchers in Brazil and Germany also are in the early stages of

studying experimental therapies using electrical stimulation.

In Belgium, a group of physicians and researchers studied whether or not getting cochlear implants would relieve the effects of tinnitus on patients who were completely deaf in one ear. The implants, which aren’t normally used to treat tinnitus, significantly reduced the disturbing noises in all 18 of the patients studied, notes Salvi, who was not involved in that research.

“In theory, if you can put some hearing activity back into the ear, you can turn down the level of tinnitus,” he explains. “This seems to be what the cochlear implants are doing for those patients.” He adds that tinnitus treatment is not an FDA-approved use of cochlear implants.

WANTED: MORE FUNDING FOR RESEARCH

One of the main goals of the ATA is to push for increased federal funding of tinnitus research. Fagerlie believes that the breakthroughs made by Salvi and his colleagues at the University of Buffalo using imaging techniques and animal studies are enabling lobbyists to make a stronger case for federal agencies and congressional committees to steer dollars toward solving the mysteries of tinnitus and developing new treatment protocols.

He says, “For the first time, researchers can see it [tinnitus] and they know where it is in the brain. We’re trying to get Congress to consider putting more money into research because we’re optimistic there is a cure on the horizon.”

The association has targeted lawmakers on the Veterans Affairs, Defense Appropriations, and Health and Human Services Committees in both the House and Senate for additional funding of tinnitus research, says Jennifer DuPriest, ATA’s director of public affairs. This year, only about \$3.5 million in combined public and private funding has been allocated to tinnitus research. But DuPriest points to one hopeful development. In November, a Department of Defense appropriations bill was signed into law that included a provision for \$50 million to study a list of conditions that included tinnitus.

DuPriest says, “From a financial point of view, it makes sense to put [money] into research because in the long run it will save the government money in disability payments and healthcare costs for veterans suffering from tinnitus.”

Indeed, in 2003, the Veterans Administration spent \$285 million on disability payments to veterans suffering from tinnitus; that figure didn’t include the cost of any care sought for their condition, according to the Veterans Administration. That cost nearly doubled to \$539 million in 2006, the VA reported. It’s expected to continue rising as more troops return to the U.S. from combat in the Middle East, DuPriest adds.

If additional dollars are allocated to tinnitus research, there will be investigators lined up with good proposals for how to spend it. Grant requests to the ATA for funding have more than tripled in the last 5 years, says Salvi, who chairs its research funding committee.

“In science, you’re always trying to go outside the circle, even if it’s risky,” observes Salvi. “If you take some risk, there can be a payoff. With tinnitus, now we’re beginning to see the payoff.”

Judith Nemes, a freelance writer based in the Chicago area, is a regular contributor to *The Hearing Journal*.