Unraveling the Complexity of Tinnitus Research

Why Is There No Cure for Tinnitus?

Regenerating Hair Cells to Repair Hearing Loss and Tinnitus

What Questions Should a Tinnitus Patient Be Asked?

Young Researchers Motivated to Help Patients

The Role of Animals in Tinnitus Research

Research on Noise and Its Health Impact

Visit & Learn More About Tinnitus at ATA.org
Sound Gifts for Friends and Family With Tinnitus

By Ann Ramsey

Tinnitus and hyperacusis are hard to live with, and many of us belong to support groups to meet others who understand the challenges and to share ideas on how to manage day to day. It turns out that many of us are utilizing inexpensive devices from a variety of sources. Because tinnitus and hyperacusis are unique to each individual, and with more and more gadgets available that could help, we never know what might work for us. So, once a year, for many years running, the Washington, DC, area tinnitus support group holds a casual “show and tell” event, where we all bring our favorite contraptions and pass them around the group to take a look and a listen.

Below are some of our favorites, including links to where they can be purchased. Please note that Amazon or the specific retailers linked to are likely not the only sources. Also, the American Tinnitus Association does not endorse products or services. The list below is intended for educational purposes only and as a helpful guide if you’re wondering what type of gadgets might make useful gifts for family and friends with tinnitus. But be sure to check return policies in case the device isn’t helpful!

Ann Ramsey lives with her husband and Maine Coon cat in Washington, DC. An avid photographer and occasional poet, she joined the ATA in 2008. In December 2007, she developed severe tinnitus and hyperacusis from unknown causes. By 2010, she habituated and remains careful of exposure to noise. She attributes her improvement to a combination of medications, mindfulness-based stress reduction (MBSR), cognitive behavior therapy (CBT), tinnitus retraining therapy (TRT), and hearing aids. She’s a long-time member of the Washington, DC, Tinnitus Support Group, where she serves as its program director.

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When you’re shopping for friends and family on Amazon, the American Tinnitus Association hopes you’ll link your shopping account to AmazonSmile, the online retailing company’s generous program that enables you to shop and contribute to your favorite nonprofit organization at the same time. Amazon pays all program expenses and donates half of a percent of the cost of your eligible purchases to your favorite earmarked charity. Won’t you choose the American Tinnitus Association to help us advance tinnitus research and treatments?
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Every Individual and Donation Counts for Change

I recently returned from an ATA board meeting and am so excited about the talent around the table, which included an accountant, financial analyst, neuroscientist, healthcare consultant, audiologists, doctors, educators, entrepreneurs, inventors, and journalists. It’s a dynamic group dedicated to serving the tinnitus community, which includes funding innovative research.

My first brush with tinnitus research was in the late 1970s, as part of a team investigating and publishing findings from a double-blind study. Around that time, my world also intersected with the relatively young ATA, which guided me on founding and facilitating a tinnitus support group in New Orleans.

Today, the ATA is in its 48th year and has distributed more than $6 million in seed grants to innovative researchers, many of whom have become today’s leaders in the field. The ATA remains the only nonprofit dedicated to representing patient interests and providing the public and professionals with information on all aspects of tinnitus.

But, like other nonprofits, the ATA is faced with declining membership and reduced giving resulting from shifts in the public’s expectation of free information and tax changes that discourage charitable giving.

In this season of giving, please remember that research got us to this point in time, where we have better treatments, access to a plethora of apps, and multiple devices in the pipeline that might help millions bothered by tinnitus. You can support the ATA by renewing your membership, giving a membership as a gift to a friend or family member with tinnitus, or making a donation using the enclosed envelope or online at www.ata.org

Jill Meltzer, AuD
Chair, Board of Directors
No Simple Solutions for Curing Tinnitus

Why are there no cures for tinnitus, despite decades of research and millions of people who would pay to banish tinnitus from their lives? The answer is complicated because tinnitus is an extraordinarily complex condition.

To help explain the challenges that face today’s research, we invited my British counterpart and friend, David Stockdale, of the British Tinnitus Association to write an abridged version of an article on the topic that he and his colleagues published recently. (See full article at https://www.frontiersin.org/articles/10.3389/fnins.2019.00802/full) His article and the accompanying Tinnitus Cure Map illustrate vividly just how complex tinnitus is; the logic of certain areas of investigation; the necessity of improved diagnostics, among other things.

Should we be bothered that the volume of tinnitus research, which has increased dramatically over the last few decades, is infinitesimal in comparison with that of other chronic conditions, such as depression and anxiety? Yes and no, because research into other areas can yield important findings related to tinnitus, such as the discovery that some people with intractable depression who underwent transcranial magnetic stimulation (TMS) for relief from that debilitating condition sometimes experienced a reduction in the loudness of their tinnitus. That discovery helped fuel research into TMS targeting specific parts of the brain that are tied more directly to tinnitus. My point here is other areas of neurological research can advance our understanding of tinnitus and open unexpected pathways to new discoveries; the answers for curing tinnitus don’t rest with auditory research alone.

To David’s point, the more precise our tools are and the more coordinated our efforts, the more likely we’ll have better treatments and viable cures in the years ahead.

Can you play a role? Absolutely! Fund research by adding the ATA to your end-of-year giving to enable us to award larger seed grants to innovative researchers. Write your Congress members to let them know that finding cures for tinnitus is urgent. Consider getting involved in research by registering as a possible participant if you live near a university or institution engaged in auditory or neurological research.
Why Is There No Cure for Tinnitus?

By David Stockdale

At the British Tinnitus Association (BTA), our vision is “A world where no one suffers from tinnitus.” We believe this is possible now, for many, using the currently available management techniques. However, we also know that these are not adequate solutions for everyone and nothing short of a cure — or cures — will do.

One question I’m always asked, frequently in exasperation, is, “Why is there no cure for tinnitus?” People living with tinnitus can’t believe we haven’t yet found a universal solution to tinnitus. I’m not sure it reduces their frustration any to hear my answer: “It’s complicated, there are a lot of factors.” So, along with colleagues, I tried to give a more comprehensive answer in a recent paper.

Tinnitus Services in the United Kingdom

Before I run through the findings of our work, I think it’s important to highlight why we wanted to write that paper. The BTA has been working hard to put in place the right tools to empower researchers and clinicians who investigate tinnitus and offer better management, as well as the tools to campaign for more research funding.

We looked at what tinnitus costs the U.K. and how much it costs to offer a tinnitus service through the National Health Service (NHS). This was an important question to ask, and one I understand the ATA is looking to answer for the United States, as well. What we found was heartening yet offered much food for thought.

We discovered that:

- Tinnitus services are cost-effective according to the thresholds set by the NHS.
- An “average” tinnitus patient costs the NHS £717 per year (US$880 million).
- Tinnitus costs the NHS £750 million per year (US$925 million).
- The societal cost of tinnitus to the U.K. is £2.7 billion per year (US$3.3 billion).
- There are 1,050,000 GP (primary care/family doctor) appointments made every year in the U.K. because of tinnitus.

These costs are comparable with those found in other similar studies (see Table 1).

Table 1. Comparison of the Cost per Person With Tinnitus per Annum in Different Countries

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<thead>
<tr>
<th>Country</th>
<th>Cost per Tinnitus Person per Annum</th>
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<tr>
<td>Netherlands (Cima et al., 2012)</td>
<td>€1544 (US$1700)</td>
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<tr>
<td>USA (Goldstein et al., 2015)</td>
<td>$660</td>
</tr>
<tr>
<td>UK (Stockdale et al., 2017)</td>
<td>£717 (US$927)</td>
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“Although this growth in research activity and publication is very impressive, the volume of published papers on tinnitus lags behind that on other conditions, such as depression, anxiety, and deafness.”

So, the good news is that we could show current tinnitus services in the U.K. were effective, although with room for improvement. We believed it was important that we also published our calculations and process of deriving our figures so that others, with new or emerging treatments, could put their costs and outcomes into that model and see how their treatments compared. An understanding of the numbers and financials was an important first step in building the case we wanted to make in the Why Haven’t We Cured Tinnitus? paper.
We found a myriad of pathways and routes patients might take to the tinnitus clinic. We wrote the costs paper on the basis of our experts’ opinions of which services were typically provided for tinnitus patients. Figure 1 shows half of the pathways we found and maps possible patient journeys for those with tinnitus associated with hearing loss. Where the expert panel didn’t know or couldn’t agree on a particular point, we surveyed BTA members to find the answer. We have since published these results as a paper, too.4 This research uncovered some troubling findings:

- Patients experienced “revolving door” healthcare — two in five patients discharged by ENT or audiology found themselves back at their family doctor (GP) asking for help.
- One in five patients said their GP took no action when they visited with tinnitus for the first time.
- More than two-thirds of patients were discharged at ENT, meaning they had had two diagnostic appointments for their tinnitus (GP and ENT), but no support with managing tinnitus (which would usually be provided by audiology services in the NHS system).
- A range of interventions were offered, with no clear rationale why some were prioritized over others.
- When patients were asked who they found helpful or unhelpful on their tinnitus journey, audiologists and hearing therapists were found to be the most helpful, and GPs were the most likely to be found unhelpful.

Both papers reached the conclusion that the U.K. has a health system that delivers tinnitus management cost-effectively — but it could be better. What we really need are more effective treatments and a better understanding of which types of treatment are best for different groups of patients.

What do people consider an effective treatment? Researchers Fatima Husain and Philip Gander found patients and audiologists have different aims for tinnitus treatment. Patients want a reduction of tinnitus loudness (63%) or elimination of the tinnitus (57%), whereas audiologists...
saw treatment success as decreased awareness (77%) and stress/anxiety relief (63%). These results may help explain why people with tinnitus think current treatments are unsatisfactory and why prospective treatments should be designed to meet patient expectations.

The final piece of this background story happened in March 2018, when the U.K. charity Action on Hearing Loss (AoHL) organized an excellent meeting titled “Translational Hearing Research Summit: Biological and Pharmacological Approaches.” Here, for the first time, negative results of recent pharmaceutical trials in tinnitus were presented. This might sound disappointing, but these findings were put forward alongside suggestions of why these trials had failed and what needed to change for future drug-based research to have an increased chance of success.

So, Just Why Haven’t We Cured Tinnitus?

Having given you the context in which the BTA is working, why did we decide to write a paper about what we haven’t done? I, alongside colleagues, felt it was important to raise awareness of the issues, and we looked to work across the tinnitus community to give a holistic view of progress to date and — more importantly — how to move forward. The paper’s authors represent charities — the patient voice — clinicians, academia, and industry. What follows is only a summary of key themes. If you’d like more detail, the full paper can be accessed at https://www.frontiersin.org/articles/10.3389/fnins.2019.00802/full

Would Patients Want a Drug?

It is clear people with tinnitus would like a drug. Fifty-two percent of tinnitus patients said they would try a drug for tinnitus if it reduced tinnitus loudness by half; 62 percent, if it eliminated their tinnitus. However, currently no drug is approved for the treatment of tinnitus by the FDA or EMA (European Medicines Agency). We need more rigorous research to fully understand a patient’s motivation to take a drug for tinnitus and what would be acceptable — a topic I’m hoping the BTA will be able to work on in the near future.

We know the potential market size for a drug for tinnitus is huge. A study published 15 years ago estimated that a tinnitus drug would have an estimated value of US$689 million in its first year. This is likely now to be an underestimate, not only because of inflation but also because of an aging population in the Western world that is leading to a growing tinnitus population. The BTA estimates there will be 14 percent more adults living with tinnitus in the UK over the next decade. There’s a market and a willingness of patients to take a drug — why hasn’t it happened?

How Much Is Spent on Tinnitus Research?

Analysis of spending on tinnitus, both in terms of amount spent and volume of projects approved, shows that it pales in comparison to spending on other conditions. Research from 2012 shows that funding by the major statutory healthcare funders in the United States and Europe is much

<table>
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<th>Table 2. Tinnitus Research Funding: Average Annual Funding by Major Funding Organizations in 2009–2011</th>
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<td>USA (NIH)</td>
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<td>EU (FP7)</td>
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Note: US figures $ millions; EU figures € millions. FP7, 7th Framework Programme for Research and Technological Development; NIH, National Institutes of Health.

Source: C. R. Cederroth, B. Canlon, & B. Langguth. Hearing loss and tinnitus – are funders and industry listening? Nature Biotechnology. doi:10.1038/nbt.2736

Although this growth in research activity and publication is very impressive, the volume of published papers on tinnitus lags behind that on other conditions, such as depression, anxiety, and deafness. (See Figure 3.) The reason for this lack of activity is unclear, and we tried not to speculate on it in the paper.
However, we did reference the need for tinnitus research to be undertaken across disciplines, and currently two European Union (EU)-funded projects are looking to address this, each with 15 PhD students working in a cross-disciplinary way on a range of questions to progress our knowledge and understanding of tinnitus.\textsuperscript{12,13} This is an important first step, but more cross-disciplinary work and closer working relationships with academic institutions, industry, and patient bodies are needed to truly drive forward research.

**Is Tinnitus Too Much of a Catch-All Term?**

It appears that subtyping tinnitus — finding and defining the different types of tinnitus — will be essential to progressing research. Tinnitus is often seen as too varied to result in reliable, repeatable outcomes, especially when looking at drug trials. Many recent tinnitus drug trials have performed well in preclinical trials (the stage before studies in humans), yet have failed in later stages. Conversely, it may be that we already have highly effective strategies to manage or treat certain types of tinnitus, but these effects are hidden if the treatments are delivered to people with different types of tinnitus. If we can understand how to categorize these different types, we may be able to identify the most effective solution for each one.

Subtyping tinnitus is a priority, many sources have identified, and doing so will then enable research to progress at pace. However, if subtyping is not possible, or if research is to happen before subtypes have been established, then allowing for the different types of tinnitus in people taking part in research trials will be necessary. This presents its own challenges — the need for internationally standardized, large, well-designed randomized controlled trials for tinnitus has already been recognized.\textsuperscript{14} Work is ongoing on developing a standardized set of outcome measures, and much work is being done on identifying tinnitus subtypes. It may also be possible

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**Figure 2. Number of articles published on PubMed with tinnitus in the title, abstract, or as a major topic per year.**


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**Figure 3. Publications listed on the U.S. National Library of Medicine PubMed database for the conditions tinnitus, deafness, anxiety, and depression in the period from 1940 to 2017.**

to revisit past trial data and analyze by subtype once subtypes have been identified for a quicker solution to identifying the most effective treatment by subtype.

**We Need Better Ways to Measure Tinnitus**

If you have consulted a medical professional for your tinnitus, they will have taken a history of your condition and probably asked you to complete a questionnaire about your tinnitus. In completing that questionnaire, you thought about your tinnitus and the impact it is having on your life. At that time, a lot of other factors influenced how you answered the questions, from your life experiences to how frustrated you felt finding a parking spot before your appointment. To put it crassly, how you scored your tinnitus might differ very much from how the next person scores theirs, yet the sound or volume at which you hear the tinnitus or the distress you feel about it may be the same.

What is needed to really move forward is a way to objectively measure tinnitus, for example, in a similar way to how blood sugar levels are measured — there’s an absolute figure, not one based on how you are feeling at the moment.

Research has probed how to do this, and so far, an objective measure has not been found, but it is an area we think the research community...
should be prioritizing. A promising early study, funded by the BTA, has already been published.¹⁵

**The Tinnitus Cure Map**

For the past two years, the BTA has been working on how to represent all of the challenges above. We’ve been trying to summarize the current state of tinnitus research, show where our knowledge gaps are, and pinpoint where we feel confident that we have sufficient insight. We have plotted these areas on a diagram we call the *Tinnitus Cure Map*. (See Figure 4.)

If you look carefully at the map, you will see that much of what has been discussed falls within the first two steps toward a cure, in the prediscovery and measurement of tinnitus phases.

Although we have published the *Tinnitus Cure Map* in the format you see here, we hope to raise the funds and publish it as an interactive online map in the next year or so. We will then expand it and increase the number of levels. The online version will link to the latest and best available research in each area, and we will be able to assess where we need more research and where a question has been answered. This map will be easily viewed so everyone can see how the drive toward a cure progresses.

**So, What Next?**

We concluded in our paper: Whilst an encouraging upturn in tinnitus research being performed is evident, it is also apparent that a step change will be needed to deliver progress towards truly effective treatments.¹

“The BTA is now looking to play its part in how to make this progress. We are seeking to do this in the following ways.

**Funding Research**

Much like the ATA, the BTA funds research into tinnitus, and our next funding rounds will focus on the recommendations from our paper and how we can progress these. Our current research priorities for funding are as follows:

- Identification of tinnitus biomarker(s) — finding a naturally occurring molecule, gene, or characteristic that indicates the occurrence of tinnitus
- Development of reliable objective measure(s) of tinnitus — moving away from questionnaires toward unbiased benchmarks
- A better understanding of animal models of tinnitus and their relevance to human tinnitus research
- Recognition that every individual’s tinnitus is unique and being mindful of this when undertaking research
- Identification of subtypes of tinnitus¹⁶

**Working in Partnership**

We are working in partnership with academia and industry to push forward research in the areas we think will make a difference to our understanding of tinnitus. We hope to be able to say more about these soon; please keep an eye on our website for announcements.

Of course, we are working closely with our friends at the ATA! Torryn, the CEO of the ATA, and I continually collaborate to see how we can better support researchers to access funding and deliver high-quality, game-changing research. In that spirit, the ATA and BTA will be working in partnership to put on a networking event as part of the Association for Research in Otolaryngology’s Annual Mid-Winter Meeting to encourage the cross-disciplinary research that is needed to really spur us forward.
There Is Hope!

The BTA and ATA are always campaigning for better and enhanced provision of services we know can help now and to make sure these are more widely available than is currently the case. We will continue to campaign for increased funding for tinnitus research and engage with the research community to encourage and support research that helps achieve “a world where no one suffers from tinnitus.”

A compassionate and motivated research and clinical community out there is progressing our knowledge and building on this daily, seeking to offer the best management and support that are available now, while focusing on providing better treatments tomorrow. There are many challenges to overcome, but we are determined to succeed and we are getting closer to answering some of the outstanding questions.

The tinnitus research community is continually growing, improving, and refining how it works. The pharmaceutical industry is aware of the here and now. There is progressing our knowledge and clinical community out there is progressing our knowledge and building on this daily, seeking to offer the best management and support that are available now, while focusing on providing better treatments tomorrow. There are many challenges to overcome, but we are determined to succeed and we are getting closer to answering some of the outstanding questions.

The tinnitus research community is continually growing, improving, and refining how it works. The pharmaceutical industry is aware of the opportunities that exist and is keeping an active watch on developments in tinnitus research, hoping for those optimal conditions that will allow investment in tinnitus research to flourish.

In the meantime, proven treatments are available that can lessen the impact of tinnitus. Though we all hope for a cure, it is important to engage with the evidence-based management techniques that an experienced and compassionate audiologist and/or mental health provider can help you with, and to live well with tinnitus in the here and now.

David Stockdale is the chief executive of the British Tinnitus Association (BTA). His background is working in senior management positions in charities. He started on that path while completing his bachelor’s degree in business studies at Sheffield Hallam University. His first role was working in youth consultation and advocating for better provision of services for children and young people. He joined the BTA in February 2010 and has sought to work alongside the global tinnitus community since then to promote better management of tinnitus, to enhance peer-to-peer support, to improve professional training, and, of course, to further research into tinnitus. He is most proud of increasing the number of tinnitus support groups in the U.K. from 34 when he started to 105 today. Having grown the team at the BTA, his focus is now on progressing research and looking at how the BTA responds to many of the points made in this paper.

3 Supplemental material can be accessed here: https://bmchealthserves.biomedcentral.com/articles/10.1186/s12913-017-2527-2
6 For details, see https://www.actiononhearingloss.org.uk/funding-cures/translational-research-initiative-for-hearing/translational-hearing-research-summit
12 The Tinnitus Assessment Causes Treatment (TIN-ACT) study, https://tinact.eu
13 European School for interdisciplinary Tinnitus Research (ESIT), https://esit.tinnitusresearch.net
15 Jackson, J. G. (2019). The cortisol awakening response: A feasibility study investigating the use of the area under the curve with respect to increase as an effective objective measure of tinnitus distress. American Journal of Audiology, 28(3), 583–596.
16 BTA, Funding tinnitus research: Looking for a cure, https://www.tinnitus.org.uk/funding-tinnitus-research-looking-for-a-cure
Scientists are currently studying a wide variety of methods to treat tinnitus. These include pharmaceuticals, magnetic stimulation, sound therapy, and electrical stimulation. A group of researchers from the University of California, San Francisco, and Veterans Affairs Health Care System, San Francisco, decided to investigate a more novel approach: deep brain stimulation.

This procedure is not new — it is currently used to control symptoms of Parkinson’s disease. However, the researchers noted published reports of tinnitus improving after patients experienced strokes in the caudate nucleus. The caudate nucleus is part of the basal ganglia at the center of the brain. It is implicated in coordinating spatial information with motor control, motor memory, control of expressive (spoken) language, learning and executive function, and emotional attachment. In this research, the authors described prior studies indicating that fMRI (functional magnetic resonance imaging) studies showed increased activity in this area in patients with chronic tinnitus.

In an effort to show effectiveness and safety of deep brain stimulation, the researchers conducted a phase I clinical trial. For the trial, they recruited patients with significant chronic tinnitus. Six people initially passed the screening process, which included chronic tinnitus for longer than one year, a high score on the Tinnitus Functional Index after conventional treatment, and ruling out significant sound sensitivity, severe hearing loss, or psychiatric conditions. Five of the six participants completed the study.

Each participant had electrodes surgically implanted in the caudate nucleus. Stimulation parameters were optimized for each participant, which took from five to 13 months and essentially consisted of trial and error. After determining the optimal stimulation parameters for each person, 24 weeks of continual stimulation was performed. Before and after deep brain stimulation, subjects were given tests to determine changes in tinnitus loudness and perception, as well as safety in regard to hearing, psychological, and behavioral well-being.

After 24 weeks of continuous stimulation, three of the subjects reported clinically significant improvement in tinnitus. That was measured with the Tinnitus Functional Index, which indicates how intrusive tinnitus is in a person’s life. None of the subjects had significant changes on tests designed to indicate safety of stimulation — meaning that nontargeted functions were not affected. Four of the subjects showed significant improvement on the Tinnitus Handicap Inventory, a measure of tinnitus severity that was used as a secondary measure.

One thing the study showed was the wide variety of stimulation parameters that participants required to achieve benefit from the stimulation. A wide range of stimulus frequencies were required for participants, and all but one required relatively high voltage levels compared to normal deep brain stimulation.

The number of participants in this study was small, but the authors reported this technique to be safe for all participants and effective for more than half. On the basis of these results, they intend to further their research by more closely studying how to optimize stimulation for patients in terms of electrode placement and stimulus parameters. They also discussed performing more randomized trials to control for bias in data. Nonetheless, deep brain stimulation may be a tool used in the future for some people with tinnitus who are not helped by less-invasive treatment methods.

From Phantom Sound to Phantom Limb Pain: Renowned Science Journalist on Living With Hidden and Visible Disabilities

By Joy Onozuka

Miles O’Brien, award-winning journalist and PBS NewsHour science correspondent, suggests lightheartedly that having tinnitus in some ways prepared him for being an amputee. “To the extent that there’s a certain mindset [about the condition], then maybe so,” O’Brien said in a recent interview. As a globetrotting journalist, he manages bothersome tinnitus by staying constantly engaged with work. But staying constantly engaged with work as a globetrotting journalist with one arm poses challenges that can’t be ignored. Like with tinnitus, he uses tech tools and pays close attention to attitude so that neither condition interferes with living the life he wants.

Comparing the phantom sound of tinnitus with the phantom pain of an amputated limb echoes O’Brien’s reporting for PBS NewsHour in 2013 on tinnitus: “They were comparing the [tinnitus] research to analogies of phantom limb pain because there’s this missing patch in your brain [for hearing sound] and your brain is trying to fill in the gaps,” he explains. “Now I’ve got tinnitus and phantom limb, so I guess my brain is consistent,” he says lightheartedly. Lack of answers about tinnitus, however, clearly bother him. “I was floored that there was nothing out there to make it go away. They don’t even want to talk about tinnitus. I had [doctors] say, ‘I can’t hear your tinnitus. I’ve got nothing for you.’ That sucks,” he says.

O’Brien has high-frequency hearing loss, which he attributes to many years of hunting and flying small airplanes without proper ear protection. He recalls that his tinnitus started during a hunting trip in Idaho about 12 years ago. To reduce the sound, O’Brien was fitted with hearing aids equipped with maskers. “I found the hearing aids helpful,” he says, adding that the maskers generating white noise were useful in covering the tinnitus. But, for the most part, O’Brien’s most effective technique for dealing with tinnitus on bothersome days is to focus on external sounds. “I put on music or put on the news.”

O’Brien’s fearless attitude, persistence, and affinity for change help him overcome mental obstacles that can hinder others bothered by tinnitus. “It could be much worse,” he says. “There’s so much to it and it’s unfair for me to project [my situation] onto someone else because everyone has their own battle.” He applies the same power-through-it approach to his...
second health condition, which could have sidelined his career.

You might imagine that O’Brien, a former CNN anchor, jets first-class around the world with a team of assistants, reporting on science and environmental news accompanied by an entourage. In actuality, he is a cost-cutting independent reporter who knows how to fly an airplane, wield a camera, and produce his own segments. The accident that caused his arm to be amputated above the elbow happened while he was reporting on his own in the Philippines. “I had finished all shoots. I was stacking up my cases. A heavy case fell on my forearm; it was a fluke thing,” he reflected. “By the time I got medical help in the Philippines, it was a little late in the game.” His left arm could not be saved.

Miserable in the hospital, he asked his doctor if he could recuperate in a hotel, which the doctor agreed to. “The first thing I did when I got in the hotel room was confront the keyboard with one hand and started writing my stories,” he says. Recalling that he had downloaded Dragon Dictate years earlier, he clicked on it and dictated his stories. “It was important for me to know where I stood,” he stresses. “I needed to answer some questions very quickly about whether I could be me.” At that point, he still hadn’t notified anyone of his accident. He was all alone.

“What I learned very quickly was that I was under the false assumption that seeking help from others was a sign of weakness. It’s the exact opposite,” O’Brien says. “My counterintuitive discovery, having lost my arm, being alone in the Philippines, a one-man band reporting, afraid to call anyone after it happened because I was worried about their response — all those things....I was the on-your-own guy who didn’t fully appreciate the insight on what it means to connect with other people until it all happened to me. That was an important insight: that we’re not alone and it’s important not to think we are.” O’Brien says his girlfriend, Suzi Tobias, plays a significant role in helping him cope. “Suzi helped me figure out the hacks I need to enjoy my active lifestyle. [She] saved my life and continues to do so.”

Psychologists working in healthcare affirm that how individuals cope with conditions that impact their quality of life differs dramatically. Some people display a fight-to-the-end attitude that seems to thwart negative impacts, and others fixate on the condition’s effect on their life to the point that it accentuates the condition, as happens when too much attention is paid to tinnitus, which tends to make the tinnitus seem louder. O’Brien says people were flabbergasted that he didn’t take time off from work after he lost his arm. Clearly, he is the type of person who accepts a situation and figures out how to work with it. “Time to just sit there would have been so much worse for me because I would not have known [if I could do my job],” he says.

The accident helped O’Brien attune more to the notions of resiliency and grief. “I feel like grief is more like a spiral, [not stages]. It comes back around. It hits you now and again. There will be a moment — same with tinnitus. I’m frustrated by some activity of daily living that I can’t do so well and all of a sudden, it’s there.”

Being an amputee also means people are curious but often uncomfortable when they see him. “Tinnitus — to the extent that you can call it a disability — is completely invisible. And unless you have it, you don’t really understand it,” he notes. “People are weird about my arm. It’s a very visible disability.” He tries to put people at ease by being himself. “It’s not the center of my existence. But, ultimately, walking down the street, people stare at me. They don’t stare at you if you have tinnitus.”

O’Brien’s life as a journalist is indeed his life. “I love my job,” he comments. And, like his tinnitus, work is always in the background. “It’s important to disengage, if you can, but it’s hard for me,” he says, explaining that he recently began meditating to try to relax. “I can do it a couple of minutes, then I’m thinking about the next deadline.” To hold his focus, he thinks about his tinnitus. “You’re supposed to think about stupid things anyway,” he jokes.

When he’s done meditating, he pushes tinnitus out of his mind and goes back to powering through another day, another story. “You have a choice of thinking about what you can’t do or modifying your life and trying to figure out what you can do and how to do it differently. So, maybe tinnitus prepared me for being an amputee. I don’t know.”

O’Brien looks off, and someone in the distance catches his attention. It’s time to start a new story.
Regenerative Therapies: Targeting Hearing Loss and Tinnitus

By Rebecca M. Lewis, AuD, PhD

Regenerative therapies are gaining popularity in several medical fields in hopes that sensory function can be restored to normal after sensory damage is sustained. This article provides an overview of how hearing sensory cells function, the history of research into regeneration of hearing sensory cells, and the possibilities and challenges in store for regenerative trials in individuals with hearing loss and tinnitus.

Current State of Hearing Loss and Tinnitus

Many people with bothersome tinnitus have a measurable degree of hearing loss. At first, hearing loss can be subtle because it happens slowly over time, most often the result of natural aging processes or exposures to loud noise. Tinnitus prevalence also increases with age and exposure to loud noise.

To address problems caused by hearing loss, such as difficulty hearing soft sounds and hearing in the presence of background noise, audiologists recommend hearing aids. Sometimes hearing aids reduce the perception of tinnitus such that it becomes less bothersome. Audiologists may also recommend other devices to mitigate bothersome tinnitus. For many people, hearing aids and/or tinnitus management devices work well and serve the intended purpose, whereas other people receive limited or no benefit. Hearing aids and tinnitus management devices continue to rely on damaged anatomical structures to pass along the sound to the brain, which limits the benefit of these devices for some people with significant damage to their hearing system.

For sound to travel from the point of origin outside of the ear to the brain, where the sound is heard and perceived, many anatomical structures must function properly. Sound is first collected by the outer ear as a series of vibrations in the air that are then changed to a mechanical signal by the tiny bones of the middle ear; these small bones send minute vibrations to the fluid-filled inner ear, which triggers a population of hearing sensory cells there to respond. Several structures beyond the hearing sensory cells are required to ensure sound reaches the brain, but these hearing sensory cells are the major culprit in hearing loss because they are the first point of breakdown for age-related and noise-induced hearing loss.

Normal Hearing Requires Normal Hair Cells

Hearing sensory cells earned the name hair cells because of the delicate structures that sit on top of the cell surface that look remarkably like delicate hair fibers (Figure 1).
These hair-like structures, called stereocilia, are extremely different from the hair that sits on top of your head, however. Stereocilia bend ever so slightly and quite rapidly in response to the small vibrations in the fluid of the inner ear that surrounds them. When the stereocilia bend in response to sound, they pass along a message to the rest of the hair cell that a particular type of sound occurred. There are several steps in the process of hair cells functioning properly and ultimately contributing to normal hearing.

The story of a single hair cell functioning on its own is remarkable, but over 15,000 hair cells in each inner ear space contribute to hearing! When enough of the hair cells are activated together, the attached nerve passes along a message to the brain and finally you will hear that sound.

Hair cells missing in relatively small numbers throughout the inner ear do not substantially affect hearing function; however, damage to a more extensive number of hair cells is a leading contributor to sensorineural hearing loss in humans. Meaningful damage is not restricted to only missing hair cells; minor hair cell damage can also result in various outcomes that yield the hair cell unusable.

For example, the fragile stereocilia could break, specific needed proteins could be depleted, or the hair cell could be isolated from the surrounding fluid. With any of these examples, the potential for the hair cell to provide reliable input to the brain is compromised. It is important to remember there must be a sufficient number of hair cells with all of these features functioning correctly to provide normal sensory input to the brain for proper hearing function.

Unlike other cells and tissues of the human body, these hearing sensory cells do not naturally replace themselves over time; instead, mammals are born with one set of hearing sensory cells that we must rely on throughout our life span. Because hair cells cannot regenerate, sensorineural hearing loss is typically permanent in humans and other mammals (e.g., rodents, primates).

Hair Cell Regeneration Occurs Naturally in Some Species

Interestingly, nonmammalian vertebrates such as birds, amphibians, and fish are not subject to the same permanent hearing loss after hair cell damage. In fact, after hair cell damage occurs in nonmammalian vertebrates, the hearing sensory organ either repairs or completely replaces the damaged hair cell to restore hearing function to normal. This incredible discovery opened the eyes of researchers to the possibility that one day we may be able to regenerate hair cells in mammals, including humans.

After more than 30 years of dedicated research since the original discovery of hair cell regeneration, knowledge about the processes responsible for hair cell regeneration in nonmammalian vertebrates has skyrocketed. Understanding the basic science behind hair cell regeneration was critical for the development of the regenerative therapies for mammals.
that are currently being tested in mice and other nonhuman mammals. Ultimately, the goal is to introduce this therapy to the human inner ear to similarly restore hearing function.

**Targeting Successful Hair Cell Regeneration**

Most recent published literature underlines the difficulty in achieving meaningful success with regenerative therapies in mammals. Attempting to regenerate hair cells in a living adult mammal is the focus of many groups intent on moving this work to human clinical trials. Although there is clearly better potential for hair cell regeneration in young (neonatal or immediately postnatal) inner ears, initial clinical trials will more likely target adults with acquired hearing loss for regenerative therapy. Robust evidence that a regenerative therapy is both safe and effective in adult mammals is needed, and several steps are required prior to achieving this goal.

**Accessing the Human Inner Ear**

A critical step prior to clinical trials of hair cell regeneration is the ability to image or evaluate the function of a live human inner ear. The fluid-filled inner ear is located within the temporal bone of the skull; current methods to visualize hair cells require that the inner ear is removed from the temporal bone, which completely sacrifices hearing function. To be able to monitor incremental successes in regenerative therapies, researchers need the ability to image the inner ear without disturbing the remaining function of the ear. In addition, researchers need to know whether these sensory cells are functioning properly using reliable noninvasive measures that can accurately reflect the progress of regenerative processes.

Without being able to verify which cells have been damaged or confirm the cell populations of the inner ear that remain for a given individual, it will be difficult to know whether a specific regenerative therapy is appropriate for a candidate or the extent to which a treatment is successful.

**Delivering Therapy to the Inner Ear**

Similarly, an essential debate in the field of hair cell regeneration is how to deliver such treatments to the inner ear — again, without disrupting the fluid-filled space of the inner ear. All proposed treatments require use of a progenitor cell population, which is a group of cells with the potential to yield other types of sensory cells like hair cells. There are two approaches that generally rule the discussion: (1) genetic reprogramming of existing progenitor cells of the inner ear, or (2) transplanting progenitor cells into the inner ear.

Nonmammalian vertebrates genetically reprogram their own progenitor cell populations that neighbor the hair cells (called supporting cells) to naturally regenerate the hair cell population.

**Figure 3: Hair cells regenerate in nonmammals.**

Nonmammalian vertebrates such as birds, fish, and amphibians experience hearing loss when hair cells are damaged; however, their hearing loss is only temporary. In the left panel, a field of undamaged hair cells is seen from the chicken inner ear. In the middle panel, hair cells have been eliminated by an ototoxic drug, gentamicin, which results in a sensorineural hearing loss. In the right panel, hair cells are regenerating in this same area of damage only 10 days later, returning hearing to normal over the next 3 to 4 weeks. Images courtesy of Dr. Jennifer Stone, Virginia Merrill Bloedel Hearing Research Center, University of Washington.
Use of supporting cells as a progenitor population is an efficient regenerative method for these animals because new hair cells are already growing in the proper location, which more quickly restores the molecular balance to the field of hair cells.

Molecular balance is important in the inner ear to prevent too many hair cells from regenerating in a given area and to ensure enough of the supporting cells remain to keep the inner ear healthy. To enable genetic reprogramming of supporting cells in humans, a proper “cocktail” of drugs and/or molecules will be needed to stimulate these supporting cells to produce new hair cells. One benefit of this approach is that this type of cocktail is expected to be quite small and relatively easier to deliver than would be transplantation of new cells into the bone-encased inner ear.

This genetic reprogramming method using supporting cells as a progenitor population could work well for mammals like humans; however, a challenge is evaluating the remaining health of the supporting cell population after hearing loss. For example, noise exposure can affect not only hair cells but also the nearby supporting cell populations. Substantial noise exposure can devastate supporting cell populations of the inner ear. In these cases, use of the supporting cell population as a progenitor population could lead to poor outcomes, and another regenerative method may need to be considered.

Another approach that circumnavigates the issue of limited supporting cell populations is to transplant an external population of progenitor cells, such as stem cells, to the inner ear. Reprogrammed stem cells could be introduced to an inner ear that lacks the structures needed for genetic reprogramming (i.e., supporting cells) and could extend candidacy for such a procedure to individuals with greater degrees of hearing loss. The challenge with a stem cell approach is that cells are much larger than a drug or small molecules and therefore are more difficult to administer to the inner ear. In addition, guiding the stem cells to appropriate areas requires knowledge of which areas are damaged and a way to ensure these areas are targeted for regenerative treatment.

Each of these delivery systems presents its own set of advantages and challenges. Pursuing both approaches to target the different types of underlying damage to the inner ear may ensure best outcomes for regenerative trials in the heterogeneous human population.

**Implications for Tinnitus**

Regenerative therapies are typically discussed as a method for improving hearing; many questions remain regarding the effect of such therapy on the perception of tinnitus. There is currently no objective measure specific for tinnitus that is not affected by hearing loss, which makes it exceptionally challenging to know the effect of a regenerative therapy on tinnitus perception. However, many people report substantial improvements in their tinnitus perception with the use of hearing aids and cochlear implants, two devices widely used to increase awareness and understanding of sounds in the environment.

Following the idea that tinnitus arises most frequently in people with some level of hearing loss and that improvement is seen when some hearing perception is “restored” through these technologies, it should be considered that hair cell regeneration may be able to improve tinnitus perception through restoration of hearing sensitivity.

Tinnitus, however, is more than simply decreased hearing at the level of functioning hair cells. Tinnitus is thought to be the result of changes in the brain triggered by that decreased hearing, a process called maladaptive plasticity. Because time is needed to create maladaptive plasticity after a change in hearing occurs, it is reasonable to consider that, after a regenerative therapy successfully restores hearing, time may be needed to allow the brain to readjust to the new hearing input and reverse the processes that originally created the tinnitus.

**Looking to the Future**

For those who await regenerative therapies to improve hearing function or to decrease tinnitus perception, clinical trials for regenerative therapies are anticipated to begin in the upcoming years. When initial participants are sought for the start of these studies, these pioneers should remember the challenges that are expected. Though these technologies certainly hold great promise, many years may be needed after the initial clinical trials to hone the therapeutic approach of regenerative therapy and ensure hearing can improve in a meaningful manner.
Rebecca Lewis received her Doctorate of Audiology and Philosophy (AuD/PhD) in 2016 from University of Washington in Seattle, where she studied mechanisms of hair cell regeneration with mentorship by Dr. Jennifer Stone. She completed her postdoctoral research fellowship under the direction of Drs. Konstantina Stankovic and Daniel Polley while also working as a clinical audiologist at Massachusetts Eye and Ear. Currently, she serves as a research audiologist at Walter Reed National Military Medical Center, contributing to the research of Dr. Kenneth Grant to improve methods of hearing assessment. Her professional interests focus on optimizing clinical care for audiology patients through advancing auditory neuroscience research, with a special concentration in assessment and management of patients with bothersome tinnitus.


Tinnitus Research Activities Around the World

We’re interested in measuring neurotransmitter levels in the brain of tinnitus patients, because neurotransmitters are crucial in enhancing or decreasing brain activity. Many scientists believe that tinnitus is related to too much activity in the auditory brain areas. This may be caused by dysfunction of GABA, for example, a neurotransmitter that normally reduces brain activity. We would like to test this by combining a number of brain imaging techniques, because if we understand which neurotransmitters are dysfunctional in tinnitus, it might be possible to use this information to develop drugs to beat tinnitus.

— Pim Van Dijk, PhD
University Medical Center Groningen, the Netherlands
Former ATA Scientific Advisory Committee Member

www.ATA.org
Young Researchers Motivated to Help Tinnitus Patients

By Joy Onozuka

In 2000, the Hearing and Speech (HESP) laboratory at the University of California, Irvine, was founded by Fan-Gang Zeng, PhD, to conduct basic and translational research in understanding the mechanisms underlying normal and pathological hearing; to improve hearing aid and cochlear implant performance; and to develop treatments for tinnitus and hyperacusis.

Earlier this year, the American Tinnitus Association’s board of directors visited HESP during one of its two annual in-person board meetings. Visits to leading laboratories engaged in tinnitus research are part of the ATA’s commitment to stay abreast of the latest research, as well as to meet up-and-coming researchers.

The lab, which is part of the UCI Center for Hearing Research, also has ties with local high schools and community colleges to provide research opportunities for young people interested in science.

Here we introduce Myung-Whan Suh, MD, PhD, Phillip Tran, PhD, and Michelle Kapolowicz, PhD, who work under Dr. Zeng’s supervision as they pursue research aimed at helping tinnitus patients. Their replies to our questions have been combined into representative group responses.

Why were you drawn to tinnitus research?

The prevalence of tinnitus is very high. In both the clinic and the lab, it is one of the most common complaints from patients. Unfortunately, we do not have a solution. Currently, all that we can do is to counsel patients to find a way to make living with this devastating disorder more manageable. It makes us feel helpless and incompetent, yet extremely motivated to find a way to help these desperate patients. Another issue that piques our interest stems from the social cost of unproven treatments. Because there is no standard treatment, it seems that some people want to make money by deceiving others bothered by tinnitus. Some patients pay unbelievable costs for faulty remedies. We hope our research can contribute to stopping such problems. Additionally, tinnitus seems to share similarities with other disorders that remain difficult to treat, such as phantom limb pain, chronic pain, or even post-traumatic stress disorder. By better understanding the mechanisms involved with tinnitus, our research may serve to inform research and treatment for these other disorders as well.

“Tinnitus is a very complex problem, and we still don’t know the mechanism that underlies it.”
What is the goal of your current research?

One of our goals is to better characterize the mechanisms that underlie tinnitus and to find any links of tinnitus with hearing loss and hyperacusis (increased sensitivity to loud sounds). By better understanding the potential causes of tinnitus as well as which parts of the brain may be involved in maintaining chronic tinnitus, we can create more targeted and effective treatment strategies. Currently, we are implementing our knowledge of how different auditory and nonauditory sensory processing regions respond to different kinds of acoustic and electrical stimulation in people who have tinnitus compared to people who are without tinnitus, with the overarching goal of treating or even curing tinnitus.

What are the greatest challenges to increasing treatments and finding cures?

Tinnitus is a very complex problem, and we still don’t know the mechanism that underlies it. It may even be that the cause of tinnitus is different for each person. This makes it very challenging for us to find potential treatments, as one method may work for one person, but not for another. Another problem we face is that we do not have a way to measure or record tinnitus objectively. Tinnitus is often reported subjectively in terms of annoyance and loudness, which again is different for each person. Having a method to objectively measure tinnitus would aid us in determining whether our treatment strategies are effective or not.
The ATA Advancing Research Relationships

ATA BOARD OF DIRECTORS, OCTOBER 2019 MEETING

The first in-person meeting of the new board of directors, who gathered at ATAs headquarters in Vienna, VA, to develop a new strategic plan with Glenn Tecker, a worldwide expert in leadership and strategy.

Torrin Brazell, ATA’s CEO, was a featured guest speaker at the AudBoss 2019 Private Practice Summit, a sold-out educational event for private practice audiologists in the United States. Brazell spoke on the urgency of increasing the number of qualified practitioners to assist tinnitus patients, patient needs, and how to build a tinnitus practice that can provide meaningful help.

Educating Hearing Healthcare Providers About Tinnitus

Loved this presentation! Torryn made our lives so much better. We know what to do and where to go for training and resources. — Rachel G. AudBoss Summit attendee

THE ATA WELCOMES NEW NIDCD DIRECTOR

Fan-Gang Zeng, PhD, Debara Tucci, MD, and Torryn Brazell, ATA CEO

Fan-Gang Zeng, member of the advisory council of the National Institute on Deafness and Other Communication Disorders (NIDCD) and the ATAs Scientific Advisory Committee, ATA CEO Torryn Brazell, with Debara Tucci, newly appointed director of the NIDCD, at her inaugural advisory council meeting, where she outlined her commitment to increasing awareness of the causes and prevention of noise-induced hearing loss. The NIDCD is part of the National Institutes of Health and has an annual budget of $474 million to conduct research on the normal and disordered processes of hearing, which includes tinnitus, balance, taste, smell, speech and language.

ATA Working With Congressional Influencers

Members of the Friends of the Congressional Hearing Health Caucus (FCHHC) and Congressional staffers after an educational tour, which included presentations and two lab visits at the NIH’s National Institute on Deafness and Other Communication Disorders. The bipartisan group, which includes the ATA, toured the Clinical Center, which is the nations largest hospital devoted to clinical research. FCHHC advocates on the Hill for increased access to hearing healthcare and maintains close ties with the NIDCD.
Standardizing How Tinnitus Is Assessed by Questionnaires

The Core Outcome Measures in Tinnitus (COMiT) Initiative

By Deborah Hall, PhD, Yaowen Wang, MD, Binbin Xiong, MD, and Lena L. N. Wong, PhD

Hearing loss and tinnitus affect at least one in 10 of the world’s population, and yet there are very few common standards of practice. Recently, colleagues from the United Kingdom led an international consortium to establish a minimum reporting standard for evaluating the efficacy of treatments for tinnitus. This article explains this standard.

Introduction

Hearing loss and tinnitus impact patients in many different ways. These chronic lifelong conditions manifest in a complex interplay of physical, psychological, and social effects. How can hearing healthcare practitioners best assess a patient’s needs? At the first appointment, it is usual to conduct history taking about past and current medical problems, prescribed medications, and co-occurring medical conditions and to collect background information about lifestyle and personal circumstances that might affect overall health and well-being. Clinical interviews such as this are important, but interviews can be supplemented by standardized questionnaires.

Standardized questionnaires comprise a fixed set of questions and response options, administered in a predefined format. Advantages of standardized questionnaires are as follows:

1. Item content has often been carefully developed so that it is relevant, comprehensive, and comprehensible with respect to the construct it intends to measure and the target patient population.

2. There are instructions for scoring and the score can be easily interpreted. For example, scores can provide a grading of symptom severity or they can help place an individual patient at a point in the expected normal distribution of the population.

3. Results can be compared across other studies conducted in the same country or across countries.

The strongest evidence for the effectiveness of an intervention is achieved using meta-analysis, which is a systematic approach to identifying, appraising, synthesizing, and combining the results of all relevant studies.

Hearing devices (including over-the-counter devices) are becoming more widely accessible across the United States, and evidence-based practice guides the field of audiology. Understanding which intervention works best for which patient helps to improve practice by improving clinical efficacy and cost-effectiveness. Evidence-based practice is therefore a positive driver that motivates the use of standardized questionnaires.
for patient diagnoses and to measure treatment-related outcomes in clinical trials. Standardized questionnaires are essential to enable findings to be compared across studies and for conducting meta-analysis (for example, Cochrane systematic reviews, www.cochranelibrary.com). Their use is commonplace in Western countries for defining eligibility for healthcare provided by medical insurance, for clinical audit, and for clinical trial design.

Standardizing Item Content

Across the world, randomized clinical trials are the most rigorous way of testing how new treatments compare with existing or placebo treatments. Well-conducted trials can make a significant impact on patient care because their findings can inform evidence-based decision making between a clinician and their patient.

The World Health Organization (WHO) recognizes that “choosing the most important outcome is critical.”

Heterogeneity in trial outcomes makes the study findings difficult or impossible to interpret, and this undermines the translation of research into practice and policy. There is growing recognition that insufficient attention has been paid to outcomes measured in clinical trials of hearing and tinnitus.

In the field of audiology, more than 50 different questionnaires have been used as outcome measures for research on adults with hearing loss and at least 60 different questionnaires on adults with tinnitus. This heterogeneity reflects a lack of consensus for assessing hearing-related conditions. A minimum reporting standard would go some way to solving this problem.

If all clinical trials used a common minimum set of outcomes, then findings could be combined and compared from different studies reporting the effectiveness of the same tinnitus intervention (i.e., meta-analysis) and findings could be comparatively evaluated across different therapeutic approaches.

Meta-analysis in a systematic review is possible only when outcome measures are adequately homogeneous.

The Core Outcome Measures in Tinnitus (COMiT) Initiative

To address this gap, Hall and colleagues recently completed an international study to determine which tinnitus-related complaints are most critical and important to assess in all clinical trials to determine whether a tinnitus treatment has worked.

The overall goal is to understand how to standardize the item content of measurement instruments so that they provide evidence for therapeutic benefit that can be trusted.

Using purposive sampling, 719 international healthcare users with tinnitus, healthcare professionals, clinical researchers, commercial representatives, and funders were recruited. Participants were primarily recruited from Europe and the United States; but across Asia, there were two from China, one from Japan, two from Malaysia, and five from Singapore.

Eligibility of participants was primarily determined by personal experience of sound-, psychology-, or pharmacology-based interventions for tinnitus.

Following recommended procedures for gaining consensus, three intervention-specific, three-round Delphi surveys were delivered online, considering sound-, psychology-, or pharmacology-based interventions, respectively. Each Delphi survey was followed by an in-person consensus meeting.

Viewpoints and votes involved all stakeholder groups, with approximately a 1:1 ratio of healthcare users to professionals. Recommendations were voted by at least 70 percent of participants. The findings are presented in Figure 1.

“Tinnitus intrusiveness” was voted as a tinnitus-related complaint

“In the field of audiology, more than 50 different questionnaires have been used as outcome measures for research on adults with hearing loss and at least 60 different questionnaires on adults with tinnitus.”
to assess, irrespective of the type of tinnitus intervention. For sound-based interventions, the minimum set also included “ability to ignore,” “concentration,” “quality of sleep,” and “sense of control.” For psychology-based interventions, the minimum set also included “acceptance of tinnitus,” “mood,” “negative thoughts and beliefs,” and “sense of control.” For pharmacology-based interventions, “tinnitus loudness” was the only additional item content.

1. Defining more explicitly the concepts and constructs underpinning each of the selected tinnitus-related complaints
2. Searching for all possible available measurement instruments
3. Identifying those instruments that have acceptable construct validity and other psychometric properties

This project is ongoing and we will be presenting some of our progress for “concentration” and “tinnitus intrusiveness” at the Association for Research in Otalaryngology 2020 Mid-Winter Meeting in San Jose, California. The study team would be delighted to hear from people across the United States and Canada who are interested in participating.

Figure 1. Minimum standard for the item content of tinnitus outcome measurement instruments.

- tinnitus intrusiveness
- sense of control
- ability to ignore
- concentration
- quality of sleep
- mood
- acceptance of tinnitus
- negative thoughts and beliefs
- ability to ignore
- concentration
- acceptance of tinnitus
- negative thoughts and beliefs
- mood
- tinnitus intrusiveness
- tinnitus loudness

Adapted from Hall et al. (2018).

The second step will identify how those complaints should best be measured and whether any of the current questionnaires have adequate item content to be recommended as a standard. This will involve three further pieces of work:

1. Defining more explicitly the concepts and constructs underpinning each of the selected tinnitus-related complaints
2. Searching for all possible available measurement instruments
3. Identifying those instruments that have acceptable construct validity and other psychometric properties

This project is ongoing and we will be presenting some of our progress for “concentration” and “tinnitus intrusiveness” at the Association for Research in Otalaryngology 2020 Mid-Winter Meeting in San Jose, California. The study team would be delighted to hear from people across the United States and Canada who are interested in participating.

Deborah Hall, PhD, has a background in psychology and hearing sciences. Her interests include cross-cultural and multinational research studies and clinical trials. She is currently vice provost at University of Nottingham Malaysia and is a National Institute for Health Research (NIHR) senior investigator. She can be reached at deborah.hall@nottingham.edu.my

Yaowen Wang, MD, is an otolaryngologist at Ningbo First Hospital in the People’s Republic of China. She has a special interest in tinnitus.

Binbin Xiong, MD, is an otolaryngologist at the Shenzhen University General Hospital in the People’s Republic of China. Her interests include tinnitus and hyperacusis. She conducted some of her research training with Dr. Wei Sun at the University at Buffalo, New York.

Long Island Community Joins Hands in Memory of Michael Haar

The American Tinnitus Association wishes to thank the family and friends of Michael Haar for holding the Third Annual Silence Was Stolen: Tinnitus Awareness Walk and Fundraiser on September 15, 2019, at Eisenhower Park in East Meadow, New York.

The fundraiser — held in memory of Michael Haar (1965–2016), who struggled with debilitating tinnitus — featured speakers from a variety of fields who addressed the need for greater support of those bothered by tinnitus, the urgency of finding improved treatments, and the importance of managing the stress, depression, and anxiety that often accompany the chronic condition.

The event brought in close to $2,400, all of which was donated to the ATA to support its mission of promoting relief, funding research toward improved treatments and possible cures for tinnitus, and prevention awareness. We thank the many people who mailed in checks or donated online to show their support of the Haar family and friends!

“As a member of the ATA, I want to do everything I can to advance research into this terrible life-altering disorder,” said Steve Haar, father of Michael.

(L-R) Rusty Zukerman, Michael’s uncle, Trevor Patten with mother Jennifer Patten, Michael’s sister, Art and Rachel Eisenberg, cousins of Michael, at the Third Annual Silence Was Stolen: Tinnitus Awareness Walk and Fundraiser

Holiday Giving 2019

Without your support, the American Tinnitus Association cannot continue its operations, which focus exclusively on advancing tinnitus patient interests. Our activities include telephone support for individuals in distress who are experiencing the onset of tinnitus and/or increased spikes in sound/s, funding of seed research, publishing credible information on tinnitus, and engaging in patient advocacy in a variety of forums, including at the federal level and at leading conferences for otolaryngologists (ENTs) as well as for audiologists.

We hope you will consider making a year-end, tax-deductible donation to the American Tinnitus Association, using the envelope in the magazine or by going online to www.ata.org.
In 1987, while doing electrical work at the World Trade Center in New York City, another trade group that installs hung ceilings was putting up ceiling rods for a suspended ceiling. The rods are fastened using a high-powered 38-caliber ceiling rod gun. Imagine six of these tradesmen shooting these guns eight hours a day; it was deafening and the beginning of my problems with tinnitus.

When I asked my foreman for hearing protection, he said it would be dangerous to use anything because I’d be unable to hear someone call out if something fell, which could leave me injured or dead.

A couple days later, when I got out of bed, one of my ears was ringing and I felt dizzy. I hoped it would pass, but when I got to my job site, I felt worse. I told my foreman I needed to leave to see a doctor.

Two hours later, I was sitting in an Urgent Care facility near my home. The doctor examined my ears and said everything looked fine. He then explained the bad news: I have tinnitus that was most likely noise-induced from the job site. He said, “You will just have to learn to live with it.” I felt so distressed hearing that. I blurted out, “Are you kidding me that I have to live with this ringing for the rest of my life?” He gave me a referral to see a neurologist and said he wished he could help me but couldn’t since there was no cure for tinnitus.

I was so distraught, wondering how I’d be able to work in the electrical industry — the only skilled trade I know — because of the noise. I was out of work for two and a half weeks to give my ears a rest, but I had to get back to work. At the time, my daughter was preparing for college and I wanted to support her; I had to go back to work.

Looking back, the one smart thing I did was file an accident report early on to make sure that ear injury was documented as work related. It was helpful that my ENT doctor drew that conclusion. When I returned to work, I had a letter from my doctor specifying that I only be given light-duty work, reflecting the danger of ongoing vertigo that meant I should stay off ladders.

When I returned to the World Trade Center job site, my foreman put me in a quiet location assembling temporary light streamers for other floors. The vertigo eventually stopped, but the loud ringing in my ear continued. After six months of loud ringing, I knew I had to adjust to it. I did a lot of research on how to deal with tinnitus. One of the first things I did was get custom-made earplugs from an audiologist to wear every day at work. The only time I took them out was when I was working in a quiet location, such as an office.

As time went by, I became outspoken about hearing protection, telling everyone to protect their ears. I made sure that the foreman had hearing protection available for workers on job sites. I suspect I was a thorn in their side because they just couldn’t imagine what I was hearing 24/7. And all tinnitus sufferers look normal. I didn’t have a cast or walk with a limp, so they had no clue what my tinnitus was like and how bothersome it could be.

I continued to search for ways to help myself cope better with tinnitus. One day I found the ATA’s magazine *Tinnitus Today*; I couldn’t wait to receive my first issue. It gave me hope that there was an organization supporting research to help find cures for tinnitus.

I also felt encouraged that one of the ATA’s founders, Dr. Jack Vernon, took calls on Fridays to answer questions about tinnitus. Finding the ATA was like seeing light at the end of a tunnel.
Unfortunately, in 1999, the ringing got louder in my left ear and started in my right. It was so bad, I had to stop working. I felt like I couldn’t take it anymore. I remember crying out to God for help because I couldn’t banish the thought that I’d be unable to endure living my life with tinnitus.

I reached out to the ATA for help and they told me about a support group in my area. I joined the group immediately and realized I was no longer alone. We shared stories about what helped us deal with tinnitus; we talked about masking sounds; we discussed articles from *Tinnitus Today*.

I started meditating while listening to CDs that I purchased though the ATA. I also learned tai chi to reduce my anxiety. I became a telephone support volunteer for the ATA, helping others struggling with tinnitus. I became a facilitator in my own tinnitus support group.

Today, I still have tinnitus in both ears, but I don’t give it the attention that it wants from me like I used to. I keep as busy as I can by doing research on my own to share with people at the support meetings. I am passionate about helping anyone with tinnitus and sharing about the tools that have helped me the last 32 years. I discovered that by helping others, I also thrive.

If you feel alone in the world with tinnitus, please find a support group where you can thrive. If you don’t have one, start one! People will come because no one wants to be alone with tinnitus.

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**WHAT’S YOUR STORY?**

Tinnitus isn’t classified as an illness, but its effects can cause tremendous mental distress for many of us, sometimes triggering insomnia, anxiety, depression, and thoughts of suicide. In our upcoming issue of *Tinnitus Today*, we’ll be looking more closely at the mental-health component of living with tinnitus. We’d like to invite you to share your story of how tinnitus impacted your mental health for possible publication. The deadline for submission is Jan. 20, 2020. Suggested word length is between 400 and 1000 words. We’re happy to work with you on developing your story, as well as to edit for clarity and grammar. Stories can be emailed to editor@ata.org or mailed to The ATA, 8300 Boone Blvd., Suite 500, Vienna, VA 22182.

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**Tinnitus Research Activities Around the World**

*The ATA is one among the few organizations worldwide that provides seed funding for high risk/high yield ground-breaking research. Such funding is crucial for training the next generation — graduate students and post-doctoral fellows — who will continue our efforts in the search for finding relief and cures for tinnitus.*

— Sylvie Hébert, PhD  
*Faculty of Medicine, Université de Montréal*
Is Tinnitus Inherited?

Summary by John A. Coverstone, AuD

Tinnitus had traditionally been thought of as a condition arising solely from environmental factors: noise exposure and hearing loss being primary causes. However, research in recent decades has suggested that genetics may create a predisposition to many ailments. A group of researchers from the Karolinska Institutet in Sweden sought to determine what role heredity may play in acquiring tinnitus.¹

To study the correlation between tinnitus and genetics, the researchers gathered data about adopted children and their biological and adoptive parents. Their theory was that genetic effects would show up in correlation with children and biological parents, whereas environmental effects would be evidenced by comparing children to adoptive parents. To gather this information, the researchers accessed data from the Swedish national registers obtained between January 1, 1964, and December 31, 2015. In all, 11,060 adoptees were located who met the researchers’ criteria, along with 19,015 adoptive parents and 17,025 biological parents.

To determine heritability, researchers compared tinnitus in adoptees to tinnitus in biological and adopted parents. From this information, odds ratios were calculated. An odds ratio is a measure of how probable an outcome (developing tinnitus) will be if a given exposure or condition exists (for instance, tinnitus in a biological or adopted parent). As odds ratios approach 1, the two conditions being compared are more likely caused by chance. The greater the odds ratio, the more likely it is that one condition is causing the other.

Tinnitus was identified using diagnosis codes from Swedish hospital and healthcare registries and national patient identification numbers were used to preserve anonymity. A total of 2019 cases of tinnitus were identified: 214 adoptees, 371 biological parents, and 444 adoptive parents.

The odds ratio associating adoptees with tinnitus to biological parents with tinnitus was 2.22, well above chance. The odds ratio associating adoptees with tinnitus to adoptive parents with tinnitus was 1.00, indicating no likely association and suggesting that environmental factors have a limited effect on development of tinnitus. This does not mean that an individual’s environment or life choices regarding risky behavior do not factor in to developing tinnitus. Rather, it indicates that family environment is not a good predictor of tinnitus in children, whereas genetics is more strongly associated with children developing tinnitus, even later in life. This suggests a possible predisposition to tinnitus if children engage in behavior that places their hearing at risk.

The American Tinnitus Association mourns the loss of Larry Evan Roberts, PhD, a gifted researcher and extraordinary person who inspired countless members of the tinnitus community to tackle difficult research to help patients. He is a reminder that each individual plays a unique role in advancing science so that better treatments and cures for tinnitus can be found.

We invite you to hear Larry speak about his work investigating the neuroscience of tinnitus in our Conversations in Tinnitus podcast. https://www.ata.org/understanding-facts/podcasts?page=1

Here are a few of the many comments we received from tinnitus researchers around the world who reflected on Larry’s leadership and impact on their lives.

I met Larry many years ago when he was visiting our research laboratory. I was just beginning tinnitus research and we connected very quickly. As an Emeritus Professor, he had recently turned his interest to the field of tinnitus after a productive research career in behavioural and auditory neurosciences at McMaster University. Larry had an inspiring, fatherly influence on me as well as on many others. He will be missed and his work will remain influential.

—Sylvie Hébert, PhD
Université de Montréal

The passing of Larry marked the loss of a wonderful professor, scientist, colleague, and friend. He was a huge figure in the scientific investigation of tinnitus as a researcher, theoretician, and voice in a divided field. His contributions included the study of neural mechanisms and etiologies, reliable measurement, and effective treatments and therapies. Larry endeavored to unite the scientific community, which is evidenced by his authorship of one of the most cited articles on tinnitus. Not only did he have a strong passion for the neuroscience of tinnitus, but also a professional and intellectual commitment to the translation of that science into benefit for patients.

—Phillip Gander, PhD
University of Iowa
ATA Scientific Advisory Committee Member

Larry was one of the foremost experts on neural activity associated with tinnitus. He was extremely knowledgeable about tinnitus and contributed very significantly to our research. On a personal level, he was a gentle soul—very kind and soft-spoken. Given his demeanor, one would never suspect his stature as an eminent scientist. His passing is a great loss to the tinnitus community and to anyone who knew him—especially his family.

—James Henry, PhD
VA RR&D Senior Research Career Scientist and Research Professor, Department of Otolaryngology, Oregon Health & Science University

Larry Roberts was a champion for tinnitus research and tinnitus patients. Through his own experience with tinnitus, he had a great deal of empathy for anyone experiencing it. His many publications and presentations gifted a great deal to our current understanding of the neuroscience underpinning tinnitus. We are indebted to his contribution to tinnitus research in general and specifically his help in advancing our work.

In remembering Larry, I am reminded of the Māori proverb: Kua hinga te totara i te wao nui a Tane, which translates as The totara has fallen in the forest of Tane. A Totara is a huge native tree of New Zealand that grows for hundreds of years. For one of them to fall is a great tragedy.

—Grant Searchfield, PhD
University of Auckland, New Zealand
ATA Scientific Advisory Committee Member

Dr. Larry Roberts sightseeing in New Zealand during a tinnitus conference.
Not Your Grandparents’ Hearing Aids
Unpackaging the Power of Today’s Hi-Tech Hearing Aids

By Thomas A. Powers, PhD

Hearing aids have evolved from simple amplifiers to include features that not only allow people with hearing impairments to hear in difficult situations but also assist users with health-related activities. The introduction of digital circuits more than 20 years ago greatly improved the processing power of hearing aids. Current devices contain more processing power than the circuits and computers that helped put a man on the moon decades ago.

To take a tour of a modern hearing aid, we should review the four key components: the microphone, the receiver, the amplifier/circuit, and the power supply. The microphone and receiver (terms borrowed from telephone technology) are also referred to as transducers. The microphone picks up signals and sends them to the amplifier, where the digital signal processing power of today’s hearing aid is contained and applied. The signals are sent from the amplifier to the loudspeaker and on to the user’s ear. The power supply can be either a replaceable battery or one that is rechargeable.

One of the most difficult hearing environments for people with hearing impairments is when background noise is present. To assist in reducing its effect on conversation, new directional microphone techniques enable the user to direct a “beam” from the directional microphone to target the speaker or sound the user is trying to hear. These “beams” can be directed to the front, side, or rear and have been shown to improve communication in noisy environments, such as restaurants, sporting venues, and social gatherings.

Another unique feature is an algorithm that can detect and reduce the effect of wind noise. This is especially useful for individuals who enjoy outdoor activities such as golf, bicycle riding, skiing, and boating. The two-microphone design of directional microphones can detect the turbulence that is created by the wind hitting the two microphones. Since this signal is different from speech or car noise, it can be classified and reduced using sophisticated signal processing.

A concern of the hearing aid wearer is the sound of their own voice. A new algorithm conducts an analysis of the user’s voice and then adapts the amplification into two pathways, one for listening to conversations with others, and one for when the user is speaking. This reduces the perception of one’s own voice sounding different, or unnatural, and increases satisfaction with the device.

For individuals with tinnitus, new sound therapies have emerged.
These include traditional sound maskers, which use white noise or several shaped noises. In addition, several therapy sounds have modulated signals that mimic ocean waves. One unique therapy sound has fractal signals. (A fractal signal is an algorithm designed to produce a non-repetitive music-like tone that sounds a bit like wind chimes. Its potential benefit is that it is relaxing, and doesn’t carry content that can be “memorized” by the listener). Because of the individual nature of the tinnitus sound experience, these sound therapies should be discussed with a hearing professional.

“For individuals with tinnitus, new sound therapies have emerged.”

The ability to remotely program and monitor biometric data has allowed hearing aids to be used more in telehealth applications. The local hearing professional can provide the user with access to a mobile phone app that contains key information on the operation of the hearing aid. The hearing professional can send updated programs directly to the patient’s phone or can connect with the user via the chat function on the user’s mobile phone for a quick clarification if information is required for a specific listening environment. One recently introduced app can detect whether the user has fallen and can send a text message to an emergency contact who has been designated on the phone.

To achieve these groundbreaking applications, it takes a small city of engineers, software developers, and many other research and development (R&D) staff. The hearing aid industry employs over 6,000 people in the R&D area and spends between 8 percent and 10 percent of its annual budget on R&D activities. The timeline for a new product starts approximately three years prior to its launch, when the initial brainstorming on new features takes place. Once the feature set is outlined, the real development activities begin. It usually takes about 18 to 24 months to develop the signal processing algorithms, software, housings, and related accessories.

As the development of the signal processing progresses, the regulatory processes also must be completed. These include submissions to a variety of federal organizations in more than 100 countries. In addition, safety and quality milestones are completed to ensure the devices meet, or exceed, the latest regulations.

Future applications may include additional sensors for various health-related monitoring. Hearing instruments will continue to add communication and health-related applications to provide enhanced benefits and increase satisfaction for the millions of hearing aid users.

Thomas A. Powers, PhD, is the managing member of Powers Consulting, providing management consulting to the hearing health industry. Powers serves as an expert audiology consultant for the Hearing Industries Association and as a consultant for WS Audiology. He received his bachelor’s from the State University of New York at Geneseo and his master’s and doctorate in audiology and speech science from The Ohio University. He began his career as a partner in an audiology private practice and has more than 35 years of experience in the hearing healthcare industry. Powers has lectured extensively at state, national, and international meetings and has published more than 40 articles. His primary areas of expertise include hearing instrument technology, industry trends, and outcome measures. Prior to his current role, he was vice president of Government Services and Professional Relations for Sivantos, Inc.
Circadian Rhythm of the Ear

Summary by John A. Coverstone, AuD

Deep within the brain lies the hypothalamus. This relatively small structure regulates many functions in the body, including temperature, appetite, hormones, and emotional responses. It also includes a group of nerve cells called the suprachiasmatic nuclei. This region of the brain regulates circadian rhythms — the biological clock of the body.

Many tissues throughout the body respond to signals from the suprachiasmatic nuclei (SCN), and the ear is no different. A 2014 paper published by scientists from the Karolinska Institutet in Sweden described a process that makes the hearing organ — the cochlea — better able to heal from noise exposure during the day. In that study, researchers found that mice developed hearing loss when exposed to moderate noise at night, whereas they did not develop hearing loss when exposed to the same noise during the day. Furthermore, the researchers were able to show that stimulating expression of a hormone called BDNF (brain-derived neurotropic factor) at nighttime caused the ear to respond similarly to noise as it does during the day.

Scientists at Karolinska Institutet furthered their previous research by looking at regulation of circadian rhythms in the ear and the contribution of specific hormones to the ear’s resilience. They first removed the SCN from the brain of mice and found that the cellular clock within the cochlea became disrupted. This established a direct influence of the SCN on the cochlea’s clock mechanisms.

The SCN regulate secretion of a hormone called a glucocorticoid. This is a steroid hormone that is sometimes used to treat hearing and balance disorders suspected to be caused by inflammation. Inflammation within the ear is gaining in popularity as an underlying mechanism for hearing damage due to noise, although the authors report that clinical trials using this treatment approach have been met with mixed results.

Knowing the glucocorticoids respond to circadian signals from the SCN, the researchers removed the mice’s adrenal glands (which secrete glucocorticoids) and monitored the cochlea’s response to noise. Without higher levels of glucocorticoids during the night, there were no differences in the cochlea’s sensitivity to noise during the day or night. In fact, without the presence of glucocorticoids, the cochlea of mice exposed to noise during the night recovered similarly to cochlea of normal mice exposed to sound during the day. The data from this portion of the study suggested that glucocorticoids have a role in promoting inflammation within the cochlea after noise exposure.

This finding, however, seemed to contradict previous research that showed that synthetic corticosteroids have a protective effect on the ear after noise trauma, as well as inhibiting inflammation in many other parts of the body. Dexamethasone and prednisolone are commonly used to treat acoustic trauma. The researchers sought to determine the effects of dexamethasone (DEX) on cochlear recovery after noise exposure. They found that DEX offered protective effects on hearing when it was administered 24 hours after noise exposure — during the day, when glucocorticoid levels are low. DEX did not protect the cochlea when administered at night, when glucocorticoid levels are high. These results do not answer the question of why higher glucocorticoid levels at night lead to greater hearing damage from noise exposure. However, they suggest that timing of corticosteroids may play an important role in helping the cochlea recover from noise exposure.

Shaowen Bao, PhD, an associate professor of neuroscience at the University of Arizona and lead researcher in the investigation of the possible role of neuroinflammation in causing tinnitus, talked to the American Tinnitus Association about the importance of the animal model in his latest tinnitus research. Bao is also a member of the ATA’s Scientific Advisory Committee. (See page 34 for a summary of his recent research.)

Joy Onozuka (JO): Why was an animal study appropriate for investigating the possible link between inflammation and tinnitus?

Shaowen Bao (SB): Our research is aimed at understanding potential mechanisms for tinnitus rather than testing a cure for the disorder. Although the two are related, they are also very different. To test a causal link between neuroinflammation and tinnitus, we need to manipulate neuroinflammation in different ways, and test their effects at molecular, physiological, and behavioral levels. That is not practical with human subjects, so it can only be done through animal research.

JO: Why are animal studies central to research?

SB: For ethical reasons, more tools and technical maneuvers are available for conducting animal research compared to human research. Thus, proof of concept needs to be done in animal models. Human studies should be conducted only after sufficient scientific evidence is found in animal research.

JO: Why is it the case that human studies often run into difficulties not found in the animal model that the research was based on?

SB: There are many reasons why a clinical trial is more difficult. Unlike animal models of research, human subjects are highly heterogeneous in terms of their genetics and tinnitus etiologies. Because of this variability, sample sizes in human studies need to be quite large. Also, what works in an animal study might work only on a small portion of the human population. It would require large sample sizes and carefully designed human study to detect such effects and identify the responding patient population. What works in animal models might not work for humans — which has been particularly true for tinnitus — which is why clinical trials are needed. A clinical trial will either demonstrate treatment efficacy, or, in the case of failure, provide valuable information about what does not work.

JO: How many animals were tested?

SB: More than 60 mice and rats were used in our behavioral tests, which isn’t a large number. The animals used in our experiments had the same genetic background and underwent the same experimental procedures. Therefore, their behaviors were highly consistent and we did not need large sample sizes.
Are Some Causes of Hearing Disorders the Result of Inflammation?

Summary by John A. Coverstone, AuD

There is a growing body of evidence that some causes of hearing disorders are the result of inflammation — both within the ear and within the neurological tracts of the auditory system. Inflammation of nerve tracts is called neuroinflammation and is known to occur widely throughout the brain in response to trauma, infection, disease, and even overstimulation of nerve pathways.

A group of researchers from the University of Arizona and Wayne State University, in cooperation with other scientists from the United States and Hong Kong, studied whether neuroinflammation may play a part in tinnitus. Specifically, they wanted to study the brain’s response to noise exposure and whether neuroinflammation may lead to tinnitus.

The first step in their research using mice as subjects was to study the presence of cytokines after noise exposure. Cytokines are molecules that aid in cell-to-cell communication. One of their functions is to signal certain types of cells toward the location of injury in the brain. A specific cytokine named tumor necrosis factor alpha (TNF-α) is known to be elevated in the ear and brain stem after noise exposure and was the target of this study.

After exposing the left ear of mice to loud noise, researchers studied the auditory cortex — the hearing center in the brain — for presence of cytokines associated with inflammation. This was done ½ day, 1 day, 3 days, and 10 days after noise exposure. They found that TNF-α levels were elevated after noise exposure and were higher on the side of the brain that corresponded to the noise exposure. Even though levels gradually reduced, they remained higher after 10 days than they had been before the noise exposure. They also found that another cytokine called interleukin was elevated, but only when measuring 10 days after the noise exposure, and it was elevated on both sides of the brain.

There are a number of supporting cells in the brain in addition to nerve cells. These are called glia. The three types of glia are astrocytes, oligodendrocytes, and microglia. Astrocytes regulate neurotransmitters (chemicals released by one nerve cell to stimulate an adjacent cell) in the space between cells. These spaces are called synapses. These star-shaped cells can sense neurotransmitter levels and release molecules that influence the activity of nerve cells. Oligodendrocytes excrete a fatty substance called myelin that surrounds the long bodies of nerve cells, called axons. This insulation helps signals travel faster and more efficiently through cells, particularly in very long cells such as those that travel from the arms or legs all the way up to the brain. Microglia are cells that respond to injury or disease in the brain and were of particular interest in this study. Microglia help to prune unused nerve cells in young developing brains. They also remove harmful substances and dead nerve cells when necessary.

When microglia are activated to respond to injury they change their shape from having longer, distinct branches (this is called “ramified”) to a less-branchy, amoeba shape (“non-ramified”). The researchers were able to determine that noise exposure caused microglia to be activated in the side of the auditory cortex opposite to the exposed ear. They also found that neighboring structures, such as the visual cortex, were not affected — indicating a localized effect.

Microglia are known produce TNF-α in the brain after injury. There is evidence that TNF-α also serves to activate microglia in a kind of positive feedback loop when nerve tracts are injured. To look at the role of TNF-α in microglial activation in the auditory cortex, the researchers used mice with TNF-α knocked out — or genetically modified to be deficient of TNF-α. When exposed to noise, the “knockout mice” did not display the same activation of microglia that normal mice did. Furthermore, the knockout mice did not show signs of noise-induced tinnitus. To ensure that this was not due to a development problem with the genetically altered mice, both sets of mice were given injections of TNF-α into the auditory cortex. When TNF-α was known to be
Our research group has a broad interest in tinnitus, from investigating its basic mechanisms to its effect on communities. With the ATA’s support, we have increasingly focused on developing and translating sound-based tinnitus therapies into clinical practice.

We are particularly focused on the concept of “precision tinnitus therapy.” Working closely with industry and colleagues in the Eisell Moore Centre (https://www.emcentre.ac.nz), our goal is to identify, improve, and develop effective individualized tinnitus treatments. Precision health combines all available information on a person to provide targeted healthcare. When applied to tinnitus, it requires integration of hearing and tinnitus tests with an understanding of the individual’s medical and psychological information to create a holistic view of tinnitus. Therapy can then be tailored to each individual using this information.

We’re working toward this ambitious goal by developing assessment tools and predictive models to help clarify who will benefit most from different treatment approaches. We’re very excited that we will soon begin to translate these ideas into practice.

— Grant D. Searchfield, PhD

The University of Auckland

New Zealand


How to Induce Tinnitus in Mice for Research

By Inga Kristaponyte, BSc

How do tinnitus researchers know if an animal model is indeed experiencing tinnitus? This matters because a significant part of tinnitus research involves testing animal subjects, such as mice, to make advances in treatment of tinnitus in humans. People can tell us they’re experiencing tinnitus. With laboratory mice, the lines of communication are less straightforward.

Two predominant methods have emerged for detecting tinnitus in mice: gap-prepulse inhibition of the acoustic startle reflex and behavioral training in a shuttle box. Typically, only one of the methods is used. However, cross-validation of the outcomes obtained by these two approaches is important due to concerns that challenge the validity of tinnitus assessment methods. My project aimed to screen mice for tinnitus-like behavior using both methodological approaches.

Inducing Tinnitus in Mice

Exposure to loud sounds is one of the leading causes of tinnitus in humans. Thus, laboratory animals are typically exposed to loud sound to induce tinnitus. To avoid causing the animals stress, they were anesthetized during the procedure. With each mouse, one ear was protected with an earplug to preserve hearing while the other ear was exposed to loud sound (this is important for subsequent tinnitus testing). Further investigation took place three months after noise exposure to be sure that chronic tinnitus had developed.

Testing to Determine Whether a Mouse Has Tinnitus

Method 1: Gap-Prepulse Inhibition of the Acoustic Startle Reflex

One approach to detect tinnitus in mice is based on the acoustic startle reflex. This reflex is elicited when a mouse is presented with a short, loud, unexpected sound: the mouse jumps a little. Many startle stimuli were presented over several days while measuring how much a particular animal jumped.

This reflex is reduced if a short silent gap is inserted in a lower-intensity constant background sound preceding the loud startle stimulus. The silent gap “warns” the animal, and it jumps less. However, if a mouse experiences constant tinnitus, the silent gap is thought to be less noticeable. Thus, the mouse should jump similarly to how it jumped in trials without the silent gaps.

Because we do not know the tinnitus pitch a mouse might be hearing, we usually insert the silent gaps in about five different frequency background sounds. In Figure 1, how much a mouse jumped is plotted before and after acoustic trauma during trial types with and without silent gaps. These data suggest this mouse developed tinnitus because after sound exposure it jumps similarly during trials with and without silent gaps.
Method 2: Shuttle Box Active Avoidance Behavioral Task

Another approach to detect tinnitus in mice involves extensive behavioral training. Several behavioral tasks exist. Active Avoidance (https://activeavoidance.wordpress.com), which was originally designed at John Hopkins University by Dr. Brad May, a leading behavioral scientist in the field of auditory research, was used.

During Active Avoidance training, a mouse is placed in a shuttle box with two separate compartments. The animal is trained to move from one compartment to the other (through a small door) when any one of 32 different tones is played. Learning is facilitated via delivery of a mild foot shock.

If a mouse experiences tinnitus, it should have difficulties hearing the tone that is similar to its tinnitus and performance should therefore be worse when such tones are played. Figure 2 shows the performance of one mouse that appears to have tinnitus. Indeed, this animal had more difficulties doing the task at one tone frequency.

Tinnitus Detection in Mice Is Not Straightforward

Though the examples in Figures 1 and 2 suggest the mice have tinnitus, the experimental data is often less clear. Mouse behavior is highly variable. They might perform well on one day but poorly on another, possibly a result of tinnitus fluctuation, alertness, or other undetermined factors.

In addition to mice exposed to loud sound for tinnitus induction, it is important to test a group of control animals—those not exposed to loud sound. Occasionally, a mouse from the control group behaves as if it has tinnitus. It is not clear whether such a mouse developed tinnitus without exposure to loud sound or whether it is simply a false positive due to the mouse not cooperating during detection experiments.

The research aimed to test whether the two described tinnitus detection approaches identify tinnitus in the same mice. Attempts were made to induce tinnitus in 18 animals, with few examples showing clear evidence of tinnitus using both approaches. Such results suggest that it is necessary to further reevaluate tinnitus screening in animals, especially in mice.

Tinnitus research using mice might provide useful data; however, it is crucial and at the same time very difficult to accurately determine which animals might be experiencing tinnitus.

Inga Kristaponyte first became interested in hearing research about seven years ago when her partner’s tinnitus suddenly became much worse. Her partner still has severe tinnitus, and this experience has thoroughly familiarized Inga with the struggles and fears that tinnitus patients have to cope with while waiting and hoping for the discovery of a tinnitus cure. Her personal daily experience reminds her of the urgent need for better auditory research. In September 2015, she started working toward a PhD at the Northeast Ohio Medical University (NEOMED) in Dr. Alex Galazyuk’s lab. She chose the NEOMED because of its well-established Hearing Research Group with a specific focus on auditory research, her primary interest. After graduation, Inga plans to continue researching tinnitus and/or hearing loss.
Understanding Tinnitus Through Animal Model Research

By Joy Onozuka

At the laboratory of Christopher Cederroth, PhD, at Karolinska Institutet in Sweden, the tinnitus research focus is always on people, even if rodents are the primary subjects of investigations. Current research at his lab aims to develop objective measures of tinnitus, which would improve research and treatments; identify biomarkers — either auditory, electrophysiological, or in the blood — specific to defined subtypes of tinnitus; and identify genes associated with tinnitus in humans that can be evaluated in animal models.

Identification of genes is of particular relevance in pharmacological research because a drug has a greater chance of success if the target gene has been shown to be involved in the condition. In the case of tinnitus, we will only know for certain the day that an animal can talk. Until then, it is the cumulative evidence of different approaches/readouts that can increase confidence in the assumptions that an animal has tinnitus. But, in my view, tinnitus suffers more than other disorders in how translatable animal findings are to humans, because there are very high expectations in the research community to have methods where doubt is minimal. However, animal research on schizophrenia has relied for 40 years on methodologies that are not optimal — having advantages and weaknesses — yet knowledge has progressed tremendously. The same applies for pain. So, why put so much pressure on tinnitus experimental research?

In recent decades there has been fascinating progress in the development of animal models, methods of assessment, behavioral approaches, and neurological readouts, and the results are positive. One can train an animal to do a specific task to estimate whether it has tinnitus or not (pressing a lever, drinking water, jumping on a stick), or reflex measures can be used, such as the inhibition startle reflex. Some species and strains seem better than others, depending on the cause of tinnitus (e.g., noise, aspirin, or cancer drugs), their hearing abilities (e.g., perfect hearing, age-related hearing loss), the behavioral task (e.g., requiring training versus reflex based), and the stimulus (e.g., white noise or tones).
Overall, there are no perfect models; one will always present a weakness somewhere and it is the overall scientific output that will help increase knowledge and progress toward a cure. Optimally, one would design a measure that is translationally relevant — meaning that the same method is used in humans and in animals — and, so far, this is lacking. Such a measure would clearly increase trust in animal models and in their potential to test drug efficacy before introducing them to humans.

**JO:** Is the auditory system of rodents similar enough to that of humans to make valid cross comparisons?

**CC:** There are indeed differences, but I think that it is still too early to say it’s similar enough. Complex brain networks are evidenced in humans with tinnitus, other networks in animals. We still have a hard time distinguishing tinnitus from hyperacusis in animals, and it hasn’t been considered in all human neuroimaging studies, and as a consequence there is still some mechanistic overlap between the two conditions that needs to be clarified. Furthermore, we don’t know if tinnitus is associated with stress or anxiety in animal models, and this would be relevant when making these comparisons due to the important emotional burden accompanying severe tinnitus in humans. More research is needed, but for this to happen, more financing is required. Researchers and patient organizations need to work hand in hand to lobby for the science needs

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**Tinnitus Research Activities Around the World**

*I was in Washington, DC, recently for the VHA (Veterans Health Administration) Shark Tank Competition, which brought together leaders within the VA to pitch solutions for some of the toughest problems facing our veterans. I was one of 15 finalists selected out of 591 entries.*

*I gave my presentation for our Tele-PTM idea, which is the telehealth version of Progressive Tinnitus Management (PTM). Unfortunately, the program was not selected by the VA leaders (“sharks”) who bid on the different programs that were submitted. The presentation did, however, generate interest among people who may be in a position to eventually support the program.*

*Because of pilot funding we have received from VA Central Office, we have our Tele-PTM program developed and ready to go. We’ve worked out most of the bugs to make Tele-PTM available via VA Video Connect (VVC) to any veteran anywhere in the country (face-to-face in their homes). And, the “anywhere-to-anywhere” legislation, which was recently passed by Congress, makes everything legal to do this. We still need funding for staff (ideally 8 people), which would enable us to ensure that every veteran in the U.S. has access to evidence-based clinical care for tinnitus.*

— James A. Henry, PhD

*VA RR&D Senior Research Career Scientist*

*VA RR&D National Center for Rehabilitative Auditory Research (NCRAR)*
of hearing loss and tinnitus at national funding agencies, not only in the U.S. but also in Europe.

**JO:** With different subsets of tinnitus in humans, are findings in animals valid for most tinnitus sufferers?

**CC:** It is still unclear what defines tinnitus subgroups and therefore it is difficult to speculate on the validity of animal findings. There is indeed a consensus that tinnitus is heterogeneous and possibly comprises what is called a “subtype.” However, there is no agreement on what characterizes a subtype. The genuine definition of a subtype is a subgroup of tinnitus patients that respond to a specific treatment intervention, such as one that suppresses tinnitus. For instance, when cutting the auditory nerve, tinnitus is eliminated in a third of patients, tinnitus stays the same for another third, and tinnitus becomes worse for another third — on top of becoming deaf.

Cochlear implants are effective for some patients, but not all. The factors or the characteristics to such deviations are still unclear, but there are clearly benefits for subgroups of patients. We now need to identify what is causing this in order to stratify tinnitus into treatment-responsive blocks: Is it genetics (a predisposition)? Is it the emotional status? Is it the body composition (e.g., fitness)? Is it the type of sounds being perceived? Is it the etiology?

Nevertheless, despite such uncertainties, direct vagus nerve stimulation was developed in animals and translated to treatment in humans. Similarly, the bimodal stimulation developed by Susan Shore was tested in animals and shows consistency in humans. These are very encouraging examples since — although the readouts and clinical outcomes are different between animals and humans — there is a translational validation. So, animal research would appear to be valid. Is it valid for most tinnitus patients? That still needs to be evidenced.

**JO:** How can we improve tinnitus research using animals so that we’re more confident that the research has significance for the human population?

**CC:** As I mentioned before, developing measures of tinnitus that are translationally validated will be very important. To acquire the trust of the research community and remove the skepticism around animal research, we need the same tools for measuring tinnitus in humans and in animals. This is a big challenge, but I believe it is possible.

I struggled to acquire financing for my animal work, which is why I decided to tackle the problem the other way around with so-called reverse translation: identify biomarkers in humans and then determine whether I find the same ones in animals. This could be a gene, a brain response, a blood biomarker. For instance, human genetics are powerful means of understanding disease mechanisms. But the association of a gene with tinnitus in humans does not prove causality. We need animal research to prove it. Thus, a mutation associated with tinnitus in humans that causes tinnitus-like phenotypes in animal models would be strong evidence of the involvement of that particular gene in tinnitus. This type of knowledge would be highly relevant for the human population, as drugs that are tested in phase II and III clinical trials are more likely to succeed if their target has been shown to be involved in the disorder by means of human genetics. When using neuroimaging techniques, having the same measure of tinnitus in humans and animals would advance drug development because it would increase the reliability of the animal models.
Does Time of Day Influence Medication’s Effectiveness?
For One Researcher, Circadian Biology Is Key

By Joy Onozuka

Tinnitus researcher Christopher Cederroth, PhD, an associate professor in the Department of Physiology and Pharmacology at Karolinska Institutet, is a leading proponent of circadian biology, which considers the timing of drug delivery to determine its effectiveness and to diminish its possible toxicity.

Emerging research suggests that the biology of the target cell determines how an organ responds to a drug, with the time of day that a drug is administered being crucial in some instances. “We previously determined the existence of strong circadian rhythms in the cochlea, correlating with greater vulnerability to noise trauma during the active phase, which is daytime in humans and nighttime in nocturnal rodents,” said Cederroth. “In our most recent research (see page 32 for more information), we found that circulating glucocorticoids play a major role in this increased sensitivity, with glucocorticoid levels varying across the day, peaking at the onset of the active phase.” When this peak of glucocorticoids was eliminated, mice were no longer vulnerable to noise trauma at nighttime.

“To our surprise, these levels may predict the efficacy of dexamethasone treatment against noise-induced hearing loss,” Cederroth said. Dexamethasone treatment was most effective when endogenous glucocorticoid levels were at their lowest, which was during the inactive phase. Cederroth speculates that this could explain the mixed success of glucocorticoid treatment in humans, which is the only approved approach for treating auditory disorders. “We believe that adapting the dexamethasone treatment for nighttime in humans could prove more effective than the current dosing during daytime,” he said. However, more work is needed for translating this finding in humans because administering treatment with glucocorticoids at nighttime is accompanied by side effects, which means that the dosage and the timing will need to be refined.

In their initial work published in 2014, Cederroth and his research partners investigated the involvement of neurotrophins in circadian vulnerability to hearing loss and found that treatment was most effective during the active phase. “Here, we found the opposite is true for dexamethasone and illustrates that considering circadian factors for the treatment of hearing loss will be very important to improve the success of drug interventions,” he said. “It doesn’t matter how much of the compound reaches the ear, it’s more a matter of what’s the biological status of the drug target when the drug reaches the ear,” Cederroth said. “If you want to block an enzyme and that enzyme is not active when you administer the drug, or you want to activate a receptor and the receptor is already occupied, your treatment won’t be effective. It’s a matter of timing. Since the majority of drugs have short half-life (less than six hours), chronopharmacology makes sense!”

“It doesn’t matter how much of the compound reaches the ear, it’s more a matter of what’s the biological status of the drug target when the drug reaches the ear.”
Noise Affects More Than Your Tinnitus

Rick Neitzel, PhD

The Problem
What if I told you that there is an invisible, odorless, and tasteless pollutant in the environment to which nearly all Americans are exposed, and that this pollutant is increasingly being associated with the number one killer of Americans (cardiovascular disease) as well as cognitive impacts, sleep disturbance, and injuries? This pollutant is also well known for its ability to cause hearing loss.

Since you are reading this article in Tinnitus Today, you may not be surprised to learn that this pollutant is noise, which has been linked to tinnitus, in addition to the other effects mentioned above. But you are in the minority — most Americans are not aware that noise is one of the most common pollutants in our environment or that so many adverse health impacts have been connected to it. This is not a coincidence and is a direct result of the fact that the United States regulates (or, more accurately, does not regulate) noise in a way that is very different from other, better-recognized pollutants that occur in our air, water, and food.

The Idea
Given the lack of recognition of noise as an important public health threat, we need to better understand and educate the public and policymakers on the health impacts associated with noise exposure.

To help do so, the U.S. Centers for Disease Control and Prevention (CDC) National Center for Environmental Health commissioned my research team at the University of Michigan to evaluate health effects potentially associated with noise. We did so using a standardized research method called systematic review.

The goal of a systematic review is to identify all current evidence relevant to a particular research question, and then to analyze and provide a comprehensive and exhaustive summary of that evidence. A systematic review also rates the level of confidence in the evidence after considering potential bias in the studies included in the review. There are a number of possible ways in which scientific studies can be biased, typically as a result of how data are collected, analyzed, and/or interpreted. Reliance on studies with a high degree of bias can lead us to draw incorrect conclusions.

The objective of our systematic reviews was to identify which noise levels, and exposure for how long, cause which health outcomes. The reviews included studies of the effects of occupational, recreational, and ambient environmental noise, with the goal of collecting information necessary to assess and address the public health risks presented by noise.
What We Studied

Based on the results of our initial review of the literature, the CDC and my team identified 11 health outcomes, each of which had been linked to occupational or community noise exposure in at least six existing studies. These 11 health outcomes, in alphabetical order, are as follows:

1. Cancer
2. Cognitive effects
3. Endocrine disruption
4. Hypertension
5. Injuries
6. Ischemic heart disease (IHD)
7. Low birth weight (LBW)/premature birth
8. Mental health and psychological effects
9. Noise-induced hearing loss
10. Obesity/overweight
11. Sleep disturbance

What We Did

We used three large databases to search for available evidence and relevant scientific studies. These included PubMed, a service of the U.S. National Library of Medicine, and two commercial databases, Embase and the ProQuest Agricultural and Environmental Science Database.

We limited our literature searches for each of the health outcomes to chronic studies where people were exposed to noise over a period of at least three weeks. We did this because, although there have been many studies done on people over short periods of time in highly controlled laboratory settings, these studies do not necessarily provide relevant information about the longer exposure periods that people experience in the real world.

<table>
<thead>
<tr>
<th>Outcome</th>
<th># of Studies</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer Include sub-outcomes for certain types of cancer, e.g., breast cancer</td>
<td>10</td>
<td>Low or evidence of no health effect, depending on sub-outcome</td>
</tr>
<tr>
<td>Cognitive effects Include sub-outcomes for reading comprehension and other than reading comprehension</td>
<td>19</td>
<td>Low to Moderate, depending on sub-outcome</td>
</tr>
<tr>
<td>Endocrine disruption Include sub-outcomes of development of, and death from, type 2 diabetes mellitus, as well as changes in cortisol levels</td>
<td>31</td>
<td>Low</td>
</tr>
<tr>
<td>High blood pressure Include sub-outcomes such as changes in blood pressure and hypertension</td>
<td>65</td>
<td>Low to Moderate, depending on sub-outcome</td>
</tr>
<tr>
<td>Injuries Available studies focused on only occupational injuries, accidents, and fatalities</td>
<td>16</td>
<td>High for nonfatal injuries, Low to Moderate for other sub-outcomes</td>
</tr>
<tr>
<td>Ischemic heart disease Include sub-outcomes such as heart attacks and stroke</td>
<td>38</td>
<td>High for heart attack, stroke, and any cardiovascular disease Moderate for other sub-outcomes</td>
</tr>
<tr>
<td>Low birth weight and premature birth Include sub-outcomes of reductions in birth weight and diagnosed premature birth or low birth weight</td>
<td>12</td>
<td>Low or inadequate evidence depending on sub-outcome</td>
</tr>
<tr>
<td>Mental health and psychological effects Include sub-outcomes of depression, anxiety, antidepressant use, and Strengths and Difficulties Questionnaire scores</td>
<td>30</td>
<td>Low, Moderate, or inadequate evidence depending on sub-outcome</td>
</tr>
<tr>
<td>Noise-induced hearing loss Include only studies of non-occupational noise</td>
<td>28</td>
<td>Low</td>
</tr>
<tr>
<td>Obesity and overweight Include sub-outcomes for waist circumference, overweight, obese, increased body mass index, and others</td>
<td>10</td>
<td>Low or inadequate evidence depending on sub-outcome</td>
</tr>
<tr>
<td>Sleep disturbance Include insomnia, difficulty falling asleep, awakenings, and other sub-outcomes</td>
<td>35</td>
<td>High for difficulty falling asleep, subjective sleep quality, any sleep-related outcome Low to Moderate for other sub-outcomes</td>
</tr>
</tbody>
</table>
We also limited the search to include only studies that assessed noise using A-weighted decibels (dBA), the standard approach for human noise exposure measurements. We did this because studies that rely on self-reported or perceived noise exposures cannot give us useful information about specific noise levels above which health outcomes become a risk. This information is essential for setting exposure limits to protect the public.

All of our systematic review searches included studies of occupational, recreational, and ambient environmental noise, with the exception of the search for noise-induced hearing loss. On that topic, another systematic review was recently published focused on occupational noise, so ours focused on nonoccupational noise only.

Finally, for each systematic review, we assessed a range of different possible biases in all studies using a bias assessment tool created by the U.S. National Toxicology Program. We also evaluated our confidence in the association between the studies and outcome (or outcomes) in each systematic review and rated that confidence as high, moderate, low, evidence of no health effect, or insufficient evidence.

What We Found

The table shows the initial results for all 11 systematic reviews. The number of studies available differed widely between reviews, from 10 for cancer to 65 for high blood pressure.

For three of the 11 health outcomes, we have high confidence that there is an association between the outcome and noise. These were ischemic heart disease, sleep disturbance, and injuries. There were another three outcomes for which we have moderate confidence that there is an association between the outcome and noise. These were cognitive impacts, high blood pressure, and mental health and psychological effects.

It may be surprising to note the low confidence noted in the table for noise-induced hearing loss. Whereas the association between occupational noise and noise-induced hearing loss has been proven beyond a doubt, most existing studies that have examined the association between recreational and ambient environmental noise and noise-induced hearing loss have been small or of low quality, which lowers our confidence in their results.

For three of the outcomes assessed in our systematic reviews, inadequate evidence is available to assess the association between the outcome and noise exposure, and more research is needed. These three outcomes are cancer, low birthweight and premature birth, and obesity and overweight.

What’s Next?

Our assessment of all 11 systematic reviews is ongoing, and the results have not yet been finalized. In particular, we continue to review the specific levels of noise associated with each health outcome as well as the statistical relationship between increases in noise levels and risk of each outcome. This information is critical to develop guidelines and recommendations to limit public exposures to noise and reduce the risk of health effects.

In the short term, my research team will work with the CDC to finalize the systematic reviews and publish our results in peer-reviewed journals. The goal of these publications will be to increase awareness among the public and policymakers of the health effects associated with noise exposure.

Over the long term, the results of these systematic reviews, as well as other reviews of the existing literature on occupational and non-occupational exposures to and impacts from noise, may be used to develop and refine recommended public exposure limits for noise. The results may also help guide public health interventions designed to reduce the risk of auditory and non-auditory health effects from noise. These efforts will be critical to improve public health in the United States from this important, but under-recognized, pollutant to which most of us are exposed. 🗣
By Rick Neitzel, PhD

Noise is an insidious and under-recognized environmental hazard that can negatively impact our lives and health in many ways. The many problems associated with noise and the fact that noise is present in virtually every aspect of our lives can make this hazard seem unconquerable. In fact, research suggests that at least one out of three Americans may be exposed to noise levels that are high enough to harm hearing,¹ and that among Americans living in the largest U.S. cities, that fraction may be as high as nine out of 10!² And it’s not just noise-induced hearing loss we have to worry about but also emerging health effects like high blood pressure, heart attacks, and cognitive impacts.

But the good news is that there are many ways for us to tackle this problem. Below are some suggestions for how to reduce exposures to and the impacts of noise.

Recognize the Risk

The first step to solving any problem is admitting the problem exists. And people living in the United States and virtually everywhere else in the world have a noise problem.

Think about your daily and less frequent activities: Where and when does it seem like you get the most noise exposure? If you want to make a more objective assessment, download a smartphone app designed to measure noise. Although such apps are typically not as accurate as dedicated sound measurement devices, they can provide a sense of noise levels during particular activities and in certain locations.

There are many noise measurement apps available, but one of the best (for iPhones only) also happens to be free and created by the U.S. government. Learn more about the NIOSH Sound Level Meter (SLM) app created by the U.S. National Institute for Occupational Safety and Health at cdc.gov/niosh/topics/noise/app.html

Protect Your Health

Once you identify areas and activities in your life that involve high noise exposures, do something!

• **Limit** your time in high noise by avoiding noisy activities when possible.
• **Move** as far away as possible from high noise sources when you can’t limit your time.
• And, when high noise is unavoidable, **use hearing protection** — either earplugs or earmuffs.

You can learn more about how to reduce your risk of hearing loss by visiting the Dangerous Decibels website at dangerousdecibels.org/

Get Educated

The United States has not always turned a blind eye to issues related to noise exposure — in fact, in the 1970s and early 1980s, we led the world in evaluating public noise exposures and their associated impacts. But all that changed in 1981.

If you’d like to learn more why the U.S. Environmental Protection Agency (EPA) — the agency formally responsible for assessing and addressing the noise problem in the nation — has been unable to take action on this issue for more than 35 years, read the historical account of the situation at airportnoiselaw.org/epaconac3.html

Reach Out

Legislators and policymakers in the United States have innumerable issues and challenges to deal with, and, unfortunately, noise has not been a high priority in recent decades. However, as citizens, we all have a responsibility — and an opportunity! — to make ourselves heard if we want policies and laws developed to address our concerns.

Take time to identify your local, state, and federal legislators, and let them know by phone call or letter that noise is harmful pollution that needs to be addressed in the same ways we address pollutants in our air, water,

How Can You Protect Yourself From Noise?
and food. Ask them to reestablish funding for the EPA Office of Noise Abatement and Control, which would allow the federal government to get back in the business of regulating harmful noise exposures among the American public.

**Become a Part of Something Bigger Than You**

If you’re reading this, you’re likely already a member of the American Tinnitus Association, which is a great start. Other organizations are also working to make the United States a quieter and healthier place. You can either join or support to help further this effort:

- National Hearing Conservation Association (hearingconservation.org)
- The Quiet Coalition (thequietcoalition.org)
- Noise Pollution Clearinghouse (nonoise.org)
- Noise Free America (noisefree.org)

### What to Expect

It has taken us decades to get to the point where we are today, and it will take decades to fully address the problem. In the short term, we can ask that noise impacts be considered in planned commercial building and public works projects and ask for the development and enforcement of local noise ordinances.

Over the longer term, we can ask that regulations be put in place to limit noise emissions from motor vehicles, roadways, railways, and other common noise sources, in the same way that emissions from commercial aircraft have been successfully reduced through regulations established by the Federal Aviation Administration. We can also ask that the U.S. Occupational Safety and Health Administration place a stronger emphasis on limiting workplace noise exposures in order to reduce noise-induced hearing loss, one of the most common occupational diseases in the nation.

To learn more about actions that can be taken to address the noise problem in the United States, watch this video created by the University of Michigan School of Public Health: https://youtu.be/KAhX0sv6Hcw

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Rick Neitzel, PhD, CIH, FAIHA, is an associate professor of environmental health sciences and global public health in the Department of Environmental Health Sciences at the University of Michigan (UM) School of Public Health, and he also serves as associate chair of the department.

Neitzel has published nearly 100 peer-reviewed articles focused on exposures to and impacts of noise and other occupational and environmental hazards. He is particularly interested in incorporating new methodologies and exposure-sensing technologies into research and has a strong interest in translating his research findings into occupational and public health practice. In partnership with Apple Inc., he recently launched a national study of music and noise exposure and associated impacts on hearing and heart rate among U.S. adults. He has created a first-ever national job exposure matrix for occupational noise exposures in the United States and Canada, available at http://noisejem.sph.umich.edu/

Neitzel is chair of the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values for Physical Agents (TLV-PA) Committee. He is a fellow of the American Industrial Hygiene Association and has been a certified industrial hygienist since 2003. He is also a cofounder of the Quiet Coalition (https://thequietcoalition.org/) and serves as an expert consultant to the Make Listening Safe initiative of the World Health Organization.
If you or someone you’re close to has a chronic medical condition, then you probably understand how it can alter the course of your life. Both my research and my experience as someone afflicted with severe tinnitus and hyperacusis affirm the challenges of communicating what it’s like to have either condition. These are subjective experiences, which are hard for others to understand because they cannot observe physically or measure objectively the extent of your suffering.

There is a great need to support people through painful life transitions, including those caused by disabling medical conditions such as bothersome tinnitus and hyperacusis. It is also crucial that people with tinnitus and hyperacusis have tools to translate the subjective experience of enduring these conditions to healthcare providers and researchers so they can get better care. This is no small part of why, when I came across it, I instantly believed scale construction methodology and psychometrics could help communicate the experience of audiological sensitivity and tinnitus into a more concrete frame of reference for healthcare providers, family, and friends alike.

Since the third grade, my life had been about playing and teaching music all around the world until the pain and extreme discomfort of tinnitus, hyperacusis, and hearing loss put an end to my career. For more than 20 years my tinnitus and hyperacusis gradually worsened to the point at which I saw no clear pathway forward in music or teaching, and realized I needed a new occupation. After attending several continuing education classes in psychology, I felt I had found my next career and applied to graduate school. I set out to specialize in research and practice aimed at helping those with tinnitus. Before my classes began, I established an ATA-affiliated support group in Los Altos, California. This was a formative experience that shaped the research I ended up doing for my dissertation and beyond, as there is nothing so impactful as hearing people’s stories firsthand. I came to appreciate the strength, resilience, and wisdom of those affected by tinnitus, as well as the dire need for better solutions and understanding of symptom diversity. I also learned that I am one of the most severe cases many people have encountered, and that because my symptoms fall at a particular intersection of tinnitus and auditory sensitivity, it can be quite hard for others to understand my challenges — both socially and professionally — and when seeking medical care.

As I began my doctoral program, I felt guided by a sense of mission to bring greater awareness to the experiences of patients with tinnitus and hyperacusis and their various subtype manifestations. A part of this comes from my own experience of not being believed and of being dismissed by people who consider themselves experts, even as I began to present internationally, win grants, and publish my own work. For example, a well-known researcher tried to convince me that my sound-sensitivity wasn’t “real,” told me that “the tinnitus wouldn’t be a problem if you could just reduce your limbic reactivity,” and refused...
to listen when I tried to explain my situation, the pain I experience, and just how many interventions I had tried (including close to 20 years of mindfulness practice).

Many people in online patient support groups have similar stories. Even though there are similarities among the stories of people with tinnitus, every individual is obviously different. Harm can be done when, for example, a practitioner suggests someone stop using hearing protection altogether when hypersensitivity is a factor — if there is underlying damage to the hearing mechanisms of the ear, a more vigilant level of protection may be necessary.

Current intervention models aren’t designed to differentiate various subtypes, and many people I have seen in clinical practice and support groups have felt dismissed by their providers by being lumped into categories they don’t fit in. Many have also been hastily diagnosed with mental health problems as the underlying issue for their auditory problems, which has fueled mistrust of psychology that at times, as a researcher, has been directed at me.

An issue many people with tinnitus and hyperacusis report is that practitioners commonly equate stress and anxiety with the disorders themselves. This includes the notion that if you simply fix the anxiety, the tinnitus will stop being a problem. Indeed, I have helped to facilitate a significant reduction if not disappearance of initial onset tinnitus symptoms by addressing the stress and anxiety that come with it, but many instances of tinnitus and hyperacusis (mine included) do not fall into this category. For example, even at times when my stress level is near zero, the tinnitus and sensitivity can still be severe, and vice versa.

Speaking as a practitioner, we need to listen more, understand the unique situation of each patient, and provide interventions that best support the individual. For example, available and popular interventions, including cognitive behavioral therapy (CBT), are great for many but just don’t help enough for some. Whatever skills and short-term interventions can help should always be offered, but they aren’t always enough for everyone. In many of the more debilitating cases of tinnitus, the level of impact, distress, and necessary life transitions involved goes way too deep to only track cognitions, emotions, and behaviors.

A greater understanding of tinnitus heterogeneity, or diversity, especially with regard to comorbid conditions such as hyperacusis, is necessary. The nature of medical research is such that to get the clearest result, having fewer confounding variables is preferable. However, that’s not how it works in the real world — individuals come seeking help with their full complexity and diversity of concerns. I think a better understanding of the various manifestations of tinnitus subtypes will assist audiologists and other clinicians to know which treatments will work best for each particular set of concerns.

The same thing applies to hyperacusis, and for that matter to mental health concerns — experiences of depression or anxiety rarely occur without other contextual factors, and even the definition of what constitutes symptoms can be largely subjective and vary person to person and culture to culture.

As a psychologist, the work I’m most proud of so far is that I created, statistically analyzed, and published a psychometrically valid scale for hyperacusis, using data from 450
participants from all around the world. Until I completed the Index of Hyperacusis Symptoms (IHS — admittedly, a play on the International Horn Society acronym, a bow to my earlier career), hyperacusis lacked a clinically viable measure. Since its publication, there has been a fair amount of international interest about this scale.

Additionally, I’ve done a lot of research into the type of tinnitus that I experience — sometimes called “reactive.” I’ve labeled it “sound-sensitive” tinnitus due to the enduring quality of tinnitus exacerbation, and I also created and validated a scale to measure for the presence of this subtype, called the Sound-Sensitive Tinnitus Index.

In my clinical practice, I work within a relational-integrative framework, considering the context of biopsychosocial factors, and applying my understanding of the neurophysiological impact underlying many forms of distress to support individuals through life challenges, and persistent psychosocial hardship. On the basis of my clinical experience and research, I believe this approach holds promise for supporting individuals for whom CBT is ineffective, or simply not enough.

Unfortunately, many individuals fall through the cracks in current clinical research models, including many of the most afflicted. For example, if a clinical trial shows positive results in 80 percent of participants, it is considered wildly effective, but I think this perspective is flawed in actual practice — my attention goes to the 20 percent of individuals for whom the intervention did not work, and I want to know more about their experience and what can be done to help them. Considering the prevalence of tinnitus, that could be millions of people.

Whereas most interventions follow a fairly standard protocol, I’m grateful to have learned a clinical approach that is flexible and that can be adapted to the needs of each individual.

Although my life continues to be hindered in substantial ways by tinnitus and hyperacusis, I believe strongly in the work I’m doing and am excited to continue my research and advocacy. For all of us who are desperately awaiting a cure, I sincerely hope that real relief may be on the not-too-distant horizon.

Benjamin Greenberg, PsyD, is a licensed psychologist in independent practice in Athens, Georgia. As a consultant, he frequently contributes to original research on health-related issues and psychometrics. He completed his postdoctoral fellowship at Boston College and his doctoral residency at California Pacific Medical Center in San Francisco. Greenberg received an ATA grant in 2013–14 for the “Development and Validation of the Sound-Sensitive Tinnitus Index.” He can be reached via email at: bengreenbergpsyd@gmail.com or through his website: www.bengreenbergpsyd.com

Measuring Sound-Sensitive Tinnitus

The Sound-Sensitive Tinnitus Index (SSTI) is a scale (see next page) designed to assess the impact of auditory sensitivity on subjective tinnitus. Although tinnitus exacerbated by sound exposure is known to correlate with increased challenges with treatment and intensified quality of life and mental health concerns, there is a lack of valid screening measures to differentiate/assess diagnostic factors and areas of impact unique to this specific symptom manifestation. Based on several pilot studies and a review of established models of tinnitus and hyperacusis measurement, the 20-item Sound-Sensitive Tinnitus Index (SSTI) was developed. It was administered as an online survey to 277 individuals from 32 countries, and showed high levels of reliability and validity through extensive psychometric and statistical analyses. The SSTI fills an important gap as a clinical tool that can differentiate and assess manifestations of combined tinnitus and auditory sensitivity symptoms in both research and clinical practice.
Please circle the response that best matches each statement.

**Sound-Sensitive Tinnitus Index**

1. After hearing loud sounds, my tinnitus symptoms can become worse.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

2. My tinnitus can get worse for even several days (or more) after I am exposed to loud sounds.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

3. It is difficult for me to be in noisy situations because it makes my tinnitus worse.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

4. In loud situations, I feel like I need to ask people to lower the volume for fear of my tinnitus getting worse.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

5. I feel that my burden of having tinnitus is increased because it gets worse after hearing loud sounds.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

6. Being sensitive to sounds makes it harder to cope with having tinnitus.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

7. I find my challenges with sound sensitivity and tinnitus difficult to explain to doctors, ENT physicians, and/or audiologists.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

8. My tinnitus and sound sensitivity can become worse when I am under stress.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

9. Because of my tinnitus and sensitivity to sounds, I sometimes avoid social situations that I fear could make my symptoms worse.
   - (1) Not at all
   - (2) A little
   - (3) Somewhat
   - (4) Quite a bit
   - (5) Very much so

10. The impact of hearing loud sounds on my tinnitus is hard to explain to friends and family.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

11. My tinnitus and sensitivity to sounds have negatively impacted my relationships with friends and/or family members.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

12. I have a hard time being in groups of people because it makes my tinnitus worse.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

13. Even being around 3 or more people in which multiple conversations are happening at once can make my tinnitus worse.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

14. Performing necessary tasks that can be noisy such as housework, errands, and shopping can make my tinnitus worse.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

15. I feel like my tinnitus and sound sensitivity have gotten worse over time.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

16. My tinnitus and sensitivity to sounds have negatively impacted my ability to pursue my hopes and dreams.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

17. When my tinnitus gets worse after hearing loud sounds or for other reasons, I can use ambient sounds to help my symptoms.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

18. I feel like I can manage my tinnitus and sound sensitivity symptoms, even when they get bad.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

19. I feel as though I have enough resources to help me deal with my tinnitus and sound sensitivity symptoms, even when they get bad.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

20. If I am exposed to loud sounds, using hearing protection can help prevent my tinnitus from getting worse.
    - (1) Not at all
    - (2) A little
    - (3) Somewhat
    - (4) Quite a bit
    - (5) Very much so

*Items 16-20 are inversely scored (1=5; 2=4, etc.)
People with tinnitus at every stage in their journey, from the first few days to many years later, can benefit from membership in a support group. Every tinnitus support group operates somewhat differently; but they all share a passion for providing meaningful discussion and a caring environment where one can be understood through shared experience. Information on meeting times and dates can be found on our website at www.ATA.org. It is recommended that you reconfirm meeting times and place with the point-of-contact person listed below prior to attending a meeting.

Tinnitus Resources

Support Group Locations

Arizona

**COMING SOON!**

**Tucson Tinnitus Support Group**
Reid Park Ramada #15
S. Country Club Rd. and E. 22nd St.
Tuscan, AZ 85716
Contact: Trudy Jacobson
E: trudyj@cox.net

**San Diego Tinnitus and Hyperacusis Support Group**
San Diego City Library
North University City Branch
8820 Judicial Dr.
San Diego, CA 92122
Contact: Michael J. Fischer, Loretta Marsh,
Dave Planeuf, Tom Sutton
E: michaeljohnfischer@hotmail.com
E: loretta.marsh@hotmail.com,
P: 858-484-9267
E: djplaneuf@yahoo.com
E: tmsutton63@gmail.com

**Colorado**

**Denver Tinnitus Support Group**
Lutheran Medical Center
2nd Floor Learning Center, Classroom #1
8300 W 38th
Arvada, CO 80033
Contact: Rich Marr
T: 303-875-5762
E: r.marr@comcast.net

**Mesa County Tinnitus Support Group**
Community Hospital, Legacy Room 1
2351 G Rd.
Grand Junction, CO 81505
Contact: Elaine Conlon
T: 970-589-0305
E: conlonelaine@aol.com

**Florida**

**Clermont Tinnitus Support Group**
Citrus Hearing Clinic
835 7th St., Suite 2
Clermont, FL 34711
Contact: Laura Pratesi, AuD
T: 352-989-5123
E: drlaura@citrushearing.com

**Sarasota Tinnitus Support Group**
Silverstein Institute
1901 Floyd St.
Sarasota, FL 34239
Contact: Carmen Trotha, Tom Terrenzi
T: 941-993-7616, 941-462-1311
E: sarasota.ata@gmail.com

**Tinnitus Self-Help Group of Palm Beach County**
South County Civic Center
16700 Jog Rd.
Delray Beach, Florida 33446
Contact: Ellen Gartner
T: 800-732-9217

**Georgia**

**Atlanta Tinnitus Support Group**
Dekalb County Public Library
Dunwoody Branch, Meeting Room
5339 Chamblee Dunwoody Rd.
Dunwoody, GA 30338
Contact: Erica Caplan
E: elcatl@aol.com

**Illinois**

**Chicago Suburban Tinnitus Support Group**
Contact: Margie B.
E: maggie318@yahoo.com

**Maryland**

**Potomac Audiology**
11300 Rockville Pike, Suite 105,
Rockville, MD 20852
Contact: David Treworgy, Gerry Baill
E: david_treworgy@yahoo.com and
gsbaill@yahoo.com

**University of Maryland Tinnitus and Hyperacusis Support Group**
University of Maryland College Park campus
College Park, MD
Contact: Christina Shields, AuD
E: shields3@umd.edu
P: 301-405-5562

**Massachusetts**

**Boston Tinnitus Support Group**
Athan's Bakery
407 Washington St.
Brighton, MA 02135
Contact: Kevin Plovanich
E: KPMA@aol.com

**Michigan**

**Holland Tinnitus Support Group**
399 E 32nd St.
Holland, MI 49423 (or TBD)
T: 616-392-2222
E: info@holaud.com
www.facebook.com/HOLAUD
Missouri

St. Louis Tinnitus Support Group
St. Louis County Library Oak Bend Branch
1640 S. Lindbergh Blvd.
St. Louis, MO 63131-3598
or
Grand Glaze Branch
1010 Meramec Station Rd.
Manchester, MO 63021-6943
Contact: Tim Busche
T: 636-734-4936
E: tennisfancincy@gmail.com

Nevada

Reno/Sparks Nevada Tinnitus Support Group
Modern Audiology of Sparks
634 Pyramid Way
Sparks, NV 89431
Contact: Scott Sumrall
E: scottsumrall@sparkshearing.com
T: 775-336-0211

New Jersey

South Jersey Tinnitus Support Group
Advanced ENT/HearMD
1020 North Kings Highway, Ste. 201
Cherry Hill NJ 08034
Contact: Beth Savitch, Erin Lustik
T: 610-797-7251 (H), 610-739-6675 (C)
E: tennisfancincy@gmail.com

Tinnitus Self-Help Group, Ewing
First Presbyterian Church
100 Scotch Rd.
Ewing, NJ 08628
Contact: Dhyan Cassie, AuD
T: 215-984-8380
E: Dhyan1@verizon.net

New York

Bronx Tinnitus Support Group
260 W. 231st St.
Bronx, NY 10463
Contact: Dr. S. Karie Nabinet
T: 917-797-9065 or 718-410-2301
E: kkwn12u@aol.com

The Long Island Tinnitus Group
Long Island Jewish Hospital
900 Franklin Ave.
(Meet in lobby before going to Shanker Bldg.)
Valley Stream, New York 11580
Contact: Anthony Mennella,
T: 516-379-2534
E: aem830@verizon.net

North Carolina

Raleigh Tinnitus Support Group
Raleigh Hearing and Tinnitus Center
10320 Durant Road, Suite 107
Raleigh, NC 27614
Meet the 4th Thursday of every month
Contact: Saranne Barker, AuD,
Sheri Mello, AuD
T: 919-790-8889
E: info@rratc.com

Oregon

VA Portland Health Care System
Tinnitus Education Group
National Center for Rehabilitative Auditory Research
3710 SW US Veterans Hospital Rd.
Portland, OR 97239
Contact: Bryan Shaw
E: Bryan.Shaw2@va.gov

Pennsylvania

Lehigh Valley Tinnitus Support Group
Location of Meetings: To Be Determined
Contact: Ed Kozelnicky
T: 610-797-7251 (H), 610-739-6675 (C)

Virginia

Northern Virginia Tinnitus Support Group
Northern Virginia Resource Center for Deaf & Hard of Hearing Persons (NVRC)
3951 Pender Dr., Ste. 130
Fairfax, VA 22030
Contact: Elaine Wolfson, Marian Patey
E: erwolfson@comcast.net
E: mjpatsey@fcps.edu

Washington

Seattle Tinnitus Support Group
Broadview Public Library
12755 Greenwood Ave N.
Seattle, WA 98133
Library Font Desk: 206-684-7519
Contact: Keith Field
T: 206-783-7105
E: keith_r_field@outlook.com

Wisconsin

Madison Tinnitus Support Group
Madison Masonic Center
85 S Stoughton Rd.
Madison, WI 53714
Contact: Deb Holmen
T: 608 219 0277
E: dholmenhearu@gmail.com

Each support group referenced here is independently operated and led by volunteers who wish to provide education and support to the tinnitus community. The American Tinnitus Association (ATA) does not sponsor nor endorse these activities and expressly disclaims any responsibility for the conduct of any independent support group or the information they may provide. ATA is not a healthcare provider and you should consult with a primary care physician or hearing healthcare professional for qualified medical advice on tinnitus and related disorders.

*Some groups do not or cannot schedule meetings far in advance to allow for flexibility in planning. We post all support group meetings in our online events calendar at ATA.org as we learn of the confirmed date and time. The above information was provided to ATA staff at the time the magazine went to print; therefore, please confirm meeting details with the contact person prior to a meeting or reference our website at: https://www.ata.org/news/events.

This is a partial listing of support groups and scheduled meetings. A complete list can be found at https://www.ata.org/managing-your-tinnitus/support-network/support-group-listing. New groups begin all the time so please check the website for updates periodically.

If you’re interested in forming a group, please contact Kevin Willmann at: tinnitus@ata.org. If there isn’t a group in your area, ATA has an extensive network of volunteers who provide email and telephone support and educational information. To connect with a volunteer in your time zone, see: https://www.ata.org/managing-your-tinnitus/support-network/telephoneemail-support-listing.
Spotlight on Patient Providers

Professional Members
Listing current as November 15, 2019

When making an appointment, please mention that you learned of the provider from the ATA, thereby ensuring that providers understand the importance of being a part of the ATA's tinnitus patient-provider network.

UNITED STATES

Alabama
Susan Sheehy, AuD
Alabama Hearing Associates
Madison, AL

Emily McMahan, AuD
Alaska Hearing & Tinnitus Center
Anchorage, AK

Arizona
Lynn Callaway, BC-HIS
Affordable Hearing Solutions
Green Valley, AZ

Judy Huch, AuD
Oro Valley Audiology, Inc.
Oro Valley, AZ

Jonathan Ramirez-Lira, AuD
Sound Relief Hearing Center
Scottsdale, AZ

Neal Sorenson, BS
Moore Audiology
Sun City, AZ

Thea Wickey, AuD
Sound Relief Hearing Center
Scottsdale, AZ

Arkansas
Kelley Linton, AuD
Center for Hearing, Ltd
Fort Smith, AR

California
Kasra Abolhosseini, AuD
Tustin Hearing Center
Tustin, CA

Melissa Alexander, AuD
Alexander Audiology, Inc.
Santa Monica, CA

Randall Bartlett, MA
Tinnitus & Audiology Center of Southern California, Inc.
Santa Clarita, CA

Troy Cascia, AuD
UCSF Medical Center
San Francisco, CA

Shahrzad Cohen, AuD
Hearing Loss Solutions
Sherman Oaks, CA

Arthur Corpus, PA
Sharp Rees-Stealy Medical Group Inc.
Chula Vista, CA

Jean M. Deiss, AuD
VA Northern California Health Care System
Martinez, CA

David DeKriek, AuD
Fidelity Hearing Center
Cerritos, CA

Jerilyn Dutton AuD
Salient Sounds Audiology
La Jolla, CA

Tracy Peck Holcomb, AuD
Hearing and Speech Center of Northern California
San Francisco, CA

Kent Holtorf, MD
Holtorf Medical Group
Redondo Beach, CA

Malvina Levy, AuD
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San Francisco, CA

Sara Mattsson, AuD
Rancho Santa Fe Audiology
Rancho Santa Fe, CA

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Los Gatos, CA

Bruce Piner, AuD
Hearing and Balance Center
Encino, CA

Jane Rosner, MA
West Valley Hearing Center
Woodland Hills, CA

Mimi Salamat, PhD
Private Practice
Walnut Creek, CA

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William F Stubbeman MD Brain Stimulation Institute
Los Angeles, CA

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All About Hearing/Lake Audiology & Hearing Aids
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Cedar Rapids, IA

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Jay Piccirillo, MD
Washington University School of Medicine
Saint Louis, MO

North Carolina

Saranne Barker, AuD
Raleigh Hearing and Tinnitus Center
Raleigh, NC
<table>
<thead>
<tr>
<th>State</th>
<th>Provider Name</th>
<th>Contact Information</th>
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<tbody>
<tr>
<td>New Jersey</td>
<td>Catherine Ahrens Berke, BC-HIS</td>
<td>Ahrens Hearing Center, Fair Lawn, NJ</td>
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<td></td>
<td>Granville Y. Brady Jr., AuD</td>
<td>Tinnitus Center at Williamsburg Commons, East Brunswick, NJ</td>
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<td></td>
<td>Valerie Kriney, AuD</td>
<td>Northern Jersey ENT Associates, PA, Glen Rock, NJ</td>
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<td></td>
<td>Beth Savitch, MA</td>
<td>Advanced ENT/Hear MD, Voorhees, NJ</td>
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<td></td>
<td>Dr. Donna Szabo, AuD</td>
<td>Innovative Hearing Solutions, Westwood, NJ</td>
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<tr>
<td>Nevada</td>
<td>Robyn Lofton, BC-HIS</td>
<td>Hearing Associates of Las Vegas, Las Vegas, NV</td>
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<tr>
<td>New York</td>
<td>Nicole Ball, AuD</td>
<td>Hearing Evaluation Services of Buffalo, Tonawanda, NY</td>
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<td></td>
<td>Carol Bass, MS</td>
<td>All Ears Audiology Tinnitus &amp; Hyperacusis, Audiological Consulting, Ithaca, NY</td>
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<tr>
<td></td>
<td>Alyssa Beaton, AuD</td>
<td>Hearing Evaluation Services of Buffalo, Inc., Orchard Park, NY</td>
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<td></td>
<td>Samantha Bayless, AuD</td>
<td>The Hill Hear Better Clinic, Batavia, OH</td>
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<td></td>
<td>Sarah Crow, AuD</td>
<td>Modern Hearing Solutions/ Choice Hearing Center, Canton, OH</td>
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<td>Eric Mounts, HIS</td>
<td>Modern Hearing Solutions/ Choice Hearing Center, Canton, OH</td>
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<td></td>
<td>Richard Reikowski, AuD</td>
<td>Family Hearing &amp; Balance Center, Akron, OH</td>
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<td></td>
<td>Babette Verbsky, PhD</td>
<td>Hearing Connections Audiology, Lebanon, OH</td>
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<td>Kyle Woods, MA</td>
<td>Modern Hearing Solutions/ Choice Hearing Center, Canton, OH</td>
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<td>Suzanne Kimball, AuD</td>
<td>University of Oklahoma Health Science Center, Oklahoma City, OK</td>
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<td>Dr. Teresa M. Mazza, AuD</td>
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<td>Christy Mitchell, AuD</td>
<td>Choctaw Nation of Oklahoma, Talihina, OK</td>
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<td>Anna Forsline, AuD</td>
<td>VA Portland Health Care System, Portland, OR</td>
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<td>James Henry, PhD</td>
<td>National Center for Rehabilitative Auditory Research (NCRAR), Portland, OR</td>
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<td>Ha-Sheng Li-Korotky, AuD</td>
<td>Pacific Northwest Audiology, LLC, Bend, OR</td>
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<td></td>
<td>Lisa A. Blackman, MA</td>
<td>A Hearing Healthcare Center, Philadelphia, PA</td>
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<td></td>
<td>Gail Brenner, AuD</td>
<td>Tinnitus &amp; Sound Sensitivity Treatment Center of Philadelphia, PA, Bala Cynwyd, PA</td>
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<td></td>
<td>Mindy Brudereck, AuD</td>
<td>Berks Hearing Professionals, Birdsboro, PA</td>
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<td>Amy Greee, AuD</td>
<td>Ear, Nose &amp; Throat Associates of Johnstown, Windber, PA</td>
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<td></td>
<td>Jeannie Karlovitz, AuD</td>
<td>Advanced Hearing Solutions, Exton, PA</td>
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<td>Edward Keels, MA</td>
<td>Hear Now Hearing Aid Center, Philadelphia, PA</td>
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<td>Holly Puleo, AuD</td>
<td>Gateway Hearing Solutions, Warwick, RI</td>
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<td></td>
<td>Todd Gibson, AuD</td>
<td>Lake Murray Hearing, Lexington, SC</td>
</tr>
<tr>
<td></td>
<td>L. Margaret Kalady, AuD</td>
<td>Kalady Audiology, Beaufort, SC</td>
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<tr>
<td></td>
<td>Alexandra Tarvin, AuD</td>
<td>Elevate Audiology- Hearing and Tinnitus Center, Easley, SC</td>
</tr>
</tbody>
</table>
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Simpsonville, SC

Angela Zuendt, AuD
Greenville ENT
Greenville, SC

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Melissa E. Baker, MA
Baker Audiology and Hearing Aids
Sioux Falls, SD

Patrick Coughlin, AuD
Hearing Care Professionals
Aberdeen, SD

Tennessee
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Ahlberg Audiology & Hearing Aid Services
Cleveland, TN

Cynthia Ellison, AuD
Franklin Hearing Center
Franklin, TN

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Vanderbilt University Medical Center
Nashville, TN

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Ear, Nose and Throat Consultants of East Tennessee
Knoxville, TN

Paul Shea, MD
Shea Ear Clinic
Memphis, TN

Texas
Theodore Benke, MD
Benke Ear Nose & Throat Clinic
Cleburne, TX

Christie Cahill, AuD
Family Hearing & Sensory Neural Center
Huntsville, TX

Jamie Hawkins, AuD
Clarity Hearing
Conroe, TX

Mary Sue Harrison, AuD
Today’s Hearing
Katy, TX

Cynthia Lockhart, HIS
Carrollton, TX

Pedro Montano, MD
McAllen, TX

Elly Pourasef, AuD
Memorial Hearing Inc.
Houston, TX

Crystal D. Wiggins, AuD
Bay Area Audiology
Webster, TX

Utah
Ashley Penrod, PA-C
Intermountain
Sandy, UT

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Ascent Audiology & Hearing
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Virginia Beach, VA

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Evolution Hearing
Richmond, VA

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Augusta Audiology Associates, PC.
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Evergreen Speech & Hearing Clinic, Inc
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Audiologists Northwest
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The Hyperacusis Network
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Sikorski Hearing Aid Center, Inc.
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West Virginia
Brandon Lichtman, AuD
Wheeling Hospital
Wheeling, WV

Erin Wells, AuD
Mountain Ears Hearing Clinic, LLC
Parkersburg, WV

Please note that the American Tinnitus Association does not verify providers’ certifications and expertise in tinnitus treatment. The list is meant expressly for informational purposes and should not be construed as the ATA’s endorsement of the providers listed. The ATA strongly advises anyone using the list to check practitioners’ websites and tinnitus services before scheduling appointments. Please note that the list includes hearing aid dispensers because hearing aids can be helpful to some people in the management of their tinnitus.

INTERNATIONAL

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Editorial Calendar

*Tinnitus Today* magazine is a print and electronic media magazine published in April, August, and December, and circulated to 25,000+ ATA contributors, donors, patients, supporters, researchers, and healthcare professionals.

The magazine editorial team empowers readers with information, including up-to-date medical and research news, feature articles on urgent tinnitus issues, questions and answers, self-help suggestions, and letters to the editor from others with tinnitus. Strong service journalism, compelling storytelling, first-person narrative, and profiles are presented in a warm, vibrant, and inviting format to encourage readers to reflect, engage, and better understand a medical condition that affects millions.

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*Editorial Calendar is subject to change.*

To advertise, contact: tinnitus@ata.org

MISSION AND CORE PURPOSE

The mission and core purpose of the ATA are to promote relief, help prevent, and find cures for tinnitus evidenced by its core values of compassion, credibility, and responsibility.

CORE VALUES AND GUIDING PRINCIPLES

*Compassion*: Evidenced in a spirit of hope reflected in the commitment to finding a cure, preventing the condition, and supporting those affected by the condition.

*Credibility*: Evidenced in accurate information from reliable sources, transparency in decision-making, and an earned reputation for trustworthiness.

*Responsibility*: Evidenced in patient-centered advocacy by a collaborative community of forward thinking leaders accountable to its mission and members.

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Podcasts

ATA’s Conversations in Tinnitus, with John A. Coverstone, AuD, and Dean Flyger, AuD

Tune In to Conversations in Tinnitus to Stay Abreast of Tinnitus Research and News

The American Tinnitus Association’s podcasts are available 24/7 to help you stay abreast of tinnitus research and other tinnitus topics. Just like listening to music on your smartphone or computer, you can tune in to Conversations in Tinnitus podcasts, cohosted by John A. Coverstone, AuD, and Dean Flyger, AuD, while you work out, take a walk, relax at home, or commute to work. To access and learn more about this unique and compelling series, visit our website at www.ata.org. To enhance listening comprehension and accommodate those with noise sensitivity, transcripts are available with each podcast.

Podcast 14: Does Tinnitus Retraining Therapy Improve Quality of Life?
SUBJECT MATTER EXPERTS: Roberta Scherer, PhD, and Craig Formby, PhD
TOPIC: Drs. Scherer and Formby guide us through the decades-long journey to conduct the first and only phase III trial of tinnitus retraining therapy, an influential habituation-based treatment protocol for alleviating the negative reactions to tinnitus. The researchers explore findings that highlight the importance of sound enrichment and working with a caring and qualified healthcare provider.

Podcast 15: Exploring Noninvasive Neurosensory Tinnitus Treatment
SUBJECT MATTER EXPERT: Hubert Lim, PhD
TOPIC: Dr. Lim, a leading scientist and thought leader in auditory neuroscience, discusses the research and development of non-invasive bimodal neuromodulation for treatment of tinnitus. He explains the scientific concept and the research being conducted, which is aimed at developing a treatment that decreases the perception of the tinnitus sound and the negative emotional reactions caused by it.

Podcast 16: Understanding the Problem of Painful Hyperacusis
SUBJECT MATTER EXPERT: Bryan Pollard, BA
TOPIC: Bryan Pollard, founder of the nonprofit Hyperacusis Research, explains what it is like to live with noise-induced pain and what is known about this often overlooked condition. As someone who lives with painful hyperacusis and tinnitus, Pollard provides unique insight into the struggles, his mission to increase research on the condition, and the importance of developing tools to enable sufferers to return to a more normal life, without fear of setbacks.

Podcast 17: Talking About Tinnitus With Children
SUBJECT MATTER EXPERTS: David Baguley, PhD, and Claire Benton, MSc
TOPIC: Dr. Baguley and Claire Benton discuss their efforts to educate parents, teachers, and healthcare providers on talking to children about tinnitus. The widespread misconception that children don’t have tinnitus has meant children suffer alone and miss critical opportunities for early intervention. They also discuss their research findings on the topic and tools to help children manage tinnitus.

To subscribe to the print or digital issue of Tinnitus Today, which is published three times a year, visit www.ata.org or email tinnitus@ata.org