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Hearing Health

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President Obama congratulates mentors in science and math.

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Hearing Loss and Hearing Aids



ages 12 and over has a hearing loss, while 1 in 8 has a hearing loss in both ears.



Approximately one third of people ages 65 to 74 and nearly half of those over 75 have hearing loss.

Hearing loss is the third most prevalent chronic health condition facing seniors.

Roughly 10 million people in the United States have permanent, irreversible hearing loss due to noise or trauma.



An estimated **12.5 percent** of U.S. children ages 6 to 19 show evidence of noise-induced hearing loss.



Hearing loss and tinnitus are consistently the top two health issues for military service members and veterans.

- Hearing aids have been shown to provide a significant benefit to individuals with hearing loss.
- About 80 percent of hearing losses can be treated with hearing aids, but only 1 in 4 individuals who could benefit from using hearing aids, including those with mild hearing loss, currently owns them.
- The risk of dementia may be up to five times greater among people with untreated hearing loss.
- Untreated hearing loss is linked to a threefold increased risk of falling.
- Hearing aids have been shown to reverse negative psychological and emotional changes from untreated hearing loss.
- Older adults who use hearing aids show reduced depression symptoms and improved quality of life.



Information is based on the 2015 update of "A White Paper Addressing the Societal Costs of Hearing Loss and Issues in Third-Party Reimbursement," prepared by the Hearing Industries Association (HIA), with input from HHF and other groups. (To learn more, see "Doing the Right Thing for the Right Reasons," page 8.) For references, see hhf.org/winter2016_references.

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Sally Longstaffe, Naída CI recipient, reading a book with her granddaughter



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1. Advanced Bionics. (2012) ClearVoice Clinical Results White Paper.

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Dear Readers and Supporters,

On behalf of Hearing Health Foundation's Board of Directors and staff, I thank you for helping make 2015 another productive year in the field of hearing and balance research. We are grateful for your ongoing support that helps us continue to focus on preventing and curing hearing loss and tinnitus through groundbreaking research as well as promoting hearing health.

We are very appreciative of your interest in Hearing Health magazine, an important information source for close to one million readers every year. Our ability to provide hearing and balance research updates, timely information on new hearing assistive devices and technologies, interesting personal experiences, and thought-provoking narratives on a range of relevant topics is due to the effort of our dedicated staff, volunteers, and researchers, and the commitment of people like you with a connection to hearing loss. In 2015, we began implementing our five-year strategic plan, achieving many milestones throughout the year.

Here are some notable highlights:

Innovative hearing and balance research funded: Our long-standing commitment to identifying and funding the highest quality research projects remains a top priority. Ten Emerging Research Grants (ERGs) were awarded in tinnitus, Ménière's disease, central auditory processing disorder (CAPD), and hyperacusis. These grants remain one of the few funding sources for early-stage scientists, many of whom go on to be awarded National Institutes of Health (NIH) grants.

Hearing Restoration Project (HRP) research published: Many HRP scientists published HHF-funded research in scientific journals, demonstrating progress toward our goal of a cure and reinforcing the value of the collaborative research approach.

Research briefings and events launched: This new series of live-video webinars provided up-to-date research updates and opportunities to interact directly with our HRP researchers. These webinars, as well as HRP research events in cities around the U.S., were interactive, engaging, and very well received.

Safe and Sound: A Partnership With a Purpose: HHF and Puro Sound Labs, a consumer headphone company, joined forces to spread the word about responsible listening, hearing loss prevention, and the importance of hearing health. Puro Sound's

wireless headphones use advanced background noise reduction, studio-quality sound, and a built-in volume limiter to allow listeners to enjoy music safely.

Taking Action Made a Difference: The Centers for Disease Control and Prevention (CDC) issued a report in August 2015 on the prevalence of disabilities in the U.S. that excluded hearing loss. HHF took action, and others, including many of you, joined our efforts; 8,500 people signed our petition that was sent to White House representatives. The result was positive; the CDC issued a statement that changes are underway.

Volunteers Connecting for a Common Cause:

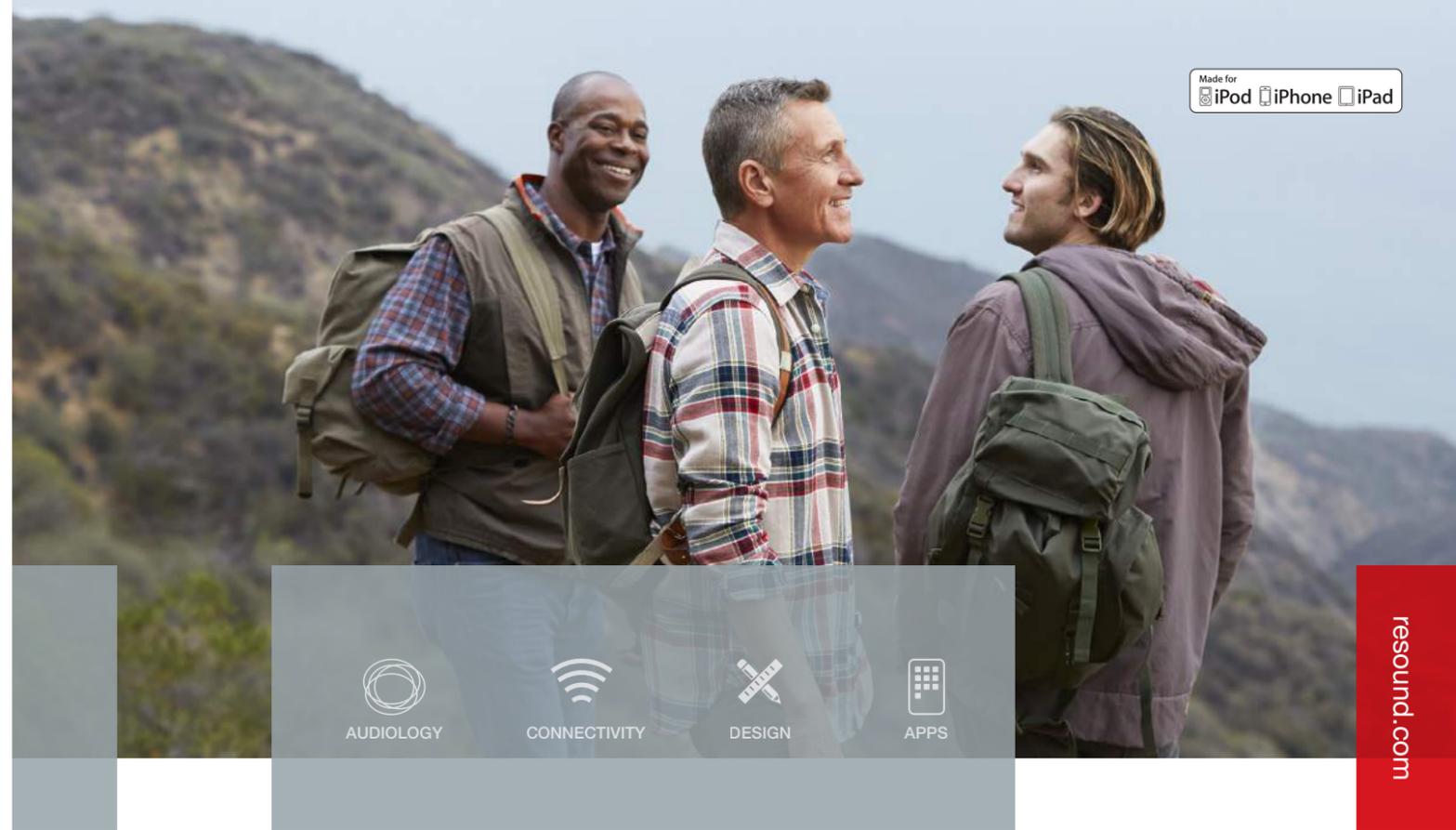
- **HHF's New York Council:** Parents of children and adults with hearing loss and tinnitus organized "Stand Up for Hearing Loss," an evening of comedy at The Stand in June 2015. Supporters and friends enjoyed this evening of stand-up comedy in pursuit of a cure for hearing loss and tinnitus.
- **Los Angeles Ambassadors' Council:** Following a successful HRP research event at the home of the president of NBC Entertainment in October 2015, a group of business executives and people with a connection to hearing loss have come together to raise awareness and funds for HHF through local events. Another event is currently in the works.

In 2016, we will build upon these achievements by funding innovative research and sharing the latest published papers from our HRP and ERG scientists, hosting live webinars and local events, developing new partnerships with companies and organizations that understand the importance of hearing health, and much more. With your continued support, HHF is moving full steam ahead, making progress toward our ultimate goal of a cure for hearing loss and tinnitus. We wish you a very happy, healthy 2016.

Sincerely,

Claire

Claire Schultz
CEO
Hearing Health Foundation



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DOING THE RIGHT THING FOR THE RIGHT REASONS

Whether the issue is micro-personal or mega-policy, organizations and the people behind them are working to engender change for those with hearing loss.

By Kathi Mestayer

ON A PERSONAL LEVEL, advocacy can be tough to rationalize. For example, why would I, or someone else, go through the trouble of filing a complaint with the Federal Communications Commission (FCC) about nonsensical captions on a rerun cop show aired on a cable channel? I tell myself that it's a public service—for everyone who uses captions. Plus, I want to see advocacy in action.

After getting the data I needed (show, time, channel, air date, cable provider), I went to the FCC's website and filled in the blanks. Within a week, a couple of technicians from my cable provider were sitting in front of my TV, watching the unintelligible captions with me. They shook their heads in disbelief, and took videos with their smartphones.

Within a week, the problem was fixed.

FROM MICRO TO MACRO

Fortunately, there are lots of ways to support accessibility and other issues for people with hearing loss, ranging in complexity from trivial to overwhelming, and in scale from micro-personal to mega-policy.

There is a dynamic group of organizations, agencies, and individuals committed to our issues. In addition to

Hearing Health Foundation (HHF), the publisher of this magazine (see "Funding Research for Nearly 60 Years," page 10), the biggest players include the Hearing Industries Association (HIA), the Hearing Loss Association of America (HLAA), and the National Institute for Deafness and Other Communication Disorders (NIDCD). The activities of these groups (and a host of others) include supporting policy changes, organizing grassroots groups with shared goals, educating the public, and supporting research that informs and focuses these efforts.

HEARING AID AFFORDABILITY

Making hearing aids and other assistive technologies more accessible and affordable is a top priority for many of these groups. One barrier is the cost of hearing aids—often not covered in full by health insurance.

The HIA is one of the leading proponents of current legislation, called the Hearing Aid Tax Credit bill, and starting in 2004 released "A White Paper Addressing the Societal Costs of Hearing Loss and Issues in Third-Party Reimbursement." Updated annually, the white paper has the support of a broad consortium of organizations including the HLAA, HHF, and the American Academy

of Audiology, an association of hearing healthcare professionals.

The proposed bill, as currently written, would provide a tax credit of \$500 per hearing aid once every five years. (One hearing aid ranges in cost from \$500 to \$3,000, according to 2015 data from Consumer Reports.) The tax credit would not apply to those who have insurance or other coverage for hearing aid costs, or whose adjusted gross income is more than \$200,000 annually. "There is broad support for the legislation," says Andy Bopp, the HIA's executive director.

For Bopp, being adaptive is central. "The pot gets stirred with every election. New senators and representatives come to Washington, and others retire, so you must constantly advocate for your cause," he says. "Some Congressional hearing champions have hearing loss, or have family members who do. Most are inspired to support the Hearing Aid Tax Credit based on vocal support from constituents back home." (To learn about different ways to help pay for hearing aids currently, see the column "Hearing Aids 101" on page 32.)

FOCUSED ON ACCESSIBILITY

"Our big issue over the long run is accessibility for people with hearing loss, regardless of technology or the venue," says Lise Hamlin, the HLAA's director of public policy. "Although the market, technology, and policies are constantly changing, that priority is not going away."

In addition to supporting the tax credit bill, the HLAA has taken the lead in proposing an amendment to Medicare to cover hearing healthcare, such as hearing exams for prescribing and fitting hearing devices, coverage of the hearing instruments themselves, and auditory training.

Hamlin says that one of the biggest accessibility game-changers was the enactment of CVAA, the 21st Century Communications and Video Accessibility Act of 2010. In addition to other provisions, CVAA directs the industry to consult with consumers and tightens deadlines for the FCC to respond to consumer complaints (which may explain why I got such quick service from my cable TV provider!).

HLAA members play an important role, too. "Our membership base gives us a way to get the word out, and

generate support," says Hamlin. "Issues flow from us to the chapters but also from the chapters to us, as well as between chapters. Over time, things bubble to the top and change in unexpected ways."

The HLAA has been able to gather and share data using member surveys, on issues like hearing aid compatibility and news captioning. It has also supported equality in the workplace, such as assisting the efforts of Dan Carione, a New York City policeman forced into retirement for wearing hearing aids to treat hearing loss he sustained on the job. (For his story, see page 31.)

BASED ON FACTS

All of this activity needs to be built on a solid base of facts. That's where the NIDCD, part of the National Institutes of Health, comes in. The NIDCD conducts and supports biomedical and behavioral research and research training in the processes of hearing, balance, taste, smell, voice, speech, and language.

In 2009, the NIDCD convened a working group on "Accessible and Affordable Hearing Health Care for Adults with Mild to Moderate Hearing Loss," which brought together researchers, federal agencies, and other institutions. The goal of the working group was to develop a research agenda to increase accessibility and affordability of hearing healthcare for adults with mild to moderate hearing loss, including accessible and low-cost hearing aids.

Amy Donahue, Ph.D., the deputy director of the Division of Scientific Programs at the NIDCD, cochaired the event. "We started with the premise that access is absolutely about more than affordability," she says. "So we talked about how, for example, hearing screenings, emerging technology, and consumer choices have an impact."

The result was a prioritized list of more than 70 research needs. "The sheer number of recommendations

was testament to the complexity of the problem, and the potential ways to address it," Donahue says. (The full list is available on the NIDCD's website.)

Recommended research topic areas included emerging technologies, such as automated screening for hearing loss, the use of smartphones, and telemedicine; barriers to screening in various healthcare settings; and the minimum technology level for hearing aid success in elderly adults.

"Access is absolutely about more than affordability. So, for example, hearing screenings, emerging technology, and consumer choices have an impact."

Since the 2009 workshop, the NIDCD has supported more than 20 research projects undertaken by various organizations. One such study the NIDCD helped fund was the National Hearing Test Project. According to a November 2014 story in the journal *Hearing Review*, an inexpensive hearing test by telephone was able to assess an individual's hearing in 10 minutes and successfully identified those who needed a follow-up hearing test by an audiologist.

The study also investigated the type and extent of follow-up needed to ensure that those who fail the test seek professional hearing services.

The National Hearing Test Project addresses one important goal of NIDCD-funded research. Since early identification of hearing loss is a critical first step to getting treatment, the NIDCD supports research projects that are exploring how to make sure hearing screenings are part of routine medical exams; whether portable hearing test "kiosks" at community events like health fairs can boost testing; and how consumers make decisions about whether to pursue hearing healthcare.

"Ultimately, we want to improve public health by providing evidence-based approaches to increase access to hearing healthcare, including hearing aids, for the people who need it," Donahue says.

BACK TO MICRO

The projects, organizations, and people described here have a huge impact in promoting hearing health. And they are joined by a growing number of other organizations working, side by side, on all aspects of accessibility and affordability.

And, still, there's always a role for that single person with a desire to make things work like they ought to—for everyone. Read about advocacy on the grassroots level, recounted by the individuals who brought about the changes, starting on page 28. 

Staff writer Kathi Mestayer serves on advisory boards for the Virginia Department for the Deaf and Hard of Hearing and the Greater Richmond, Virginia, chapter of the Hearing Loss Association of America. She writes about the science of sound at beaconreader.com/kathi-mestayer.

SHARE YOUR STORY: What would affordable hearing aids mean to you? Are you able to take care of your hearing healthcare needs? Tell us at editor@hearinghealthmag.com.



SUPPORT A CURE: HHF.ORG/DONATE

Funding Research for Nearly 60 Years

Hearing Health Foundation, the publisher of this magazine, has worked with all three of the groups mentioned in this story in areas of research, prevention, and advocacy. Since 1958, HHF has been the largest nonprofit funder of hearing and balance research in the U.S., funding science through our Emerging Research Grants (ERG) program. ERG research has led to cochlear implant technology and many of today's standard treatments for otosclerosis (abnormal bone growth in the ear) and ear infections.

The primary aim of the ERGs is to support early-stage researchers. "The ERG program is like a dress rehearsal for a career as an academic scientist," says Elizabeth Keithley, Ph.D., who reviewed grant proposals for HHF in the 1990s and is now chair of HHF's Board of Directors. "When these scientists receive

funding from HHF, they have the opportunity to develop their own ideas. The best path to achieving a world where everyone can hear is to continue bringing new people with their innovative ideas into the field of hearing and balance research."

It was ERG-funded research that led to the discovery that chicks can regenerate their inner ear hair cells after they are damaged, thus retaining their hearing. The Hearing Restoration Project (HRP), launched in 2011, is applying this knowledge and using a consortium model to bring together the best minds in hearing research to find a cure for hearing loss and tinnitus. A review of recent research discoveries by HHF-funded scientists starts on page 18.



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President Barack Obama greets Ratnanather at the White House in June 2015.



Mentoring the Future

Tilak Ratnanather, D.Phil., received a Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring, an outstanding recognition from the White House. An associate research professor at Johns Hopkins University, Ratnanather describes how he came to understand the critical role mentors play, especially for those with hearing loss, in the fields of science, technology, engineering, and mathematics.

By Tilak Ratnanather, D.Phil.

PHOTO COURTESY THE WHITE HOUSE PRESS OFFICE

In the late '80s I was a graduate student completing a doctorate in mathematics at the University of Oxford in the U.K. One Friday afternoon when nothing was going right, I stumbled on an announcement about a mathematical biology seminar on the topic of cochlear fluid mechanics. Looking at my watch, I realized I was a few minutes late but ran to the seminar. An hour later I knew what I could be doing for the rest of my life.

My Ph.D. research was in the numerical analysis of fluid flows, but up to that point it hadn't even occurred to me that I could model this flow in the cochlea—a fluid flow that allows us to hear soft sounds at certain frequencies.

While I did postdoctoral work in London, I had an opportunity to visit Bell Labs in New Jersey in 1990. That same year, I attended the Centennial Convention of the Alexander Graham Bell Association for the Deaf and Hard of Hearing (AG Bell) in Washington, D.C.

There I heard William Brownell, Ph.D., discuss his famous discovery of cochlear outer hair cell electromotility—which is now regarded one of the important factors behind the remarkable frequency sensitivity and selectivity of mammalian hearing. A brief conversation with him resulted in my moving to Johns Hopkins University, where he was conducting research, the following year.

It was also at the convention where I came across this statement from the 1989 Strategic Plan of the then-newly established National Institute on Deafness and Other Communication Disorders (NIDCD):

“The NIDCD should lead the NIH [National Institutes of Health] in efforts to recruit and train deaf investigators and clinicians and to assertively pursue the recruitment and research of individuals with communication disorders. Too often deafness and communication disorders have been grounds for employment discrimination. The NIDCD has a special responsibility to assure that these citizens are offered equal opportunity to be included in the national biomedical enterprise.”

I was born with a profound hearing loss. When I read this statement I realized I could become a role model for other scientists with hearing loss working in science, technology, engineering, and mathematics (STEM). I wanted to leverage my experience as the first person with profound congenital hearing loss in the world to obtain a Ph.D. in mathematics and the first to pursue postdoctoral research in the auditory sciences.

A Quarter Century Ago

In 1992, at the first Annual Midwinter Meeting of the Association for Research in Otolaryngology (ARO)—now the premier meeting in hearing research—I began

my advocacy mission. I suggested accommodations, such as assistive listening devices (e.g., FM systems and real-time subtitles), for people with hearing loss who were attending. (Over the years, it's become clear that attendees who are non-native English speakers with typical hearing benefit from these accommodations as well.)

In 1992, there were three researchers at ARO with hearing loss. Besides me, there was Henry Adler, soon to be the first American with hearing loss to get a Ph.D. in auditory sciences; and Vivek Kamath, who would in 1995 coauthor with Robert Shannon, Ph.D., one of the most famous papers in cochlear implant research, in the journal *Science*. One late night, over a case of beer, the three of us launched our informal ARO group for scientists with hearing loss, called Hearing-Impaired ARO (HI-ARO). A year later we were joined by Peter Steyger, the first European with hearing loss to get a Ph.D. in auditory sciences.

HI-ARO brings together undergraduates, graduates, postdoctoral fellows, research scientists, and faculty with hearing loss doing research in auditory sciences. Now there are about 50 members, including seven faculty from the U.S. and Europe on the mailing list and 15 to 20 people attending our HI-ARO dinner at the ARO meeting.

Young members benefit from discussions on navigating the educational system, seeking postdoctoral mentors, obtaining a faculty position, and advocating for support services such as captioning in a positive manner. Older members network with their colleagues to obtain laboratory experience for the younger ones.

Our connection with HHH stems from this time. In the early 1990s, I received an ERG for my research involving the computer modeling of cochlear outer hair cell mechanics; later Steyger joined HHH's Council of Scientific Trustees; and Brownell, who convinced me to move to Johns Hopkins, is on HHH's Scientific Advisory Board.

In parallel, since 1994 I have worked with AG Bell to provide information about STEM for teens and young adults with hearing loss. Activities include serving on AG Bell's College Financial Aid Committee since 1996 and as cochair of its Research Symposium since 2004. In these roles I am able to recruit students with hearing loss to do research in STEM, and inform parents and educators of children who have hearing loss that with cochlear implants (CIs) and digital hearing aids anything is possible, including careers in STEM.

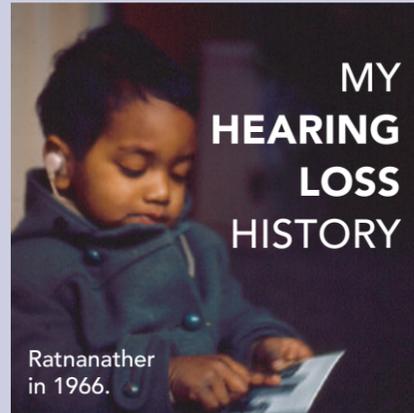
Former mentees include Lina Reiss, Ph.D., and Dominic Pisano, M.D. Lina became the first person

who is congenitally deaf to get a doctorate in biomedical engineering, and she was an ERG recipient in 2012 and 2013. She went on to win funding from the NIDCD for her work on hybrid CIs, which make use of residual hearing ability. Dominic is one of an unprecedented four Johns Hopkins students and four others with hearing loss I worked with in my lab before completing medical school. Over the years I've had 15 personally pass through my lab and through HI-ARO have impacted more.

Still Underrepresented

However, the picture for people with hearing loss in STEM is not at all that rosy. A critical factor is the preparation of students attending higher education institutions that cater to those with hearing loss. The number of students at these institutions is on average 3,000, a fraction of the 417,000 attending college overall in the United States.

The specialist institutions tend to focus on preparing



I was born in 1963 in Ceylon, now known as Sri Lanka, and was about 5 months old when my grandmother noticed that I did not respond to everyday sounds, such as the barking of the family dog (aptly named Fury). My mother was a pediatrician, as was my grandfather, so I was whisked off to ENT consultations. One doctor said nothing could be done until I was 5 years old!

Around my first birthday, I was given hearing aids ordered from the U.K. by an ENT surgeon. But ill-fitting ear molds meant I could not use the hearing aids. My mother sought advice from her professional colleagues in England with whom she had done postgraduate training. It became clear that I would benefit from assessment and training in England.

In London at age 18 months, I was first seen by a doctor who was a family friend and referred to the Nuffield Centre for Hearing

and Speech (now at University College London, or UCL). The head of the clinic was Dr. Edith Whetnall, who was one of several pioneers in Europe and the U.S. in early identification, diagnosis, and intervention via amplification. After my severe to profound hearing loss was confirmed, at age 20 months I was fitted with bilateral, body-worn hearing aids, which I am told I almost immediately accepted.

After a few months, Dr. Whetnall thought that I could return to Ceylon with an "auditory trainer." But the family friend, who was aware of the audiological and educational services in Ceylon, advised otherwise. As a result, my mother and I stayed and attended individual half-hourly sessions at the Nuffield Centre two to three times a week. We saw a teacher of the deaf and occasionally a speech-language therapist. At home I spent 15 to 20 minutes twice daily with my mother using an auditory trainer. The reports say I was focused, interested in the amplified sounds, and rarely refused these sessions.

At age nearly 3 years in 1966 I attended London's Woodford School for the Deaf, one of the few specialized schools in the U.K. that emphasized the development of residual hearing and an auditory oral approach. Children in small classes used group hearing aids,

and parents were closely involved in writing daily, weekend, and holiday diaries. The school (now closed) was one of the first in England to appoint a full-time speech-language therapist.

With an all-encompassing view of language development and speech, Woodford's teachers of the deaf and speech-language therapists encouraged listening and speech discrimination as well as attention to phrasing, pauses, stress, and rhythm. This approach created an enlightened, natural language, auditory-oral environment for teaching a child with hearing loss.

Just before age 11, I started at Mary Hare School, the national grammar school for children with severe to profound hearing loss, where for seven years I followed the national curriculum and eventually matriculated at UCL in 1982.

Critical factors for being able to participate in the mainstream are identification and diagnosis, early intervention, auditory stimulation, and family involvement. Because these four factors were met—revolutionary for the mid-1960s and 1970s—eventually I became the first person with a profound hearing loss to major in mathematics at UCL, and was among the top students in the class, which yielded an invitation to pursue a doctorate at Oxford. —T.R.

students for technical rather than scientific careers in STEM, despite receiving substantially funded mandates from Congress along with several training grants from the NIH and the National Science Foundation. This skewed funding means that a college student with hearing loss who has been mainstreamed has to compete with other underrepresented minorities in order to gain research opportunities in STEM.

Now—with about 10 people with hearing loss doing research in auditory science and engineering, worldwide—there is a unique opportunity to change the landscape. Striving to be the best and being exposed to cutting-edge research with these unique role models implicitly raises the bar and thus the expectations for these students.

In the next few years, HI-ARO faculty members who are in the U.S. will work with AG Bell to invite the top college students with hearing loss to obtain research experience in STEM. We believe that if the best students with hearing loss coauthor a conference abstract or a peer-reviewed paper, they will have a firmer foothold either in academia or industry and then progress to take leadership positions. ERG funding that recognizes early-career scientists can help us further this goal.

Leading by example and encouraging others to act as role models will accelerate the accumulation of people with hearing loss who are succeeding in STEM. Our goal is to help trainees with hearing loss become scientists, not technicians—there is more to (auditory) science and engineering than just learning laboratory skills.

The expanding cohort of scientists with hearing loss doing research in auditory science and engineering provides unique STEM perspectives on hearing loss. We have Lina's work in hybrid CIs and binaural hearing; the genetics research of John Brigande, Ph.D., who is a member of HHF's Hearing Restoration Project; and my upcoming research about auditory areas of the brain. I truly believe our contributions will enable all auditory scientists to develop new ways of thinking about the significance and impact of hearing research.

For references, see hhf.org/winter2016_references.

Tilak Ratnanather, D.Phil., is an associate research professor in biomedical engineering at Johns Hopkins University in Baltimore, Maryland. Ratnanather was a recipient of an Emerging Research Grant (ERG) in 1993, and has continued to champion HHF and its mission to prevent and cure hearing loss and tinnitus, along with Peter Steyger, Ph.D., another early supporter whose latest research is detailed on page 20.

Ratnanather's mentee, Dominic Pisano, M.D., served on HHF's inaugural National Junior Board (now known as the

New York Council) in 2012. Another mentee, Lina Reiss, Ph.D., was an ERG recipient in 2012 and 2013; she wrote about hybrid CIs in Winter 2014's "Turning Pixels Into Pictures," at hearinghealthmag.com. Read about recently published research by ERG grantees starting on page 24.

SPEECH BANANA



For almost 30 years, I had been functioning well in the mainstream with bilateral hearing aids and a stable hearing loss. But I decided to get a cochlear implant (CI) in my left ear, in 2012, to preempt the onset of age-induced loss of residual hearing. The difference has been like night and day. I know that auditory retraining will be a lifelong process, but I also know that being able to do so speaks to the brain's remarkable neuroplasticity.

For me, the cost of auditory training has been only partly covered by insurance in the U.S.; those with CIs in the U.K. do not get more than twice yearly sessions. These adults are literally left to their own devices!

Contrast this with infants and children who get CIs, most of whom are able to acquire language and speech skills at near-normal rates. Many adults go without auditory training on a weekly basis, rendering the CI suboptimal. Though online programs can replace and supplement in-person training, their focus is limited to words and phrases, cultivating skills relevant to the program but not necessarily to everyday life, and many are geared toward children.

So for two years, I have been leading a team of Johns Hopkins undergraduates to develop an app called Speech Banana (now available for the Apple iPad and eventually other platforms). Our hope is that adults with hearing loss will be able to learn speech comprehension, reducing the frequency of clinic visits, while also allowing for targeted in-person training; the app sends a user's progress back to the therapist.

My aim is to fill a gap in auditory training. As for the name, the region of the audiogram that shows where human speech falls is shaped just like a banana. —T.R.

SHARE YOUR STORY: Have you had an inspiring mentor who helped you manage your hearing loss at school or work? Tell us at editor@hearinghealthmag.com.



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PHOTO COURTESY OF TILAK RATNANATHER

My Mid-Career Hearing Loss (or, Mistakes I Made)



By Katherine Bouton

The vast majority of people with hearing loss in the workplace didn't start out that way. Their hearing loss probably came on gradually over a period of time, the result of noise exposure or aging. It can take a while before you are aware of a problem, and even longer before you can accept it. The timing of disclosure is affected by your psychological journey to acceptance of the loss. That journey can take a long time. On average, people wait seven to 10 years between first noticing a hearing loss and deciding to accept it and purchase hearing aids.

I discovered my initial hearing loss when I was 30, in 1978. But for the first decade after, I ignored it. I was working as a freelance magazine writer, so I wasn't at meetings or even talking much to people. In 1988, I started working for The New York Times Magazine as an editor. Back then, I literally danced around my hearing loss, keeping people on my right, my good ear.

Fast-forward to August 2001, when I turned 54. The next month, 9/11 happened. The world as we knew it changed forever. After months of intense work I developed flu-like symptoms, a ringing in my ears, dizziness, and nausea. I also was not hearing as well as I had been. The ENT ordered an MRI, tests for autoimmune disorders, the whole workup. He prescribed two weeks of high-dose steroids and recommended hearing aids—for both ears. The loss had progressed in my left ear, and I now also had moderate to severe loss in my right ear. Hearing aids were no longer an option; they were a necessity.

I remember the embarrassment and trepidation I felt when I told my boss about my hearing loss and new hearing aids. I told him the truth, that I had an unexplained but serious loss. A few years later, when he left the magazine, a colleague and I were candidates to replace him, but the other person got the job. When I realized I'd never actually been in the running, I felt demoralized and humiliated.

Was it my hearing loss? I knew it had affected my ability to jump into discussions. I sometimes couldn't follow what was said and often was reluctant to speak up because I wasn't sure what others had said. But more importantly—and it took years to realize this—I was working so hard to follow conversations and meetings that I didn't have the mental energy left over for proposing

creative projects. I was suffering from an overwhelming case of what neuroscientists call “cognitive load.”

In 2007, the Times moved to an open-plan, glass-and-steel tower. The acoustics were terrible, in the lobby, cafeteria, conference rooms—even the elevators seemed to resonate. By now, hearing loss was an undeniable presence in my daily life. As my confidence plummeted, my hearing loss grew worse. Or was it the other way around? I stayed at the magazine in a more executive oversight role, but I needed my hearing for all of the meetings. As the parameters of the job became clear—as the necessity to hear well became more a part of my work—I should have gone to management, explained my hearing loss fully and frankly, and asked them to find me a job that better suited my hearing abilities.

In October 2008, after another period of immense stress, I got sick. The buzzing in my ears was so loud the ENT had to type questions on his computer for me to read. Eventually I was ready to get a cochlear implant. An implant is pretty hard to hide—but still I tried, yanking my hair over my ears, wearing scarves.

When a company-wide buyout offer was in effect, I needed a sense of my new boss's plans. He responded with such venom about moving me out of the department that I reeled out of his office in shock. By the end of the year, my two decades at the Times were unceremoniously over.

The answer is full disclosure. Do everything you can to keep that job. Ask (or if needed, demand) the accommodations due you under the Americans with Disabilities Act. Keep a record of denied or ignored requests. Report incidents of unintentional discrimination. Keep the union rep informed, if you have one.

My mistakes were understandable, but that doesn't mean they weren't mistakes. Hopefully, you can learn something from them.  Excerpted with permission from “Living Better With Hearing Loss” by Katherine Bouton (Workman, 2015). For more, see katherinebouton.com.

SHARE YOUR STORY:
How have you handled (or not) your hearing loss at work?
Tell us at editor@hearinghealthmag.com.

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A LIFETIME OF LISTENING AND LANGUAGE

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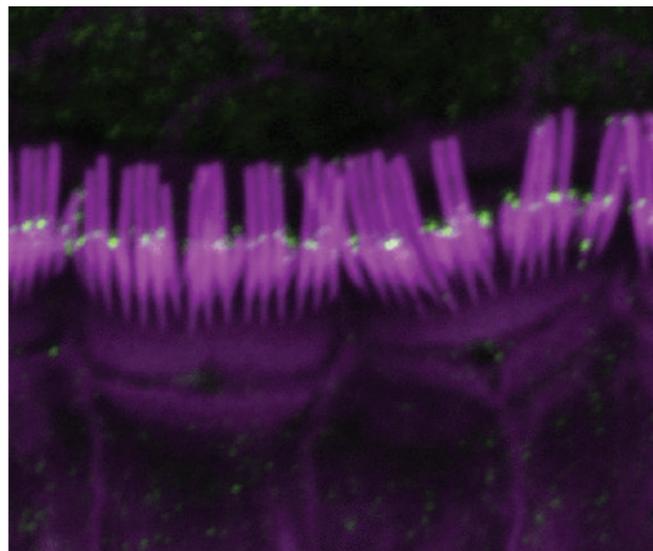


Building Key Hearing Structures

A group of researchers, including an investigator funded by Hearing Health Foundation, identifies two forms of a molecular motor protein necessary for hearing.

A research team led by scientists at the National Institute on Deafness and Other Communication Disorders (NIDCD), part of the National Institutes of Health (NIH), has discovered that a protein essential for building key hearing structures in the inner ear also plays a critical role in maintaining them throughout life. The researchers report that healthy hearing involves two distinct forms of a molecular motor protein called myosin 15 (MYO15A)—one form that helps build stereocilia, and a second, much longer, version of the protein that is needed to maintain them. Stereocilia are the finger-like projections that extend from the surface of hair cells, the inner ear’s sensory cells.

The discovery could lay the foundation for new approaches to preserve hearing and prevent or minimize the most common forms of hearing loss. Approximately



The larger form of myosin 15 (green) is found in the shorter rows of mouse hair cell stereocilia (magenta). New evidence indicates that this larger version of myosin 15 is involved in maintaining the shorter stereocilia, which play a key role in detecting sound.

15 percent of Americans (26 million people) between the ages of 20 and 69 have high frequency hearing loss due to exposure to noise at work or during leisure activities.

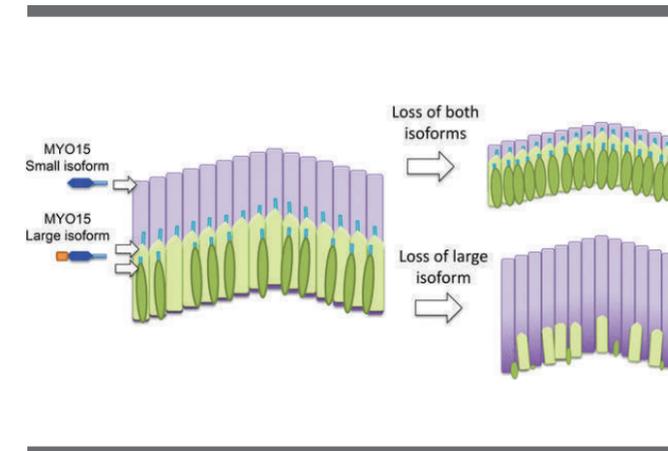
The study published in the journal *eLife* in October 2015 was a collaboration between the NIDCD, the University of Michigan Medical School Department of Human Genetics, and the University of Kentucky. The new work builds upon decades of research to understand the formation and function of stereocilia by NIDCD scientists and others (including coauthor Mirna Mustapha, Ph.D., funded in 2007 and 2008 through HHF’s Emerging Research Grants program).

Stereocilia are like antennae, sensing sound waves passing through the ear and converting them to electrical signals that are transmitted to the brain. They are arranged in rows of increasing length on the hair cell surface, forming a staircase-like structure that is critical to their function.

Researchers have previously shown that some mutations in myosin 15 stunt stereocilia growth and prevent them from reaching their normal height, causing profound deafness. Scientists believe that myosin 15, which like other motor proteins can move around the cell, helps to build stereocilia by delivering critical component parts.

The current study was prompted by an earlier discovery of an unusual, deafness-associated mutation in the myosin 15 gene in a large Pakistani family (reported in the *European Journal of Medical Genetics* in 2012). Previously studied myosin 15 mutations lie in the latter half of the gene, but this mutation lies toward the front of the gene. The affected family members did not have as substantial a hearing loss as expected based on work with the earlier mutations. This difference led the scientists to wonder if there were two forms of myosin 15, each with a separate function in the inner ear.

The structure of the myosin 15 gene also suggested to the researchers that it could produce two forms of the



Far left: This illustration shows the three rows of stereocilia in a normal hair bundle; the first row (dark green) is the shortest and the third row (purple) is the tallest. This height difference results in a staircase-like structure. The stereocilia in the first two rows mediate the process of mechanotransduction, and the larger form of myosin 15 localizes to the tips of these stereocilia; the smaller form is found primarily in the taller stereocilia in the third row. The difference between the two forms of myosin 15 is that the larger form has an extra region (orange) at its N-terminus. **Near left:** When both forms are defective or absent, the stereocilia in the third row do not reach normal height (top). If the N-terminal extension in the larger form is absent in mice, hair bundles develop normally but some stereocilia in the first two rows degenerate in older animals (bottom).

protein—a full-length form and a shorter form, lacking the front end. The novel mutation would only affect the longer version, leaving the shorter one intact. This could explain why the associated deafness was slightly less severe than for the previously studied mutations, which would damage both forms.

To further explore the possibility that there are two versions of myosin 15 involved in hearing, the researchers altered the gene in mice to have the same mutation as the unusual one found in the Pakistani family. Like their human counterparts, these mice produced the shorter form but lacked the longer one. By comparing them to normal mice and to mice missing both forms, the researchers would be able to distinguish any unique functions associated with each version.

When they examined the mice with the altered gene, they found that early on, these mice could hear loud sounds in their most sensitive frequency range, but by 4 to 6 weeks, their hearing had quickly progressed to profound deafness. These findings mirrored the researchers’ observation that the mice’s hair cells initially produced typical staircase-shaped arrays of stereocilia, but that over time, progressively lost the shorter stereocilia “steps” at the bottom.

“We were shocked when we first looked at the young mice and saw that the stereocilia appeared normal,” says Jonathan E. Bird, Ph.D., the communicating author and a postdoctoral fellow in the NIDCD Laboratory of Molecular Genetics. “The other mouse models, which lack both versions of myosin 15, produce stunted stereocilia from the beginning, so we knew right away that something completely different was going on here.”

The results revealed that while the shorter version

of myosin 15 is sufficient for the construction of the stereocilia staircase, the longer version plays a critical role in maintaining it. Imaging studies showed that the shorter form is produced predominantly early in development throughout the staircase, while the longer form is largely made later and localizes to the shorter rows, providing further support for their distinct roles.

Together, the findings show that myosin 15, through its dual forms, not only helps construct the stereocilia staircase of hair cells, but also works to maintain them, a process that until now has been poorly understood.

“We know that noise-induced damage to stereocilia is a major contributor to age-related hearing loss,” says Thomas B. Friedman, Ph.D., the chief of the NIDCD Laboratory of Molecular Genetics. “By digging deeper and learning more about the mechanisms used by myosin 15 to maintain stereocilia, we may be able to find ways to enhance the process and possibly preserve hearing to some extent in the later years.”

For references, see hhf.org/2016winter_references.

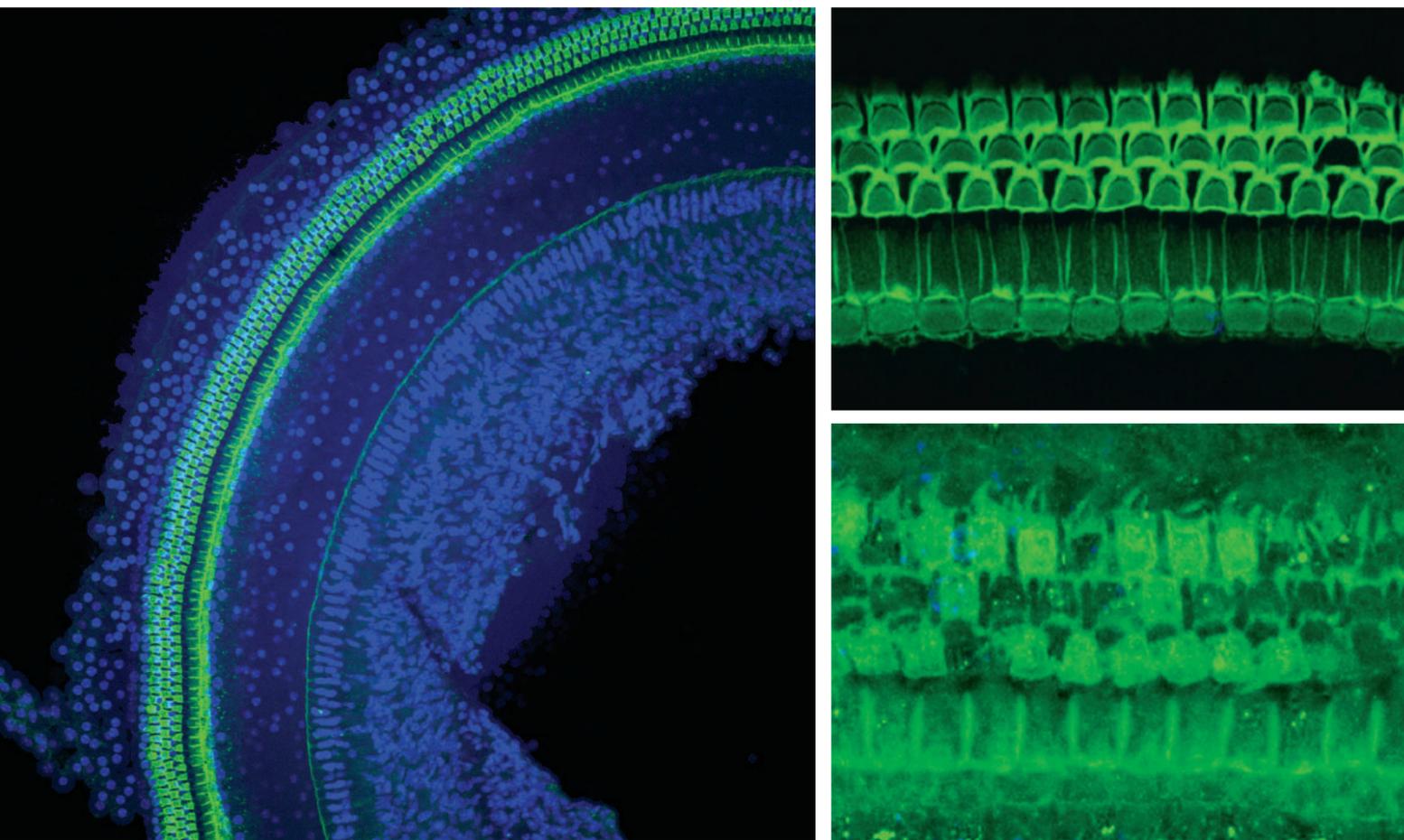
Reprinted with permission from the NIDCD. This work was supported by funds from the NIDCD intramural research program (DC000039–18 and DC000048–18); NIDCD extramural funds (R01–DC005053, R01–DC008861, P30–DC005188); Hearing Health Foundation; a University of Michigan Barbour Scholarship; and a James V. Neel Fellowship. Coauthor Mirna Mustapha, Ph.D., the recipient of Emerging Research Grants in 2007 and 2008, heads the Mustapha Lab at Stanford University School of Medicine.

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PHOTO CREDIT: JONATHAN E. BIRD AND THOMAS B. FRIEDMAN, NIDCD/NIH (LEFT); ILLUSTRATION COURTESY OF ELIFE

Lifesaving Antibiotics, But Lifelong Consequences

The risk of hearing loss from an antibiotic used worldwide is much greater than previously thought, according to Peter S. Steyger, Ph.D., a member of HHF's Council of Scientific Trustees.



Above left: The four rows of hair cells in green surrounded by supporting cells in the organ of Corti in the mouse cochlea. **Above right, top:** The intact organ of Corti showing three rows of outer hair cells, and one row of inner hair cells. **Above right, bottom:** A damaged hair cell region with missing hair cells after treatment with kanamycin, an aminoglycoside antibiotic.

Seeking to stem the tide of permanent hearing loss from the use of lifesaving antibiotics, researchers at Oregon Health & Science University (OHSU) have found that patients stricken with dangerous bacterial infections are at greater risk of hearing loss than previously recognized. Inflammation from the bacterial

infections substantially increased susceptibility to hearing impairment by increasing the uptake of aminoglycoside antibiotics into the inner ear, the researchers report. Their findings were published in the journal *Science-Translational Medicine* in July 2015.

“Currently, it’s accepted that the price that some

PHOTOS COURTESY OF
OHSU COMMUNICATIONS

patients have to pay for surviving a life-threatening bacterial infection is the loss of their ability to hear,” says Peter S. Steyger, Ph.D., a professor of otolaryngology–head and neck surgery at the Oregon Hearing Research Center, OHSU School of Medicine, and a member of Hearing Health Foundation’s Council of Scientific Trustees. “We must swiftly bring to clinics everywhere effective alternatives for treating life-threatening infections that do not sacrifice patients’ ability to hear.”

Steyger adds, “Most instances in which patients are treated with aminoglycosides involve infants with life-threatening infections. The costs of this incalculable loss are borne by patients and society. When infants lose their hearing, they begin a long and arduous process to learn to listen and speak. This can interfere with their educational trajectory and psychosocial development, all of which can have a dramatic impact on their future employability, income, and quality of life.”

Aminoglycosides—antimicrobials that are indispensable for treating life-threatening bacterial infections—are toxic to the ear. Relied on by physicians to treat meningitis, bacteremia, and respiratory infections in cystic fibrosis, aminoglycosides kill the sensory cells in the inner ear that detect sound and motion. Infants in neonatal intensive care units (NICUs) are at particular risk. Each year, about 80 percent of 600,000 newborns admitted into NICUs in the United States receive aminoglycosides. The rate of hearing loss in NICU graduates is 2 to 4 percent compared with 0.1 to 0.3 percent of full-term births from congenital causes of hearing loss.

When Steyger and colleagues gave healthy mice a low amount of aminoglycoside, the mice experienced a

small degree of hearing loss. If the mice had an inflammation typical of the infections treated with aminoglycosides in humans, the mice experienced a vastly greater degree of hearing loss.

The study lays the groundwork for improving the standard of care guidelines for patients receiving aminoglycosides. To shield patients’ hearing, the researchers called for the development of more targeted aminoglycosides and urged clinicians to choose more targeted, nonototoxic antibiotics or anti-infective drugs to treat patients stricken with severe infections.

Due to their widespread availability and low cost, aminoglycosides are used frequently worldwide. Clinical use of aminoglycosides is limited due to the known risk of acute kidney poisoning and permanent hearing loss, yet they are crucial lifesavers in cases with potentially fatal infections.

Reprinted with permission from Oregon Health & Science University. Peter S. Steyger, Ph.D., is a member of HHF’s Council of Scientific Trustees, which he chaired, and also a former HHF board member. Read about Steyger’s earlier aminoglycosides research in Spring 2012’s “Drug-Induced Deafness,” at hearinghealthmag.com, and his connection with other scientists with hearing loss working in auditory research, on page 12.

*The authors of “Endotoxemia-Mediated Inflammation Potentiates Aminoglycoside-Induced Ototoxicity,” published in *Science-Translational Medicine*, include Steyger; Ja-won Koo, M.D., Ph.D.; Lourdes Quintanilla-Dieck, M.D.; Meiyang Jiang, Ph.D.; Jianping Liu, M.D., Ph.D.; Zachary D. Urdang; Jordan Allensworth; Campbell P. Cross; and Hongzhe Li, Ph.D. (a 2010 Emerging Grant Recipient).*

This research was supported by: National Research Foundation of Korea grant 2011-0010166; Seoul National University Bundang Hospital 03-2011-007 (J.K.W.); National Institute of Deafness and Other Communication Disorders R01 DC004555, R01 DC12588 (P.S.S.), R03 DC011622 (H.L.), and P30 DC005983; and the Department of Otolaryngology at OHSU (L.Q.D.).

“We must swiftly develop effective alternatives for treating life-threatening infections that do not sacrifice patients’ hearing.”



Steyger received an aminoglycoside antibiotic to treat meningitis at age 14 months. It saved his life but left him with severe to profound hearing loss.

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Where We Are, and

Where We Are Going

Hearing Health Foundation's Hearing Restoration Project (HRP) is an international research consortium comprising 14 leading scientists in the hearing and balance space. They are collectively searching for a biological cure for hearing loss and tinnitus through inner ear hair cell regeneration.

The HRP has three phases of research. Phase I, underway since our inception in 2011, uses "discovery science" methods to identify molecules that may be involved in hair cell regeneration. Phase I also includes bioinformatics (the analysis of discovery data), which allows us to compare results from different experiments with our three different model systems (fish, bird, and mammalian hair cells).

Last year marked the HRP's foray into Phase II, testing candidate molecules found in Phase I to determine if they are truly part of the regeneration response in fish or birds or if they block regeneration in mammals. Phase II projects are very important, both for validation of the data from Phase I and for the transition to Phase III. Phase III involves screening for drugs that can stimulate hair-cell regeneration.

The HRP meets annually in person each fall in Seattle. In this article we review accomplishments and next steps from the meeting held November 15–17, 2015.

For HRP consortium members, our annual in-person meeting is the highlight of the year. The two days of exchanging information often leads to fresh insights into our data and stimulates dialogue about new research areas for future pursuit.

On the first day of the meeting, investigators of the 2015 funded projects discussed the significant progress made. The Phase II project by the University of Washington's Jennifer S. Stone, Ph.D., and David Raible, Ph.D., along with Andy Groves, Ph.D., of Baylor College of Medicine, was successful in using a system known as CRISPR/

Cas9 to test genes in zebrafish, and then extending those observations to mice and chicks.

In addition, the Phase I project of single-cell transcript analysis by Stefan Heller, Ph.D., of Stanford University, is nearing completion, which will allow us to see the molecules used during hair cell regeneration in chicks.

We also discussed several ongoing projects, most importantly the X-cells project, which arose out of the 2014 annual HRP meeting (see Spring 2015's "Examining X-Cells," at hearinghealthmag.com). Several HRP investigators had noticed that cells with some characteristics of hair cells, which we dubbed X-cells, could be seen weeks or months after damage to the mouse cochlea that had fully eliminated hair cells. The consortium was excited, as X-cells could be supporting cells that had begun to turn into hair cells, but were unable to fully turn into hair cells. After finding that these cells proved to be rare and that their properties were difficult to define, it was agreed that research into X-cells should not receive additional HRP funding.

However, the X-cell observations are important and notable, and having the research published would be a service for the field. This is a great example of science at its best: an unexpected observation, followed by experiments to test whether the observation is relevant. It's worth noting that I expect that the number of HHF-supported research papers from HRP consortium members will substantially increase in 2016 and beyond. Publishing the HRP's work is important because dissemination of research is considered a major benchmark of progress and defines success within the scientific community.

One of the key goals of the meeting was to have strategic, forward-looking discussions. We agreed that the consortium needs to focus on additional discovery experiments; deeper bioinformatics analysis of existing data; and the development of suitable model systems for testing candidate pathways. Biological processes usually follow pathways, which are sequential steps that transform a signal or chemical from one state to another. We hypothesize that there are pathways in bird and fish hair cells that promote hair cell regeneration, and pathways in mammalian hair cells that prevent it.

The key objective in stimulating hair cell regeneration in humans is to understand which pathways are relevant. Do humans lack pathways that promote regeneration, or do they have an overly active pathway that inhibits it? Our next steps depend on addressing this question.

Consortium members proposed two new methods for testing pathways, which include specialized methods for turning on genes in the mouse ear and assessing the

growth and differentiation of supporting cells in vitro. In addition, the consortium endorsed continued support of a separate Raible-Groves-Stone project (different from the X-cells project previously mentioned) that tests pathways in fish (using CRISPR, an extremely precise gene manipulation method), in genetically modified mice, and in birds, using drugs that activate or disrupt pathways.

Our November 2015 meeting capped off a very active year of research for the HRP consortium and set the stage for exciting research in the coming year. The more we learn about hair cell regeneration, the more we see how complex the challenge is. It is important to remember the HRP has made significant progress toward our goal—we are getting closer to finding the key to unlock a cure for hearing loss and tinnitus.

For more details about the HRP projects cited here, see hhf.org/curing_hearing_loss.

Peter G. Barr-Gillespie, Ph.D., is the scientific director of the HRP consortium and a scientist at the Vollum Institute at Oregon Health & Science University.

HHF Is Reaching Out

HHF has launched a number of research-focused outreach initiatives. These include quarterly letters from the HRP's scientific director, Peter G. Barr-Gillespie, Ph.D., on HRP developments, as well as events and webinars featuring either Barr-Gillespie or an HRP scientist presenting on the group's research findings and progress. We held two such webinars over the past year.

In addition, we have partnered with HRP members' universities in providing layman's summaries of their published research funded by HHF. A new "Spotlight On" series further connects supporters to our HRP consortium researchers. (To see transcripts from the webinars and the "Spotlight On" series, please visit hhf.org.)

As we ask you to stay tuned for ongoing updates in 2016, we'd like to sincerely thank you for your continued support of HHF and the HRP.

Your help is our hope.



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These published papers by recent Emerging Research Grant (ERG) recipients underscore the importance of supporting early-career hearing and balance scientists as they bring fresh approaches and critical thinking to determine answers to complex questions.

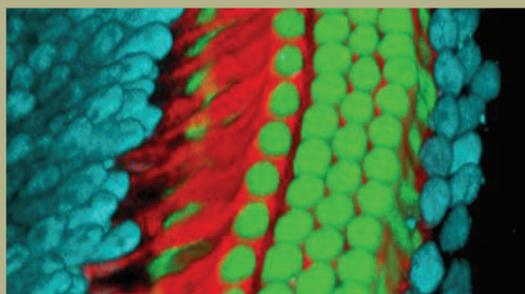
RESEARCH ROUNDUP

Michigan and Harvard Medical School who was funded by the Wesley H. Bradley, M.D., Memorial Grant.)

But their more remarkable discovery was that if supporting cells are lost in the newborn mouse, the ear rapidly regenerates new supporting cells—and hearing is completely preserved through adulthood.

They found that the inner border and inner phalangeal cells—the two types of supporting cells surrounding hair cells—play a greater role in the restoration of hearing than previously thought.

The existence of this intrinsic regenerative ability of the supporting cells in the very early days of life presents a new potential area to be harnessed to cure hearing loss. The next step is to identify molecules responsible for regeneration and to eventually “turn back the clock” to induce regeneration of these critical supporting cells.

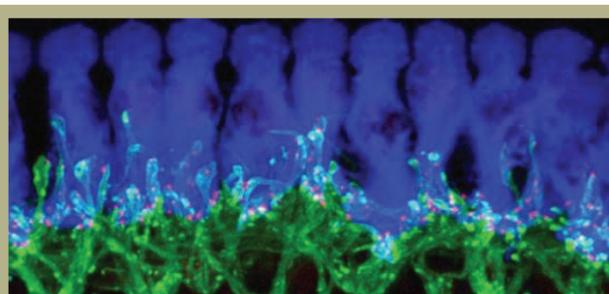


This microscopic view of cells deep within the ear of a newborn mouse show the supporting cells (red and blue) surrounding the hair cells (green) that send sound signals to the brain. A Proceedings of the National Academy of Sciences report says supporting cells, if damaged in the first days of life, can regenerate, allowing hearing to develop normally and giving new clues for ways to restore hearing.

Mouse Inner Ear Supporting Cells Can Spontaneously Regenerate

The cochlea, or inner ear, contains two major cell types: hair cells and supporting cells. Unlike in birds and fish, it has been known that in mammals hair cells do not regenerate after damage or loss, which results in permanent hearing loss.

Researchers reporting in the Proceedings of the National Academy of Sciences (PNAS) in October 2014 found that damage to the supporting cells in the mature mouse results in both the loss of hair cells and profound hearing loss. Hair cells and supporting cells are both needed to hear. (The investigators from the University of Michigan Medical School, St. Jude Children’s Research Hospital in Tennessee, and other institutions included Guoqiang Wan, Ph.D., a 2014 ERG recipient at the University of



From a report in eLife, this image of tissue from a normal mouse ear shows how ribbon synapses (pink) form the connections between the hair cells of the inner ear (blue) and the tips of nerve cells (green) that connect to the brain.

Scientists Restore Hearing in Noise-Deafened Mice

Scientists have restored the hearing of mice partly deafened by noise, using advanced tools to boost the production of a key protein in their ears. By demonstrating the importance of the protein, called neurotrophin-3 (NT3), in maintaining communication between the ears and brain, these new findings pave the way for research in humans that could improve treatment of hearing loss caused by noise exposure and normal aging.

The team led by Gabriel Corfas, Ph.D., of the University of Michigan Medical School’s Kresge Hearing Research

Institute and Harvard University reported the results of their work to understand NT3’s role in the inner ear, and the impact of increased NT3 production on hearing after a noise exposure, in the journal eLife in October 2014. Lead author Guoqiang Wan, Ph.D., was a 2014 ERG scientist and a coauthor of the October 2014 PNAS report about supporting cells (see opposite page).

The eLife research further demonstrates the critical role of supporting cells along with the NT3 molecules that they produce. It shows that NT3 is crucial to the body’s ability to form and maintain special connections between hair cells and nerve cells, called ribbon synapses, that allow for the extra-rapid communication of signals traveling back and forth across tiny gaps between the two types of cells. Ribbon synapses are only found in the ear and eye.

Using a special genetic technique called conditional gene recombination, the researchers made it possible for some mice to produce additional NT3 in cells of specific areas of the inner ear after they were exposed to noise loud enough to reduce hearing—and they found that mice with extra NT3 regained their ability to hear much better than the control mice. They also tested another nerve cell growth factor, or neurotrophin, called BDNF, but did not see the same effect on hearing.

Rare Gene Variant Linked to Middle Ear Infections

Why do only some people get frequent painful or chronic middle ear infections, known as otitis media? According to a June 2015 paper in the journal Nature Genetics, the reason may stem from rare genetic variants in the gene A2ML1. Lead author Regie Lyn P. Santos-Cortez, Ph.D., is an assistant professor of molecular and human genetics at Baylor College of Medicine. She was an ERG recipient in 2011 as well as 2012, when she won the Collette Ramsey Baker Research Award, an award created in memory of HHF’s founder.

In addition to researching genetics, Santos-Cortez was trained as an otolaryngologist in the Philippines. She created a family tree, or pedigree, of an indigenous Filipino community where most of the people were related, identifying those who suffered from recurrent ear infections and those who did not. Since the community shared the same environment—sources of food, water, exposures to cigarette smoke, etc.—an environmental factor was unlikely to be causing the ear infections.

Santos-Cortez and colleagues then used next-generation gene sequencing to sequence the genes of several people in the population, discovering that 80 percent of those who carry the variant in the A2ML1 gene developed otitis media. The researchers also found the same gene variant

in Galveston, Texas, among children prone to chronic ear infections. It may be that one person from outside both populations, likely from Spain, introduced the variant more than 150 years ago. The next step is understanding how the variant predisposes people to otitis media. One theory is that it appears to undermine the immune system’s response to protecting the ear from infection.

A Mouse Model to Study Mammalian Hearing Loss

Shikha Tarang, Ph.D., a postdoctoral research associate at Creighton University, was a 2014 ERG recipient funded by the Hulme family. In a February 2015 report published in Frontiers in Cellular Neuroscience, lead author Tarang and colleagues describe the creation of a novel mouse model and its potential use in studies of hair cell regeneration in the mammalian inner ear. The new mouse model overcomes what had been serious limitations of investigating the precise role of retinoblastoma 1 (Rb1), an essential gene regulating cell proliferation in many tissues and organs, including the auditory system.

Using Multisensory Cues to Make Sense

Our brain uses input from a variety of senses to process information. In a February 2015 eLife report, lead author Ross Maddox, Ph.D., a postdoctoral researcher at the University of Washington, has demonstrated how auditory and visual cues are used together. Maddox, a 2013 ERG recipient funded by the General Grand Chapter Royal Arch Masons International, and colleagues wanted to investigate how the timing of inputs affects the processing of multisensory information. They found that in everyday conditions, where listeners can often see the source of a sound, temporal cues provided by vision can help listeners to select one sound source from a mixture.

For references, see hhf.org/winter2016_references.

These briefs were prepared using materials from Baylor College of Medicine; Creighton University; the University of Michigan Health System; and the journal eLife.

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Breakthroughs in hearing and balance research would not be possible without the generosity of donors like you. HHF sincerely appreciates the support of its Emerging Research Grants program via the Wesley H. Bradley, M.D., Memorial Grant; the Collette Ramsey Baker Research Award; the Hulme family; and the General Grand Chapter Royal Arch Masons International. Learn more at hhf.org.



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PHOTO CREDITS: GUOQIANG WAN, UNIVERSITY OF MICHIGAN (FAR LEFT); CORFAS LAB, UNIVERSITY OF MICHIGAN

Let's Make Earplugs This Generation's Bike Helmet

Knowing firsthand the challenges of living with hearing loss, a parent and Hearing Health Foundation board member works to educate her children and other young people about the dangers of noise-induced hearing loss.

By Shari Eberts

“WHEN I WAS GROWING UP, we did not wear bike helmets, sunscreen, or even seat belts. And kids often sat in the front seat of the car! Today this seems crazy, given what we now know about concussions and permanent skin damage from too much sun exposure. Our parents didn't know the risks, so they could not protect us.

I'm sure that today's generation of parents is making similar mistakes in different areas, and that our children will one day look back and wonder why we did not protect them from these dangers. However, there is one risk that we know about and can take action on immediately—and that is to protect our children's hearing through the use of earplugs.

We live in an incredibly noisy world, one that seems to get noisier each day. Whether it's going to rock concerts, large sporting events, or even certain restaurants, noise levels are often so high that they can cause hearing loss. Hearing loss is permanent, and chronic tinnitus

(ringing in the ears) is another risk.

This is an immediate problem as the incidence of teens with hearing loss is already on the rise. A Journal of the American Medical Association report says one in five adolescents ages 12 to 19 shows signs of hearing loss. The ubiquitous earbuds are part of the problem, but so is exposure to dangerous noise levels at concerts, dance parties, and other social events.

According to my iPhone decibel (dB) reader, the talent show at my children's elementary school measured at 90 dB! Prolonged exposure to any noise at or above 85 dB can gradually lead to hearing loss.

These days, if things aren't loud, they are somehow deemed old-fashioned, boring, or dull. Loud has become equivalent to fun. I took my children to see the Broadway show "Wicked," but my 9-year-old son was holding his ears at certain parts until I found the earplugs I always keep stashed in my purse. A friend told me the movie "Cinderella"—a children's movie!—also felt excessively loud.

Studies have shown that when loud music is played at restaurants and bars, patrons eat and drink faster, and therefore purchase more drinks—the part of the meal with the highest margin. I can understand wanting to drive revenue, but putting your patrons and staff in harm's way is not a good option.

There have even been loudness

contests at sporting venues. The current record is held by fans at a Kansas City Chiefs game at 142.2 dB. This level—the equivalent to the sound of a jet taking off—can damage hearing in under one minute of exposure. Most stadiums don't allow smoking due to strict secondhand smoking laws. But what about secondhand hearing loss?

All this loudness is very frustrating for someone with hearing loss. Not only does it make it incredibly unpleasant, but it also makes it unsafe for everyone, often without their realizing the risk of permanent hearing loss and chronic tinnitus.

While Hearing Health Foundation works on a cure for hearing loss and tinnitus, we owe it to ourselves, and future generations, to spread the word about hearing protection and the risks from excessive noise. Together, we can help make sure wearing earplugs becomes as second nature as using bike helmets.

From 2012 to 2015, Shari Eberts served as chair of Hearing Health Foundation's board of directors, of which she remains an active member. Eberts lives with her family in New York City and blogs at livingwithhearingloss.com.

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The author with her husband and kids.

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It Starts With One Person

Each of the stories below begins with just one individual who, in taking a stand—for accessibility, equal rights, or safe noise levels—is making a difference to many.



From a Verbal Fog to Perfect Clarity

AS I SAT IN A HISTORIC ABBEY on Scotland's Isle of Iona, the worship leader's amplified words reverberated off its stone walls. When they reached my ears, the sound was a verbal fog.

A hearing assistance sign with a "T" indicated the presence of a hearing loop, a surrounding wire that magnetically transmits the sound from the public address system to a hearing aid T-coil (telecoil)—a simple \$2 sensor that now comes in most U.S. hearing aid models and all cochlear implants. When I turned on my hearing aids' T-coils, the fog instantly cleared. I was in ecstasy.

After that Iona experience, and after seeing hearing loops spread to tens of thousands of venues across Britain and Scandinavia, I wondered, why not loop America,

too? Returning home, I looped my home TV room. With the press of a button, muffled sound becomes clear. My hearing aids act as wireless speakers, delivering sound customized for my hearing loss right into my ears.

Next I asked my community in Holland, Michigan, to embrace this technology. Today, we have hearing loops in nearly every worship place and auditorium, including those of the Hope College campus, where I teach.

In nearby Grand Rapids, hearing loops have not only spread to most worship places, but also to its convention center and to Michigan's second largest airport. Down the road is America's largest hearing loop installation, the 12,200-seat Michigan State University basketball arena.

Loops also are serving people in smaller venues—at thousands of British post office windows and in all London taxis, and now at New York City subway booths and in new taxis. In all such looped venues, the telecoil transforms hearing instruments into customized, wireless,

This sign shows a loop is available.



in-the-ear speakers. With my hearing aid microphones turned off and my T-coils turned on, sometimes I can hear the spoken words better than the typical hearing folks next to me.

Thanks to the initiative of dedicated hearing advocates based in New York City, Wisconsin, and elsewhere, and with support from the Hearing Loss Association of America and the American Academy of Audiology, the momentum is growing. Hearing loops are spreading across the U.S. in places such as Arizona, California, Colorado, Florida, Indiana, Minnesota, New Mexico, New York, Utah, Washington, and Washington, D.C.

Unlike traditional assistive listening devices in the U.S.—which are incompatible with hearing aids and require locating, borrowing, and wearing conspicuous equipment that delivers generic sound—people actually use and love sound delivered directly to their own hearing devices. Although more costly to install (several thousand dollars for a modest-sized auditorium), the much greater usage means that loops often cost less per user. In a 2014 Hearing Review survey, 866 people with hearing loss were asked about their hearing loop experiences. Nearly 9 out of 10 respondents "strongly agreed" or "agreed" the hearing loop system increased their satisfaction with their hearing aid or cochlear implant.

Just 16 years from that ear-opening experience in Scotland, we can now foresee a future where hearing aids and cochlear implants will have doubled their functionality—as personal wireless speakers in all sorts of public venues. Hear ye! Hear ye! —David G. Myers

How Loud Is It?

IN EARLY 2014 MY WIFE AND I were looking for a home to buy in Los Angeles. The street traffic at our apartment was loud and we wanted to find a quiet new place. Prior to that I had rented an apartment that I belatedly discovered was down the street from a noisy, 24-hour car wash. Before we drove across town to look at a house, I wanted to find out how loud it would be if we lived there. Looking for that information online, I couldn't find anything and was quite surprised this kind of data compilation didn't already exist.

So using my background in applied math I decided to create noise-level "Soundscore" profiles of L.A. neighborhoods. I work with a geospatial specialist and a

computational math specialist to create 3D mathematical models that aggregate noise sources such as street traffic, flight routes, restaurants, auto repair shops, etc. We take into account how noise is attenuated, or reduced, as it travels through the air, and either reflected or dampened as it hits the ground or buildings. These effects also occur differently at various frequencies, so we track each frequency band separately as it travels through space. We also consider the time of day for the sources we look at.

Using this information we can produce "heat maps" of sound levels—red is noisier, green quieter, and yellow in between. The more urban activity you have, the more noise you have. Of course that's not surprising, but seeing it on a map is pretty striking.

You can type in a Los Angeles address at howloud.com and a map is generated. After a successful Kickstarter campaign, we have been working on a version for the entire U.S., available in January 2016. Eventually we intend to set up a crowd-sourced component so that people can inform us of specific sources, such as a bar that is really loud on certain nights.

We've had really exciting interest from several public health specialists who would like to study the effects of environmental noise on health but had not yet had a good data source. We have a uniform process for the entire U.S., so now they have a resource for their studies. We are also working with real estate companies, so they can offer this as another piece of useful information for their clients. As for my wife and me, we ended up



Red indicates the noisier areas in HowLoud's maps.

PHOTO CREDITS: ISTOCKPHOTO.COM/PIIDJOE (TOP); COURTESY BRENDAN FARRELL (BOTTOM RIGHT)

moving to Silver Lake in Los Angeles. And incidentally, as I write this I can hear a car alarm going off around the corner from my house. Otherwise it's pretty quiet for Los Angeles—in the morning I can hear children playing at a school nearby, but I like that. —*Brendan Farrell*

A Message in a Video

SINCE COWRITING THE SUMMER 2015 cover story, “Turn Down the Noise, Turn Up the Quiet,” there has been one concrete outcome: the creation of a public service video about the dangers of noise-induced hearing loss. The Beverly Hills Health and Safety Commission produced the video as part of its ongoing series on public health issues. I appear in part of it, and now have new respect for actors and television news reporters—it’s harder than it looks! The video was posted on the city’s website in October 2015. Watch it at beverlyhills.org or vimeo.com/141692231. —*Daniel Fink, M.D.*

Working the Network

AT THE DISABILITY RESOURCE CENTER in Fredericksburg, Virginia, Arva Priola skillfully leverages relationships to make sure the right people pay attention to accessibility issues. Priola, the center’s deaf and hard of hearing coordinator, made healthcare accessibility a priority when a local doctor’s office was taken to court by the U.S. Department of Justice (DoJ) for not providing a way to communicate with a deaf patient, which is required under the Americans with Disabilities Act (ADA). A large hospital in Virginia had also been taken to court under the DoJ/ADA’s “barrier-free healthcare initiative” a few years earlier.

Based on the lawsuits and her own experience (she wears bilateral cochlear implants), Priola knew that patients’ ability to communicate effectively is critical to positive healthcare outcomes. “We needed a statewide effort to bring our healthcare facilities into compliance with the ADA,” she says. “Healthcare costs go up when people are readmitted because they don’t understand what to do—and what not to do—when they get home. Hospitals, caregivers, patients, and families all benefit from effective communication.”

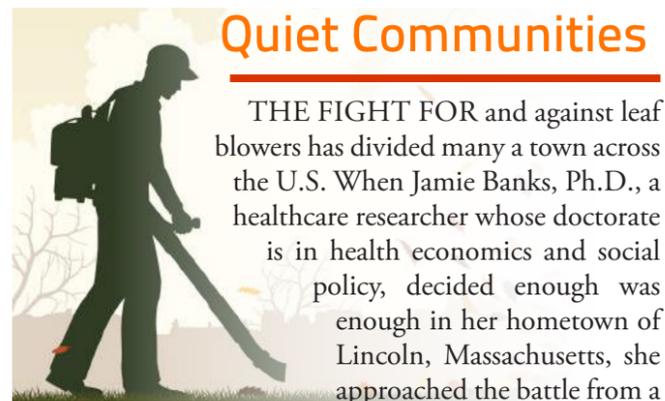
She remembered an old friend, Bobby Orrock, who now serves in the Virginia House of Delegates, whom she knew because he had taught at the high school that Priola’s children attended. Her email to Orrock started

with: “Dear Bobby: You know I do not come to you unless it is something important.”

The rest of the email highlighted recent events, enough to grab Orrock’s attention. He introduced and sponsored House Bill 1956, which was signed into law by Governor Terry McAuliffe in March 2015.

HB 1956 directs the Virginia Department of Health to “work with stakeholders to develop guidelines for hospitals to ensure that hospitals are complying with requirements of the Americans with Disabilities Act and that patients with sensory disabilities are able to communicate effectively with healthcare providers.”

As a stakeholder, Priola will continue to be involved in making HB 1956 a reality. And she’s keeping her eye out for potential supporters—including a new member of the State Senate she’s known since he was a child. “He went to the same school as my children,” Priola says. “You never know who will make a difference in the lives of people who are deaf and hard of hearing.” —*Kathi Mestayer*



health perspective and not just as a nuisance.

“We recognized the public health importance of noise and air pollution in getting town support around this issue,” Banks says. “In our town, there are people who are affected regularly—such as those who work at home or have young children—and others who are not affected. We knew we needed to educate our town population to get broad-based support for actions to curb excessive use.”

After forming a citizens’ group, Quiet Lincoln, in 2012, they convinced attendees at a town meeting to form a study committee. In addition to surveying residents, the committee looked at health and environmental effects; not only is noise an issue, but the dust kicked up by the blowers prompted warnings against them by the American Lung Association.

The group created a website with evidence-based resources and held demonstration events, recommending alternatives such as rakes, sweepers, and sustainable

landscaping, such as using the leaves for mulch and compost. Battery-powered blowers are another option. While these blowers do not eradicate the problem of dust, there are no exhaust emissions and some newer models are much quieter than their gas-powered cousins.

In addition, banning gas blowers outright may not be the answer. Most landscapers says they are more efficient and critical for their business. But restricting their use to big spring or fall cleanups and on grass only (not on hard surfaces or in planted areas) can do a lot to cut down on noise and toxic air pollution, according to Banks.

The group has expanded nationwide. “With education, training, and new technology,” Banks says, “there is no reason why our landscapes cannot be maintained cleanly and quietly.” See quietcommunities.org. —*Yishane Lee*

Fighting for a Job—and More

AFTER 26 YEARS with the New York City Police Department (NYPD), Deputy Inspector Dan Carione was forced to retire for wearing a hearing aid to treat a hearing loss—a hearing loss he sustained on the job. In 1996, the police officer experienced gunshots at close range and lost hearing in his right ear. When an assignment in 2008 placed his office close to an active elevated train line, Carione says he decided to forgo his vanity and seek the benefit of a hearing aid.

Since his hearing loss was the result of an on-duty gun battle, the NYPD paid for Carione’s hearing aid. But shortly after receiving it, in 2009, he was forced into disability retirement—at age 44. The NYPD bans the use of hearing devices, maintaining they prevent officers from fully performing their jobs because they can be compromised, such as being knocked out of the ear.

Carione and NYPD Sergeant James Phillips, who was also forced to retire for using a hearing aid, could have stopped working—with pensions—but they were in their 40s and loved their jobs. It took five years for the complaint they filed with the Equal Employment Opportunity Commission to reach the courtroom. The NYPD opted to settle on the first day of the trial, in March 2015.

By the terms of the settlement, Carione and Phillips got their jobs back. More importantly, the settlement stipulates that officers like themselves can take the officers’ fit-for-duty hearing test while using their hearing aids.

“The hearing aid ban makes no sense and is highly discriminatory,” Carione says. “Today’s hearing aids are digital wonders. They are durable and dependable. There are thousands of hearing disabled Americans

who are qualified to be police officers with the use of modern hearing aids.”

Carione says he hopes this legal victory will help veterans returning home with combat-sustained hearing loss requiring hearing aids. “They, more than anyone, deserve the opportunity of serving with the NYPD,” he says. The Hearing Loss Association of America, AARP, and veterans organizations helped support Carione and Phillips in their legal battle. —*Y.L.*

Firefighters Sue Over Sirens

NEARLY THREE DOZEN New Jersey firefighters, each with decades of employment, have sued a siren maker and five fire truck manufacturers for what they say was knowingly subjecting them to hazardous noise levels while on the job. The lawsuit filed by former and current firefighters in eight towns around New Jersey says they “have suffered irreversible hearing loss and a permanent decrease of their hearing,” and that the manufacturers were aware of the risks and failed to develop sirens and alarms safe for use.

A similar lawsuit has been filed in Buffalo, New York, and the claims join others around the country filed since 1999 in Illinois, Pennsylvania, Missouri, and elsewhere in New Jersey and New York. —*Y.L.*

To learn more about hearing loops, see Spring 2014’s “Keeping You in the Loop” and Winter 2013’s “Completely Accessible,” both at hearinghealthmag.com.

Hope College psychology professor David G. Myers is the author of “A Quiet World: Living with Hearing Loss,” a member of the Advisory Council of the National Institute on Deafness and Other Communication Disorders, and the creator of hearingloop.org.

Brendan Farrell is the founder and CEO of HowLoud, at howloud.com.

Daniel Fink, M.D., is an internist in Beverly Hills, California, who developed both tinnitus and hyperacusis after a one-time exposure to loud noise. Active in efforts to reduce public noise, he serves on the board of the American Tinnitus Association.

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Your Health Insurance May Help Cover the Cost of Hearing Aids



By Barbara Jenkins, Au.D., BCABA

A patient recently lamented to me that she could not afford the hearing aids that were best for her. I asked if she had checked her health insurance for coverage. She was surprised, saying, “I’ve had three sets of hearing aids and no one has even suggested that insurance might pay for them!”

As it turns out, her insurance did pay \$2,500 toward a new pair every three years. She looked back and discovered that she could have used this benefit for her previous sets as well.

Hearing aids are advanced computers that need servicing to keep them running, as well as adjustments as your hearing and needs change. So the cost typically includes not only the device itself, but lifetime servicing as well. This can be more than some can afford.

Thankfully, insurance may be an option. Even if you are positive that you do not have hearing aid coverage, check again. Things may have changed, and a phone call could save you thousands! Here is an overview of how some of these plans work.

Medicare: Medicare does not cover hearing aids, but it will pay for a diagnostic hearing evaluation if your doctor recommends it. Tell your doctor you are concerned about your ability to hear in order to get a referral for a diagnostic evaluation.

If you need hearing aids, check your options for coverage, such as:

Supplemental Medicare insurance: There are generally two types of supplemental coverage plans for

those on Medicare. Some plans will only cover what Medicare covers, and nothing else.

Some supplemental plans do, however, cover hearing aids, either directly or via a third-party broker (which I’ll cover below). In all cases, check your benefits manual for possible full or partial coverage, but also call the supplemental insurance carrier to confirm what it says.

Private insurance companies: Aetna, Blue Cross, United Healthcare, and others all have their own requirements and benefits, and each company offers different coverage for its various plans.

Just because your neighbor with Aetna does not have hearing aid coverage, this does not mean that you also do not have coverage on *your* Aetna plan. In fact, each insurance carrier can have multiple hearing aid benefit options. As with Medicare supplemental plans, the coverage may be direct or through a third-party broker. These benefits can change yearly, so check for the current year even if you were denied last year.

For my patient, her insurance covered the hearing aids of her choice directly. She verified that she had coverage and obtained preauthorization. At this point, she had the option of submitting the bill to her insurance provider herself, or having us do it for her.

Make sure you obtain your hearing aids from a contracted provider for

maximize your benefit. (This is like using an in-network physician vs. one who is out of network.) Most plans will only cover hearing aids with contracted providers.

As stated in my patient’s policy, she soon received a check for \$2,500 to cover her benefit. Some patients get full coverage for hearing aids and end up paying nothing out of pocket. I hope this is your case as well! This is the most traditional type of coverage, and provides you with the most options for hearing aid choice and care providers.

Broker or third-party coverage: This type of coverage is becoming more and more common, as it is easier for the insurance companies to leave the logistics of hearing aid coverage to others. There are many such providers, including but not limited to HearUSA, HearPO, EPIC, HiHealth, and more.

There are differences among them; Hear USA and HearPO are discount plan models, while EPIC operates like vision and dental plans, offering insured hearing products underwritten and approved by state insurance departments.

These companies allow you to purchase hearing aids at a price significantly reduced from what most hearing aid manufacturers charge. But be sure to check the length of follow-up service included with your purchase. When this expires, the provider is free to charge you whatever they generally charge for

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office adjustments and cleanings. Over time this may end up costing the same as, or even more than, a hearing aid you purchase on your own. Depending on the price of hearing aid services in your location, using third-party plans may or may not be a significant benefit.

Each of these plans is different, so you will need to obtain specific details from the third-party insurance carrier as well as speak with your hearing healthcare provider to run the numbers. Then you should be able to decide whether this type of plan is best for you.

What if you discover that you don't have any insurance coverage for hearing aids? You should review all of your insurance plan choices at your next annual open enrollment. There are so many plans available now that you may be surprised at your options. Currently, Affordable Care Act options are run similarly to Medicare or Medicaid. Check your individual plan for details.

I also encourage you to look at alternative ways to fund your devices. There are many nonprofit programs that provide good-quality, used hearing aids. We use the Sertoma Hear2Work program, which provides hearing aids that are just two to three years old, and of very good quality. EPIC is an affiliate of Audient, a nonprofit that provides new brand-name hearing aids at a discount to low-income patients. Also, look into interest-free financing, available in most hearing healthcare offices.

Our elected representatives are making the effort to make hearing aids affordable (through the proposed Hearing Aid Tax Credit bill; see page 8). In the meantime, you owe it to yourself to call your insurance company to find out what's covered. And then spread the word! 🗣️

Staff writer Barbara Jenkins, Au.D., BCABA, of Advanced Audiology in Colorado, has more than 25 years of hospital and clinical experience in treating patients with hearing loss and tinnitus. Jenkins serves as Colorado's professional state commissioner for the deaf and hearing impaired, and was awarded the 2010 Leo Doerfler Award for Clinical Excellence by the Academy of Doctors of Audiology. For more information, see advancedaudiology.com. Special thanks to Karen Thompson, Advanced Audiology's insurance billing specialist, who has more than 15 years of experience in the industry.

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Early Identification Has Long-Term Benefits

By Kristen Calabrese, Au.D.

Today, it's a new world for children diagnosed with hearing loss. Deafness can be detected in a matter of hours, not years. Infants can be fit with digital hearing aids when they are a few weeks old, and early intervention services can help build a solid foundation for these children to listen and talk. By kindergarten, many are ready to attend mainstream schools with their hearing peers.

Early diagnosis is key to this equation, and the Joint Commission on Infant Hearing recommends a "1-3-6 Rule": screening by 1 month of age, diagnosis and amplification by 3 months, and appropriate early intervention by 6 months.

The first step is Universal Newborn Hearing Screening, based on the 1993 National Institutes of Health recommendation. Administered shortly after a baby is born, a probe is inserted into the ear canal. It first emits and then detects a response to sound. In order to be accurate, no fluid can be present in the middle ear, so the test is administered to babies born via cesarean 24 hours after birth. If the infant does not pass the test, it is repeated a day or two later.

If the infant does not pass again, the family is referred to a pediatric audiologist for a more sophisticated test called an auditory brainstem response (ABR). This is a measure of hearing sensitivity and is the gold standard of hearing testing of babies. If hearing loss of any degree is detected, the family can then take time to learn about all of the available communication options for their child. If they decide that they want their child to learn to listen and talk, the infant is fit with hearing aids.

I'm often asked: "If an infant can't hear, what's the point of hearing aids?"

To begin with, if a child is born deaf, they may have some residual hearing. So, although a baby can't talk, the months leading up to his or her first words are critical. Hearing aids help babies absorb vital environmental information, such as patterns and rhythms of speech. This in turn builds connections in the still-developing brain, which helps to facilitate language development.



Early fittings help infants become accustomed to wearing hearing aids. They help parents learn how to operate and care for the device, and they provide data for audiologists for future cochlear implant surgery. Additionally, by using hearing aids early on, parents can become comfortable discussing their baby's hearing loss with family, friends, and even strangers.

At Clarke, I typically see children within two weeks of an audiologist's diagnosis. My primary role at this juncture is to help families understand what their child's hearing loss means in terms of daily living. We talk about mealtime and bathtime; about sounds that are easy or hard for their child to hear; and how to maximize their baby's listening environment. Together, we work with the speech therapist and any audiologists who will also be working with the family.

Although I've seen babies as young as 2 weeks old, it's important to note that the "1-3-6" timeline may not happen for many babies. By no means should those families be discouraged. Clarke sees many 3- and 4-year-olds who have not had early intervention services, and after working with a seasoned team, they go on to do beautifully.

Regardless of what age I first see a child, the most important tool I can give to their parents is to help them become the very best advocates possible. They need to be strong, determined, and informed, and in turn they can teach their child how to advocate for him or herself. 🗣️

This is the second of eight columns by Clarke about children with hearing loss, their families, and the professionals who serve them. Read the first column, "Enabling Success," available at hearinghealthmag.com. Next: Amplification.

Kristen Calabrese, Au.D., is the audiologist at Clarke in New York City. To learn more about Clarke Schools for Hearing and Speech, see clarkeschools.org.

1. OVERVIEW

2. DIAGNOSIS

3. AMPLIFICATION

4. EARLY INTERVENTION

5. PRESCHOOL

6. MAINSTREAM

7. SOCIALIZATION

8. ADVOCACY

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NAME:

Andrew Dimitrijevic, Ph.D.
Cincinnati Children's Hospital

BIO:

A Hearing Health Foundation 2015 Emerging Research Grant scientist, Dimitrijevic is a General Grand Chapter Royal Arch Masons International award recipient who is researching central auditory processing disorder. After receiving his Ph.D. in auditory neuroscience at the University of Toronto, Dimitrijevic completed postdoctoral work at the University of British Columbia and the University of California, Irvine. He is now an assistant professor in the Department of Otolaryngology–Head & Neck Surgery at Cincinnati Children's Hospital in Ohio.

IN HIS WORDS:

Clinicians and researchers have realized that the standard audiogram hearing test is not a reliable indicator of hearing ability. There are many cases where patients have "normal" audiograms but poor speech understanding, especially in noise.

This is definitely the case with auditory processing disorder (APD), also known as central auditory processing disorder. I want to understand the mechanisms underlying this apparent disconnect. Is it a bottom-up (ear to brain) or a top-down (brain) disorder? Are there different subtypes of APD? The long-term aim is to develop rehabilitation strategies, which will involve characterizing a person as having a bottom-up or top-down deficit in order to better target the intervention and treatment.

I've always tried to understand individual perceptions in patient populations, as it can reveal interesting insights. For example, when I was a postdoc in California, one of our experiments used continuous sounds with occasional pitch changes in order to study pitch change detection ability in people with hearing loss. When I asked one of our patients how it sounded, he replied, "I don't hear anything... ah, you mean the

beeps?" But there were no beeps, just changes in pitch! It turns out he was hearing the beginnings of the tone which then, for him, faded away into silence. So each "pitch change" was perceived as a single beep instead of a change in pitch from one frequency to another.

This very important "accidental" finding helped us understand that different types of hearing loss are linked with different gene dysfunctions, a discovery that was eventually published in the journal *Brain*. It was an "accident" because usually we are only interested in the final test performance; a test subject isn't typically asked to describe how something sounded during the test.

I was always interested in nature and animals—but all kids are! I had pet turtles, lizards, and frogs. The first science experiment I was particularly proud of was in the fourth grade. I created an electromagnetic motor—a coiled wire attached to a battery created a magnetic field that opposed a permanent magnet. A slight push of the finger would send this coil in an endless spin. Then as an undergraduate I studied zoology. The neuroscience came later, an interest sparked by the fact that my grandfather had Parkinson's disease.

I'm into extreme sports: kite surfing, mountain biking, and snowboarding. These hobbies are not related to my research, but being outdoors and gliding through the air clears your mind, and in this cleared state I often come up with new experiments.

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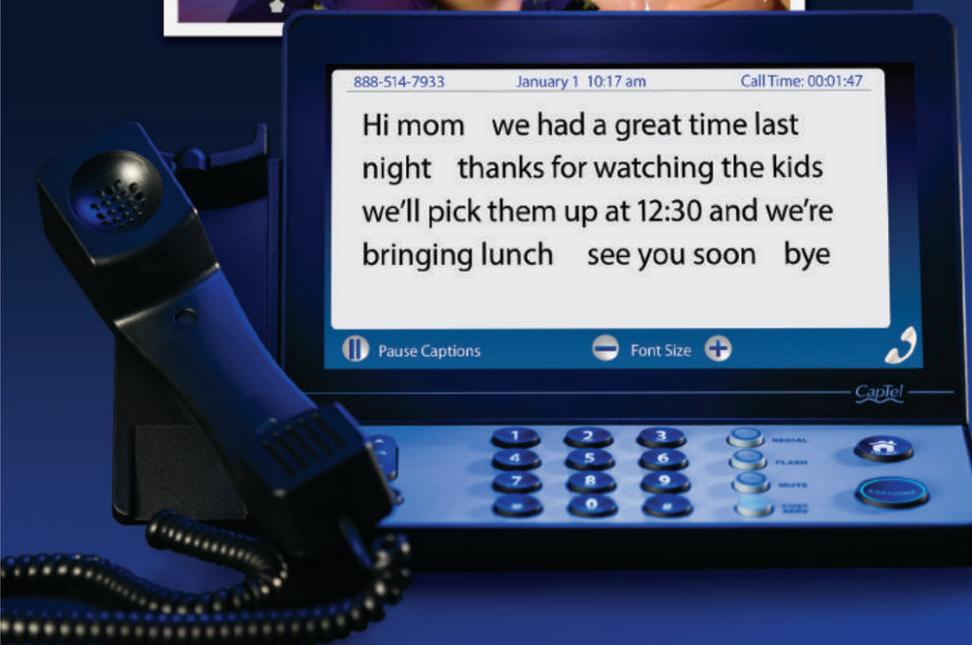
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