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VOL. 30, NO. 3, SUMMER 2014

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Since 1958, Hearing Health Foundation has been the leader in preventing hearing loss and in funding research into advanced treatments. Now we are close to developing the first genuine cure for hearing loss and tinnitus by regenerating the damaged inner ear hair cells that make hearing possible. Help us making hearing loss and tinnitus a thing of the past at hhf.org/donate.

Hearing Health

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1958

Collette Ramsey Baker founded Deafness Research Foundation to help further research and improve treatments for the millions of Americans with hearing loss.



1987

Funded research that discovered spontaneous regeneration of hair cells in chickens, thus igniting the field of hair cell regeneration in humans.

1960

Creation of the National Temporal Bone Banks Program, to collect and study the human temporal bone. In 1992 the registry was taken over by the National Institute on Deafness and Other Communication Disorders (NIDCD).



1990s

Advocacy for Universal Newborn Hearing Screening legislation increased testing from 5 percent to 97 percent of newborns by 2007.

1961

Honored Georg von Békésy with an achievement award in New York City, where he learned he had won the Nobel Prize in Physiology or Medicine

2002

Acquired Hearing Health magazine, the ultimate consumer resource on hearing.



1972

Began funding research on cochlear implants. This remains a primary area of research funding, with later grants exploring single channel versus multichannel implants, speech perception among cochlear implant users, and implants for children.



2008

In celebration of our 50th anniversary, rang the opening bell at the New York Stock Exchange.



2010

Launched Safe and Sound prevention program to prevent noise-induced hearing loss.



1977

Funded research in outer ear hair cell motility that led to a new method for measuring the health of a newborn's ear.



2011

Hearing Health Foundation became the new name for Deafness Research Foundation.



Launched the Hearing Restoration Project to develop the first biologic cure for hearing loss and tinnitus.

1985

Started funding research to understand how sensory cells transmit sound from the world to the brain, and began funding tinnitus research.



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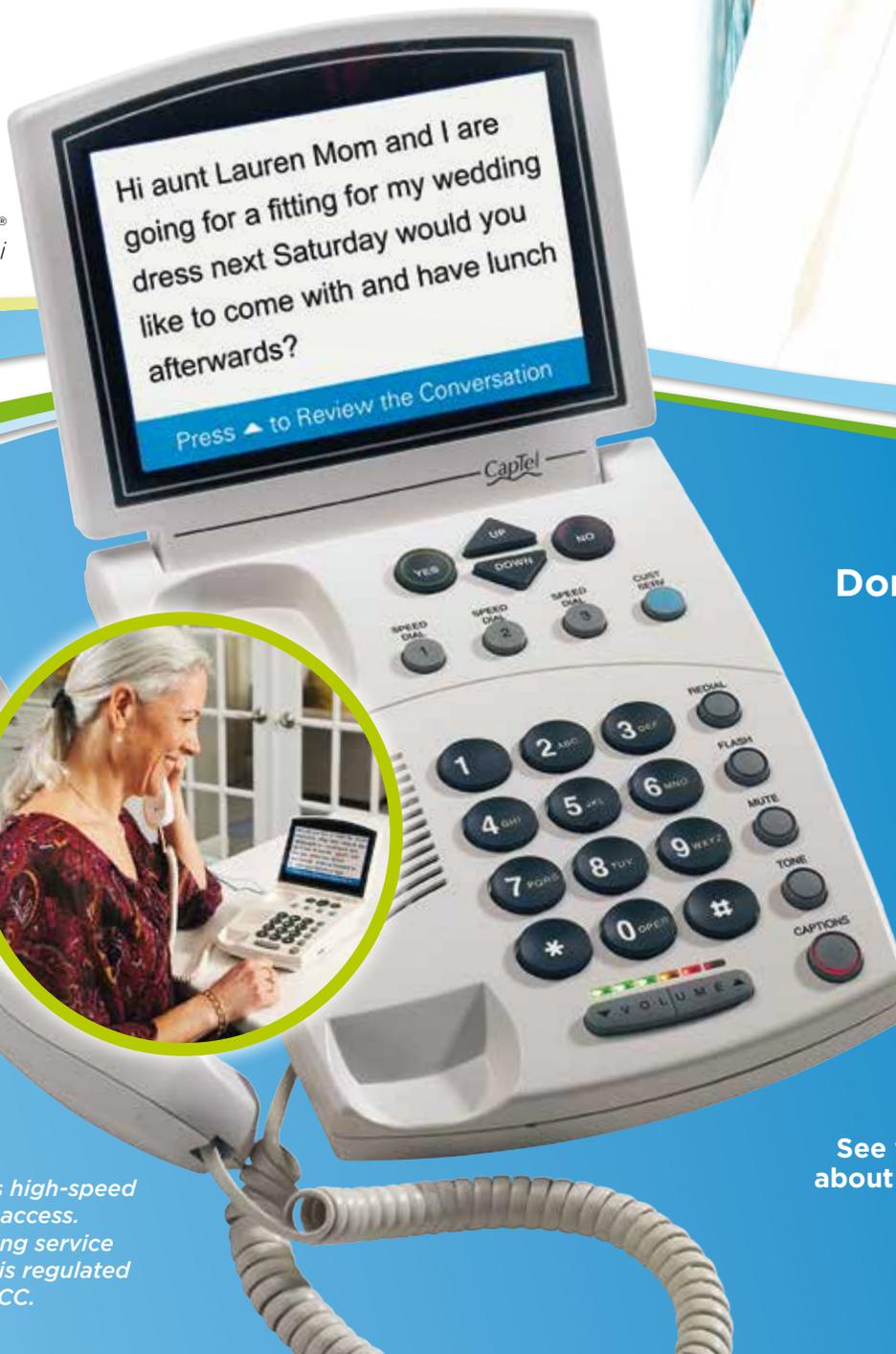
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NEWS



Shari Eberts, chair of HHF's board of directors, presents Chris Chromey-Marquis, Regal Entertainment Group's regional promotions coordinator, with HHF's Partner for Hearing Health Award.

National Junior Board Summer Event in New York City Raises \$60,000 for HHF

On June 9, HHF's National Junior Board hosted its second annual "A Summer Soirée" event to benefit a cure for hearing loss and tinnitus. Held at the restaurant Ainsworth Park in New York City, nearly 200 attendees enjoyed cocktails and hors d'oeuvres while participating in a silent auction and raffles.

The event raised more than \$60,000, a portion of which will be allocated to naming an Emerging Research Grant.

Regal Entertainment Group was presented with the Partner for Hearing Health Award, awarded annually, for its commitment to people who have hearing loss. Regal is dedicated to providing solutions for hearing impaired moviegoers, and showcased a pair of newly released closed captioning glasses at the event.

HHF appreciates the support from Regal as well as additional event sponsors UBS, Advanced Bionics, Legendary Pictures, Macquarie Capital, ACS, Blue Moon, and DASHA Wellness.



Walgreens' Joe Manzullo and Kajal Sheth (left and center) stand with NFL legend and Blue Heron owner Ron Jaworski at the Walgreens Senior Tour event at Blue Heron Pines Golf Club, N.J., on June 1.

Summer Health Events With Walgreens

HHF is participating in several of Walgreens' Senior Tour health events at Ron Jaworski golf courses in New Jersey this summer. Information about HHF, including copies of Hearing Health magazine, is being distributed, and HHF staff is on hand to answer questions.

HHF Attends Annual BTIG Charity Day

On May 13, HHF CEO Claire Schultz, HHF Director of Development Doug Olson, and HHF Board Member Robert Boucai attended the 12th Annual BTIG Charity Day. Boucai presented Steven Starker, the co-founder of global equity trading and fund services company BTIG, with a plaque, thanking BTIG for inviting HHF to participate a third time and for supporting the foundation's work to cure hearing loss and tinnitus.



HHF Board Member Boucai (left) presented BTIG's Starker with a plaque in thanks for BTIG's work with HHF.

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NEWS

CLAIRE SCHULTZ NAMED NEW CEO OF HEARING HEALTH FOUNDATION

HHF announced the appointment of Claire Schultz as chief executive officer in late April.

“I am delighted to welcome Claire Schultz as our chief executive officer,” says Shari Eberts, chair of HHF’s board of directors. “Claire’s depth of leadership and management experience make her uniquely qualified for this vital role. I am confident that she will galvanize our mission to prevent and cure hearing loss and tinnitus through groundbreaking research through the Hearing Restoration Project, and that she will help navigate a path to build and strengthen HHF with vigor, resolve, and imagination.”

Schultz comes to HHF with extensive experience in the public and private sectors. She most recently served as the chief external affairs officer of Amnesty International USA, where she was responsible for all revenue development, marketing, communications, digital engagement, and entertainment relations. At HHF, she will be responsible for strategic leadership and direction of the organization helping to increase its prominence and impact.

“It is an honor to be joining HHF and to be working with its forward-looking leadership and the distinguished scientific research community,” Schultz says. “The mission of HHF is personal for me. As someone with a parent who has a hearing loss, I have seen firsthand the challenges a person faces on a daily basis. I am motivated to expedite scientific breakthroughs for the millions of people who live with hearing loss and tinnitus.”

Schultz also previously served as the senior vice president for strategic marketing and communications at JDRF (Juvenile Diabetes Research Foundation), where she launched the organization’s national rebranding initiative, and the JDC (Joint Distribution Committee), where she established the first marketing



and communications plans aligned with fundraising. She created award-winning videos documenting the critical humanitarian needs of the most vulnerable children and the elderly around the world. Prior to her nonprofit work, Schultz held management positions at NBC, Microsoft, and Disney/ABC.

Schultz received her B.A. in communications from Tulane University in Louisiana, and has a certificate in linguistic studies from University of East Anglia in Norwich, United Kingdom. 

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NEW SCIENCE BEHIND HIDDEN HEARING LOSS



Inner ear hair cells have been thought to be the most vulnerable part of the ear and the reason for hearing loss due to noise or age. But new research on mice and guinea pigs points to cochlear nerve fibers as being even more susceptible to damage. M. Charles Liberman, Ph.D., the director of the Eaton-Peabody Laboratory at Boston's Massachusetts Eye and Ear Infirmary, and colleague Sharon G. Kujawa, Ph.D., presented their findings at a meeting of the

Acoustical Society of America in Rhode Island in May.

The researchers say a "hidden" hearing loss occurs when the synapse between the nerve terminal and hair cell is broken. This prevents the normal function of the ear, where sound wave vibrations that reach the inner ear are changed into electrical pulses in fibers of the cochlear nerve, which then transmits the information to the brain. A person with up to 90 percent cochlear nerve damage can still detect a tone in quiet and have a normal audiogram, unlike

someone with hair cell damage.

After staining the synapses, the scientists found that many were lost after a noise exposure. "Each missing synapse represents a cochlear nerve fiber that has been disconnected due to retraction of the terminal segment," Liberman says. "Within a few months or years, the rest of the neuron will disappear."

However, the death of these neurons is relatively slow, he adds, so there may be a window during which chemicals that reestablish synaptic connections may work.

HEARING HEADLINES



NANOPORES HELP HEARING

How do we tune in to a single voice amid a sea of noise? According to the Massachusetts Institute of Technology (MIT), our ears' selectivity comes from a tiny inner ear membrane. The tectorial membrane acts as a filter to help sort specific sounds, and its firmness—and sensitivity to different frequencies—depends on the size and distribution of tiny pores, called nanopores.

The tectorial membrane carries sound waves that stimulate a particular kind of sensory receptor. Though the process is too quick for neural processes to keep pace, an effective electromechanical system that can keep up with the speed of these sound waves evolved in the ear.

The MIT team, led by graduate

student Jonathan Sellon, studied two genetic variants that cause nanopores within the tectorial membrane to be smaller or larger than normal. The pore size affects the membrane's sensitivity to different frequencies. The team found that the typical pore size observed in mice is optimal for combining frequency discrimination with overall sensitivity. Pores that are larger or smaller impair hearing. The findings were published in *Biophysical Journal* in March.



A BILL TO BENEFIT VETERANS

The International Hearing Society and U.S. Senator Jon Tester of Montana introduced legislation in the Senate in early May to help U.S. veterans get easy access to quality hearing healthcare. The bill, S. 2311, has

been referred to the Committee on Veterans' Affairs.

According to the Department of Veterans Affairs (VA), the two most prevalent service-related disabilities for veterans are tinnitus and hearing loss. "More veterans than ever are returning home with seen and unseen injuries, including hearing loss," Tester says.

Veterans needing help with their hearing often face long wait times for appointments, significant travel distances to the nearest VA clinic, and limited follow-up care. The bill proposes to let the VA hire hearing aid specialists internally and requires the VA to report to Congress annually on wait times and network provider utilization rates. 



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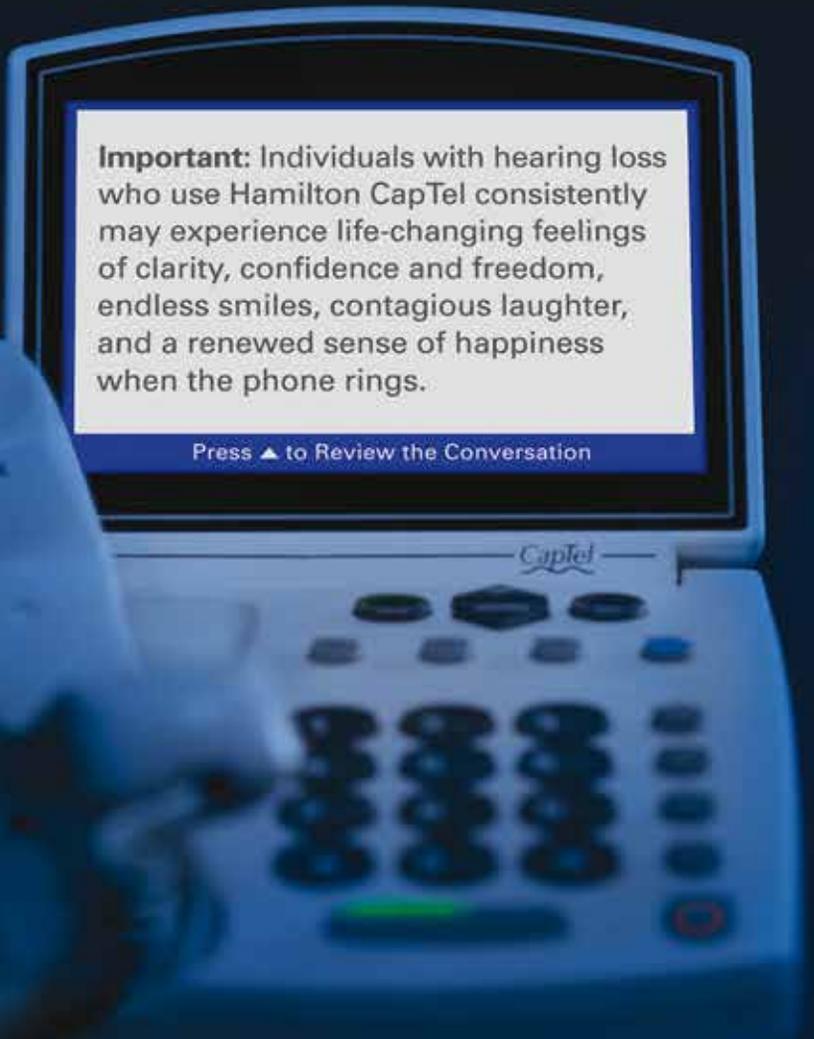
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For the Love of Music, and Flight

A retired Air Force officer traces his tinnitus back to work as well as play.

By Roger Lesser

“THEY SAY WE PAY FOR OUR youth as we get older. It must be true. For me, it all started when I played guitar in a rock band in high school and college. I loved those Marshall amps and Fender Stratocasters. I played gigs as long and loud as I could each night. Was it the music that caused my tinnitus? Well, yes. But at the time it was worth it—girls dig the guitar player. Reality set in after college, and I joined the United States Air Force and became a flight line maintenance officer.

I spent more than 20 years working on a variety of aircraft, from two-man OV-10s to C-141 transports. OV-10s were like young children. When they'd run up the engines, they had a high-pitched whine. The transporters had four large engines, and when they prepared for takeoff, you'd better hold onto your hat and plug your ears. Which

I did not, but I kept my hat.

The true demon that contributed to the development of my ringing ears was the helicopter. I worked with every version the Air Force had at the time, and the biggest monster of all was the H-53 rescue helicopter, which only became airborne because it beat the air into submission.

I first noticed the tinnitus while at a movie—“The Empire Strikes Back”—and I thought it was just a passing thing. But then I started noticing that every time the kids were in bed and my wife and I were sitting and reading or watching TV, I could still hear the ringing. I asked my doctor what the deal was, and he said it should pass but to try something called “ear defenders” (earmuffs) that were worn over your ears. So I did, but they only muted the sound.

As I got older and the ringing got worse, I found I had to listen intently during dinner conversations and at meetings (sometimes a blessing). People around me started noticing I was asking them to repeat things. I would tell them “Quasimodo” was acting up. I tried ignoring it, thinking it was just a fact of life.

But sleeping really got to be a problem. My wife is a goddess for putting up with me using earbuds to listen to the radio in order to drown out the ringing. Music didn't help, so I listened to sports talk or



any talk show. (Eventually I decided on-air psychologists needed to be put in a very large room to analyze one another.) To this day I still use the radio overnight.

Then about a year ago my wife heard a radio ad for a hearing center that offered a potential way to alleviate tinnitus. I made an appointment, had the hearing test, and discussed the use of devices that I wear for about 45 minutes a day. These ear-level devices have three settings that offer relaxing tones. (The irony is that they are bell sounds—a ringing sound to take care of my ringing sound!)

The theory is the brain does not like “dead zones” in the frequencies our ears can hear, so the devices are intended to rewire the brain. I have had the devices now for some months, and there are days they definitely do make a difference. Other days, not so much. I get frustrated and think, to heck with the ringing—let's listen to Led Zeppelin!

I have had others who suffer from Quasimodo tell me that you get used to it. Right—like getting used to the annoying neighbor who mows the lawn at the crack of dawn on the weekend. (Hope he gets tinnitus.) My real hope is that as technology advances, we will find a cure or at least some relief. Now, where did I put the Fender...? 📞

For more on veterans affected by hearing loss and tinnitus, see hhf.org/veterans.

A retired Air Force lieutenant colonel and former magazine editor, Roger Lesser lives with his family in Colorado.



The author with his extended family.

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Hit the Mute Button

To protect your child's hearing, speak up about the noisy dangers they face every day.

By Elizabeth Stump



It's been commonly reported that one in five people in the United States has a hearing loss. What is even more startling is that this includes children ages 12 and older. The statistic comes from Johns Hopkins University research published in the *Archives of Internal Medicine* in 2011, and it echoes a 2010 *Journal of the American Medical Association (JAMA)* report that tracked hearing loss in children. The JAMA study also detailed a 31 percent jump in child and adolescent hearing loss compared with the previous decade.

Children and teens are often referred to as “the MP3 generation,” a group that seems to be always plugged into personal digital music players via earbuds and headphones. Their constant use is a strong potential cause for the increase in hearing loss among young people. The surprising lesson? You can get noise-induced hearing loss (NIHL) simply by listening to music at a high volume.

Hearing loss can happen over a short period of time when exposed to extremely loud noise (such as attending music concerts, going clubbing), and it can happen over a longer period of time with elevated noise levels (such as listening to music at unsafe levels for hours every day).

“Kids with NIHL may not notice it, and it is sometimes not until the combination of aging and NIHL accumulates that a person is symptomatic,” says Peter M. Rabinowitz, M.D., an associate professor in environmental and occupational health sciences at the

University of Washington, Seattle. Prevention in the absence of symptoms is key, he says.

Safe listening levels depend on volume and duration, or how loud and how long, says Brian J. Fligor, Sc.D., who is board certified in audiology with a specialty in pediatric audiology. Having published widely on the topic of NIHL as the director of diagnostic audiology at Boston Children's Hospital, he says research demonstrates an individual susceptibility to NIHL, so that two people with identical noise exposure will not necessarily end up with the same hearing damage. (But determining just who is more susceptible has so far proven elusive, he adds.)

Exposure to any noise at or above 85 decibels (dB) can cause gradual hearing loss. This is the sound of a lawn mower or heavy traffic. It is also the sound of an MP3 player at only 70 percent of its top volume.

The risk is especially acute with earphones that do not block outside noise such as earbuds, which are like a pair of tiny speakers worn inside the ears, Fligor says. Because they emit sound directly into the ear canal, without blocking any ambient noise, people tend to increase the volume by several decibels to drown out external sounds such as other music or conversation. The New York City Health Department recently ran a series of subway ads (pictured opposite) warning of the risk to hearing from listening to loud music using earbuds.

In addition, digital music players can play for hours

without needing to be recharged. Listening for hours at unsafe levels means the ears never get a break.

WHERE IS IT TOO LOUD?

It is not just personal music players that put children and teens at risk for hearing loss. Have you ever spent time in a schoolroom? What about band practice, shop class, or a school event such as a dance or sports?

All of these have excessive sound levels. Construction and maintenance activities in or around schools can also be harmful, as can recreational activities. The volume at video arcades has been measured as high as 110 dB—the same as a car horn from three feet away.

And don't forget toys. In a 2012 article in the journal *Communication Science and Disorders*, Fligor and colleagues cited a University of California–Irvine study detailing common toys that emit sounds at decibel levels high enough to cause permanent hearing damage. Rattles and squeaky toys have been measured at sound levels as high as 110 dBA (dBA measures how the human ear perceives sound). Musical toys, drums, and horns can reach 120 dBA, and toy phones between 123 and 129 dBA.

THE IMPACT ON LEARNING

NIHL typically first affects the higher frequencies between 3,000 and 6,000 Hertz (Hz). Soft, high-pitched sounds become more difficult to discern, and these are the most important for hearing subtle differences in words (for example, “first” vs. “thirst” and “walk” vs. “walked”).

Because hearing is essential to speech and language development, learning, and communication, children with untreated hearing loss are at risk for problems with academic achievement, vocabulary, and pronunciation, as well as social isolation and poor self-esteem. Tinnitus, or hearing a ringing or buzzing in the absence of any external source, also occurs in the majority of NIHL cases. In severe cases, this can disrupt concentration and sleep.

The earlier hearing loss occurs in a child's life, the more

serious the effects on the child's development—but the earlier the problem is identified and intervention begun, the less serious the ultimate impact.

THE 80/90 RULE

Given the near-pervasive dangers of excessive noise, take time to teach your children how to avoid damaging their hearing. Help them adopt these protective behaviors:

- Identify sources of loud sounds and avoid or limit exposure to them.
- Turn down the volume of music systems, and lock in settings to limit the maximum volume that can be played.
- Use hearing protection devices like earplugs at loud concerts or sporting events.
- Follow the 80/90 rule for MP3 players: Listen at no more than 80 percent of maximum volume for no more than 90 minutes. (Lower the volume even more and listen for an even shorter duration if using a CD player and headphones.)

Clues that your child has been exposed to excessive noise include temporarily hearing a ringing in the ears or sounds that are muffled. Over time, you may notice your child is missing parts of conversation, asking speakers to repeat themselves, or having problems at school. If you suspect a hearing loss, immediately seek a hearing evaluation by a certified audiologist. (For more, see Fall 2012's “10 Clues Your Child Can't Hear You,” at hearinghealthmag.com.)

“Parents also need to be good role models,” Fligor says. “Use earplugs or earmuffs when using the lawn mower or power tools such as leaf blowers or chainsaws, and don't blast the music too loud yourself.”

Whatever the source of the noise—loud music you're listening to voluntarily or construction you can't avoid—the injuries are the same, says Fligor: hearing loss and tinnitus. And since children need good hearing to succeed in school, they need to be proactive about protecting it, with the help of adults around them.

“The most effective prevention is avoiding excess noise and making hearing protection ‘cool,’” Rabinowitz says.



The New York City Health Department recently launched a subway advertising campaign warning about the dangers of NIHL.

So look for hearing protection sized for children and that come in fun colors and patterns. These include earmuffs by Alpine Muffy, My-T-Muffs, Peltor Kid, Pro-Ears, and Silenta. (Baylen Brees, the then-1-year-old son of football player Drew Brees, wore Peltor to watch his dad and the New Orleans Saints win the Super Bowl in 2010.) For older children, Westone Audio's DefendEar custom earplugs are available in glittery colors and swirly patterns.

Children can still enjoy music and video games with the help of volume-limiting earbuds, such as Etymotic's Ety-Kids and KonoAudio's Kidzsafe.

"Decisions you make regarding how you value your

hearing influence how you'll hear when you're 20 years old, 40 years old, and 80 years old," Fligor says. It's never too early to teach your child healthy hearing habits that will help them their whole lives. 

For links to more information and resources, see hhf.org/childhood_hearing_resources.

Staff writer Elizabeth Stump is the former editor-in-chief of the Hearing Loss Association of America's Manhattan chapter newsletter.



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Off-Duty Risks

Nearly half of active duty enlisted personnel are ages 18 to 25, according to a 2011 report by the Office of the U.S. Deputy Under-Secretary of Defense. Like other teens and young adults, they need to protect their hearing—now.

The military is one of the noisiest professions. But it's not just work that is a concern. The U.S. Department of Defense Hearing Center of Excellence (HCE) warns against harmful noise exposure both on and off duty. While leisure activities are ways to relax and be entertained, they should not occur at the expense of auditory injury.

If someone is three feet away from you and you can't hear them, the noise levels in your surroundings are probably high enough to damage hearing. This is often the case in noisy restaurants and nightclubs

as well as rock concerts, sporting events, gyms, music festivals, and parades, HCE says. Exposure to these "routine" noises in everyday circumstances can gradually damage hearing. Motorboats, motorcycles, and snowmobiles have noise levels ranging from 85 dB to 120 dB. Music broadcast in health clubs can reach 118 to 120 dB.

The U.S. Army Health Command estimates that 50 to 60 percent of one's situational awareness comes from hearing. With bad hearing, it takes about 90 seconds to identify a target. With good hearing, it takes about 40 seconds. According to HCE, those 50 seconds could be the difference between mission success or failure—or life or death.

—Yishane Lee, Editor

(For more about the military's efforts to prevent NIHL, see "A Fight for the Long Haul," page 20.)

There are no FDA-approved drugs for NIHL or any sensorineural hearing loss condition at present, says Brian J. Fligor, Sc.D. Ten compounds have been evaluated, he says, and research results published in scientific literature from 1993 to 2013 show some level of protection from NIHL. But getting to human trials is long and rigorous.

"There are several compounds that show promise to lessen NIHL susceptibility, and perhaps can be given at doses that are safe for humans," Fligor says. "A huge challenge, though, is finding people who are noise-exposed enough to need more protection—but then who can be exposed to that noise

The Challenges With Testing NIHL Drugs

for the sake of research."

Jonathan Kil, M.D., the chief medical officer at Sound Pharmaceuticals in Seattle, is hopeful about one drug treatment. "We have completed the first Phase 2 clinical trial for preventing NIHL in the U.S. with our oral novel drug SPI-1005. The results are very positive and the drug was highly effective," he says. "SPI-1005 is the furthest [NIHL drug] along with human proof of concept."

SPI-1005 mimics an enzyme called glutathione peroxidase, which the

body naturally produces to protect ears from damage. After a clinical trial using 83 subjects, the drug appears to have no side effects. But it will be at least until the end of 2015 before a large-scale clinical trial can begin.

Kil describes another challenge with testing on people. "I'm really concerned with what we observed in our Phase 2 trial," he says. "A significant number of [pediatric/adolescent] volunteers already had a greater than 25 dB hearing loss and did not qualify for enrollment into our study."

—E.S.

(For the military's search for noise-protective supplements, see "The Promise of PIHL," page 22.)

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A FIGHT FOR THE LONG HAUL

Effective hearing conservation efforts can help prevent auditory injury for both active and off-duty military service members as well as veterans.

By Col. Mark Packer, M.D.

Up to 50 million U.S. adults report some degree of hearing loss. This number includes the estimated 1.5 million-plus veterans suffering from a hearing-related, service-connected disability. Of those with hearing loss in the U.S., roughly 10 million cases are attributed to noise-induced hearing loss (NIHL), a preventable hearing loss caused by excessive noise exposure.

NIHL and tinnitus (a ringing or buzzing in the ears) are the top two service-connected disabilities among U.S. troops. NIHL is one of the most common occupational diseases; it can occur gradually over time or with one single exposure. For instance, a service member may gradually experience hearing loss as a result of his or her exposure to loud ambient noise for 12-plus hours of work on a ship. NIHL can also be the result of a one-time exposure to high-intensity noise such as small-arms fire, improvised explosive devices, or artillery fire.

Individuals with NIHL may be unaware of their hearing loss and may not notice communication difficulties when in quiet listening situations. However, in noisy listening environments such as communicating in combat, around military vehicles and aircraft, or during weapons fire or industrial operations, hearing becomes difficult and can adversely impact communication and mission readiness.

With extended or up-close exposure, noises that reach a level of 85 decibels (dB) or higher can cause permanent damage to the hair cells in the inner ear, leading to hearing loss. A jackhammer is 130 dB, gunfire 145 dB, a jet engine 155 dB, and a bomb blast 175 dB.

As a result of these risks, the U.S. Department of Defense Hearing Center of Excellence (HCE) was created in 2009 and has been working to promote effective hearing conservation efforts that can help prevent auditory injury for active and off-duty service members as well as veterans.

The first step in hearing conservation is knowing how to recognize potentially harmful noise in work, recreational, and home environments. Service members can then take precautions to protect their ears from damage. If they cannot remove themselves from harm in cases where the volume cannot be reduced or the risk cannot be mitigated, they should use appropriate hearing protection devices (HPDs). These can be powerful tools for preventing NIHL.

Some believe that wearing hearing protection can interfere with one's ability to communicate with colleagues and hear orders from superiors. Some may even think that wearing hearing protection may prevent them from hearing an enemy approaching or determine the source or location of enemy gunfire.

However, with today's increasingly sophisticated technology, soldiers no longer need to choose between "deaf or dead." There are HPDs available that can simultaneously protect hearing and enhance situational awareness. Earplugs, ear muffs, and noise attenuating helmets provide different levels of noise reduction depending on the need. The trick is understanding how to select the most appropriate HPDs for the job or environment. Next, it is important to remember that in the end, the efficacy of any given HPD depends on whether it is worn consistently and correctly.

EARPLUGS

Traditional earplugs are effective in preventing hazardous noise from entering the ear canal, but they can interfere with mission communication requirements, such as being able to hear speech or low-level combat sounds. To solve this problem, scientists at the French-German Institute in Saint Louis, France, along with the U.S. Army Center for Health Promotion and Preventive Medicine, created "level-dependent earplugs."

Level-dependent earplugs have a small filter that enables soft noises to be conveyed at full strength while eliminating any high-frequency or impulse noise. This allows a soldier to hear key verbal and combat sounds but provides increased attenuation from dangerous levels of noise such as explosions or machine gun fire. These and other forms of updated earplugs are an effective solution for protecting a service member's hearing.

Earplugs are easily transportable and can be used in a variety of situations, such as while operating weapons on the ground or in combat. They provide more freedom to move around and communicate verbally. Since they provide less attenuation than aviator helmets or headphones, earplugs should be used only in combination

with other HPDs when operating aircraft or combat vehicles. Because of their small size, care should also be taken to not misplace them.

Earplugs should be placed snugly in the ear canal so that they completely block the ear canal. When the earplug is correctly in place, a seal will form between the surface of the skin on the outer ear canal and the earplug. To test this, a wearer should listen to the sound of his or her own voice. If the earplug is working effectively, the user's voice will seem louder and slightly muffled. Additionally, a vacuum sensation or feeling of pressure in the ear canal may be felt. Each wearer is unique, so a specialist should make sure the earplugs fit and are correctly in place.

EAR (OR NOISE) MUFFS

Ear (or noise) muffs contain two tightly fitted ear cups that cover each ear entirely, blocking noise from entering the ear. They are best used for intermittent exposure to noise and provide attenuation as well as durability.

While earmuffs provide greater noise reduction than earplugs, they can make it harder to pick up softer sounds necessary for verbal communication. To overcome this, an electronic communication system in the earmuff allows wearers to communicate clearly with one another.

Earmuffs are simple to put on and take off and consistently provide a high level of protection. Their size means they are easy to keep track of, and they are comfortable to wear. Optional ear cup seals provide extra protection and warmth in cold environments as well as an added level of comfort. Additionally, unlike earplugs, they can be worn in spite of ear infections or impacted earwax. But earmuffs can be uncomfortable to wear in hot climates, in which case earplugs may be preferred.

Remember that earmuffs block out sound by creating an airtight barrier around the entire ear. If this barrier is too loose or stretched out because of improper fit, air pockets will be created, allowing noise to enter.

NOISE ATTENUATING HELMETS

Noise attenuating (reducing) helmets are recommended for use by any military personnel operating an aircraft or combat vehicle. These helmets protect the wearer from hearing loss, crash impact, and eye injuries while also increasing communication ability through a radio communication piece.

Noise attenuating helmets consist of the basic helmet, liner, ear cups, visors, chin and nape straps with ear cup retaining pads, boom microphone, and speakers. Technologically advanced helmets include an active noise

reducing technology that monitors the sound energy around the ear and cancels any unwanted noise while preserving verbal communication. A communication earplug serves as a microphone and can be worn in addition to the helmet for high-quality verbal clarity.

Helmet sizing, helmet fitting, ear cup placement, and ear cup fit are all important to fully protect hearing. When fit accurately and securely, helmets can be some of the safest HPDs.

CONCLUSION

Permanent hearing loss can result from repeated, unprotected exposure to hazardous noise levels over time as well as from a sudden, high-intensity sound.

Within the U.S. population at large, auditory injuries represent the third most common physical medical condition (after arthritis and heart disease). In the military, it is estimated that auditory injury is rising 13 to 18 percent annually. About 60 percent of returning service members have hearing loss or tinnitus or both.

Active and veteran service members should seek

annual hearing healthcare services from a hearing healthcare professional. A comprehensive hearing test is recommended as soon as possible in the event of NIHL symptoms, which include experiencing tinnitus, fullness in the ears, and muffled speech.

Although NIHL is on the rise among military personnel, this type of hearing loss is completely preventable. HCE encourages all service members to not only choose the appropriate HPD for their environment, whether it is at work or at play, but to also make sure it is correctly fit and consistently used in order to preserve hearing. 

For more information about veterans affected by hearing loss and tinnitus, see hhf.org/veterans.

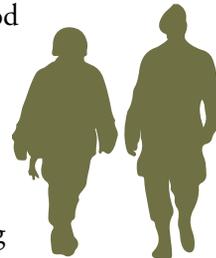
Col. Mark Packer, M.D., is the executive director of the Hearing Center of Excellence (HCE), Lackland Air Force Base, Texas. For more, see hearing.health.mil.



SUPPORT A CURE: HHF.ORG/DONATE

PIHL stands for pharmaceutical interventions for hearing loss, and it is a major research area for the military. HCE established a working group pursuing standardization for PIHL, and the Office of Naval Research (ONR) is also investigating the area. According to an ONR article from May 2013, “Early investment from ONR proved

research is promising. According to the article, “Studies by ONR and other entities indicate that medicine already approved by the Food and Drug Administration could reverse the effects of both noise-induced hearing loss and mild traumatic brain injury symptoms, including



now—are untenable in a combat situation, he says, and side effects that could include nausea and disorientation will also have to be ruled out.

In other words, an ideal PIHL drug for the military, aside from primary goals of safety and efficacy, requires easy access

THE PROMISE OF PIHL

that timely delivery of antioxidant compounds helps to mitigate the effect of noise exposure,” says Rick Rogers, Ph.D., a Harvard School of Public Health scientist who has been working with the ONR.

The ONR story says Rogers is examining the possibility that inhaled antioxidants can protect against NIHL in the field. Early

dizziness and memory loss.”

Separately, Col. Mark Packer, M.D., HCE’s executive director, told the journal *Chemical & Engineering News* in April 2014 that its PIHL working group’s standardization efforts include requirements for any PIHL to be used in the field. Steroid injections for sudden hearing loss—one treatment used

and delivery, an adequate shelf life, and good tolerance. Such a drug would also need to withstand temperature fluctuations and sun exposure. Packer adds that current development options for military applications favor preventive medications over rescue therapies for the treatment of NIHL.

—Yishane Lee, Editor

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The Harm From Noise

Of all causes of hearing loss, noise is the most preventable.

By Stanley Pelosi, M.D.

WHAT IS NOISE-INDUCED HEARING LOSS?

Noise-induced hearing loss (NIHL) refers to a permanent hearing impairment from exposure to loud sounds. Of all causes of hearing loss, noise exposure is the most preventable cause.

HOW COMMON IS NIHL? WHO IS AFFECTED BY NIHL?

The most common cause of NIHL is thought to occur due to workplace exposure to loud sounds, with an estimated 10 million Americans at risk from occupational-related NIHL. Other causes include noise exposure from recreational activities such as shooting sports, music concerts, and listening to portable music players at high volume.

Overall, a greater percentage of males compared with females are affected by NIHL. Individuals of any age can be affected by NIHL, and the risk is not known to be

higher in young or old patients. Significantly, 60 percent of returning military service members have NIHL or tinnitus (a ringing or buzzing in the ears), or both.

WHAT CAUSES NIHL?

Sounds are measured in units called decibels (dB). Most sounds that are measured to be under 75 dB (such as normal conversation, kitchen appliance noise) are unlikely to cause NIHL. However, sounds above 85 dB have the potential to cause damage to hearing structures. This may include brief, extremely loud “impulse” noises such as gunshots, explosions, or sirens. Continuous sounds of moderately loud intensity, frequently encountered in the workplace environment or with use of portable music players, can also result in NIHL.

Excessive noise causes damage to inner ear sensory cells, known as hair cells. These cells receive the energy from sound waves that reach the eardrum and convert

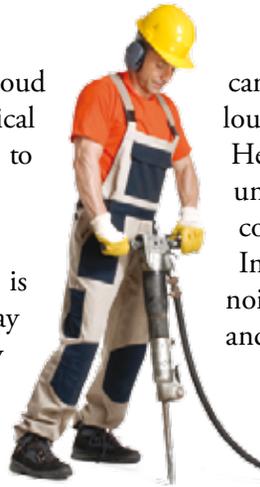
them to nerve signals that travel to the brain. Loud noises can damage hair cells through mechanical injury and cause their eventual death, leading to permanent hearing loss.

WHO IS AT RISK FOR NIHL?

Any individual exposed to excessive noise is at risk for NIHL. As described earlier, this may include workers in manufacturing or heavy industries who are exposed to continuous, loud workplace sounds, or it can include individuals exposed briefly to impulse noises while participating in recreational activities. (To learn about NIHL and the military, see “A Fight for the Long Haul,” page 20.)

HOW IS NIHL DIAGNOSED?

NIHL is suggested by hearing loss in an individual with a history of exposure to loud sounds. The hearing loss



can be temporary (lasting one to two days after a loud concert, for example), or it can be permanent. Hearing loss may also be gradual and initially unnoticed. People who have NIHL frequently complain of tinnitus in addition to hearing loss. In addition, recent research has shown that chronic noise exposure can worsen complaints of fatigue and irritability.

Diagnosis of NIHL is suggested in patients who, on a hearing test (audiogram), demonstrate hearing loss. The hearing loss is sensorineural in nature (which means it stems from problems in the inner ear or the auditory nerve), and may disproportionately affect specific sound frequencies (3,000 hertz, or in the high frequencies). No laboratory or imaging studies are specifically indicated for diagnosis of NIHL, although these tests may be useful for investigating other causes of the hearing loss.



Researching the Effects of Noise

HHF has a long legacy of supporting NIHL and tinnitus science through its Emerging Research Grant program. Here are three recent recipients.



Debashree Mukherjea, Ph.D., Southern Illinois University School of Medicine

In order to identify inflammatory targets involved in the development of NIHL, the inflammatory response of the cochlea due to noise trauma will be examined. The goal is to provide a tangible option (via a localized or a systemic treatment) and a window of opportunity for the treatment of NIHL. (Following this HHF grant, Mukherjea received numerous awards from the National Institutes of Health to continue her research.)

a role in the generation or modulation of central tinnitus. The goal of this project is to understand how different neuromodulators control the neural activity in the central auditory system, and their role in pathological auditory processing.



Guoqiang Wan, Ph.D., Children’s Hospital Boston and Harvard Medical School

“Benign” noise levels, initially thought to only result in temporary hearing loss, can cause irreversible damage to the connections between hair cells and auditory neurons (the synapses). This can lead to permanent hearing loss. The overall goal of this study is to examine the potential of the neurotrophic factor, neurotrophin-3, to assist in preserving or regenerating these synaptic connections in the cochlea after noise overexposure. These experiments will provide a better understanding of the pathophysiology of NIHL and the potential of neurotrophin-based therapeutics for treating hearing loss.



Zhengquan Tang, Ph.D., Oregon Health & Science University

The mechanisms underlying tinnitus are poorly understood. The dorsal cochlear nucleus (DCN), one of the first stations of the ascending auditory pathway, receives dense serotonergic input. Recent evidence indicates that the DCN may be a site of central tinnitus, and it is possible that serotonin might play

HOW CAN NIHL BE PREVENTED?

The prevention of NIHL first requires identifying the environmental sounds that can cause hearing damage (those above 85 dB). In cases where exposure to these sounds cannot be avoided, hearing protection is necessary. This may include protective devices such as earplugs or earmuffs that dampen environmental sound intensity. The Occupational Safety & Health Administration (OSHA) requires employers to implement hearing conservation programs in workplaces where sounds exceed 85 dB. This includes the provision of free hearing protection devices.

WHAT ARE THE TREATMENT OPTIONS?

There are currently no medical treatments available to reverse the damage caused by NIHL. For those with significant hearing loss, hearing aids and assistive listening devices (such as frequency modulation, or FM, systems) can help amplify environmental sounds.

The natural history of noise-induced hearing loss is variable. Some patients may exhibit no change, while others may experience worsening of hearing due to persistent noise exposure and/or concurrent age-related hearing changes.

WHAT RESEARCH IS BEING DONE ON NIHL?

There are several active areas of research on NIHL. One involves the further examination of the causes and sites of hair cell damage in NIHL patients. Another involves the examination of genes and proteins that may have a protective effect in preventing NIHL caused by noise-related trauma. (For HHF-funded research, see “Researching the Effects of Noise,” previous page.)

WHERE CAN I LEARN MORE ABOUT NIHL?

Visit HHF’s website (hhf.org/preventing-hearing-loss). The National Institute on Deafness and Other Communication Disorders website (nidcd.nih.gov) has additional information regarding NIHL, including a directory of organizations that can provide information and counseling. OSHA (osha.gov) also has information about workplace-related NIHL. 

Stanley Pelosi, M.D., is an assistant professor in the Department of Otolaryngology–Head and Neck Surgery at the New York Eye and Ear Infirmary and a member of HHF’s Council on Medical Trustees.

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REDUCE YOUR



The most common underlying cause of tinnitus is inner ear damage, and the most common underlying cause of inner ear damage is noise. Here is how to reduce or prevent noise-induced tinnitus.

By Barbara Jenkins, Au.D., BCABA

Tinnitus is any sound you hear that is not created by an external source. It can sound like a buzz, high-pitched tone, pulsing, or another sound. It can come on gradually, starting mildly at first, and then increase in intensity and frequency over weeks, months, and even

years. You can get tinnitus in an instant. One minute you're living in a quiet world; in the next your world has been invaded by a constant auditory interloper.

Tinnitus is a symptom, not a disease. Consequently, there are many causes and many treatments. By far the

most common underlying cause of tinnitus is inner ear damage, and the most common underlying cause of inner ear damage is noise. Nearly one-third of all tinnitus cases can be traced back to noise damage.

Unfortunately, noise damage is insidious. As is often the case with skin damage from sun exposure, you may not realize your ears have been damaged for years to come. It's not uncommon for noise-induced tinnitus to start years after exposure to loud noises.

You may have been told that there is nothing you can do to prevent or reduce tinnitus. Although there are many physicians and audiologists trained in the diagnosis and treatment of hearing loss, there are very few who are specifically trained in tinnitus care.

I have been treating tinnitus in hospital and clinical settings for more than 20 years, and I opened one of the first tinnitus clinics in the United States. The suggestions below are gleaned from my experience and are what I personally use to prevent my own tinnitus from worsening.

BEFORE NOISE EXPOSURE

Noise exposure can both cause and exacerbate tinnitus. Preventing noise-induced tinnitus is relatively easy, but you must plan ahead, especially if you know in advance that you are going to be exposed to loud sounds.

Prepare your ears: A plethora of studies show that using certain antioxidants and vitamins (both available over the counter) prior to noise exposure helps the ears recover from noise trauma.

The U.S. Navy has been researching the use of antioxidants to protect service members exposed to noise. Two found to be very effective are N-acetyl-cysteine (NAC) and acetyl-L-carnitine (ALCAR). A 2011 naval study published in the journal *Noise & Health* found that NAC protected the cochlea after exposure to impulse noise, such as that coming from gunfire, whose peak levels reached as high as 165 decibels (dB). Papers in the journals *Acta Oto-Laryngologica* and *Hearing Research* have shown that NAC and ALCAR reduced the amount of damage to the inner ear hair cells in animals after exposure to loud sounds, and that their protective benefit persists even one to four hours after exposure.

Getting enough magnesium and vitamins

A, E, and C daily has shown significant protective benefits as well. Just as there are certain nutrients known to protect your eyes, there are nutrients that have antioxidant capabilities to protect the inner ear's hair cells. Natural (non-synthetic) vitamin and mineral supplements should help in this regard. No megadoses are necessary; the recommended dosages are sufficient.

To avoid the risk of harmful interactions, always talk with your primary care doctor before taking any supplements—especially if you have other health issues or are taking any other medications or over-the-counter drugs or supplements.

A healthy ear is a strong ear. And a strong ear is more likely to be able to withstand loud noise.

Protect your ears: Using hearing protection is a no-brainer. (Hearing protection devices for the military are covered in detail in “A Fight for the Long Haul,” page 20.) Make sure to wear the ear protection before the noise exposure starts, not after it has already begun. Sometimes tinnitus begins immediately at the first loud sound, so every second counts.

If you are using earplugs, practice putting them in ahead of time. The small foam-type work well but can be difficult to insert fully and properly, especially if you have smaller ear canals.

DURING NOISE EXPOSURE

At concerts, professional car races, health clubs: Position yourself as far away from the source of sound as possible while still being able to enjoy the atmosphere. Every 15 to 20 minutes, go outside or to a quiet room to give your ears a break. When you are exposed to noise, your ear's hair cells move in response. With loud noise they can actually become irritated, so that healthy ones may weaken, and weak ones may die. A few minutes of rest may be the difference between ears that are temporarily irritated and those that are permanently damaged.

Using earbuds or headphones with personal music players: First, take the time to adjust the settings on your device so that the maximum volume is reduced at least two levels, or about 6 dB. This may prevent you from going over a safe level when you aren't thinking about it. Next, set your music to a level you enjoy, but turn it down just one or two notches. Even a 3 dB drop in volume



can reduce damage. Finally, every 15 minutes or so, turn down the music significantly or turn it off entirely, giving your ears a few minutes of recovery time.

Using power tools or target shooting: If you are serious about protecting your ears, “double up” by using earplugs and earmuffs together. Every decibel of extra protection will help at this volume of noise. One gunshot at ear level near an unprotected ear can produce tinnitus.

Take off your earmuffs if you need to speak with someone else, but never remove the earplugs when you are still in a very noisy area. The tinnitus that is experienced by many of my patients began when a gun or air compressor went off just after they removed their hearing protection. Leave the noisy environment first before removing the last layer of protection.

Damage from this level of noise can be immediate. Take protecting your hearing seriously. Of course, if you are the victim of an unexpected sudden loud noise, know that there is little you could have done beforehand to protect yourself. (Read about the hearing loss and tinnitus experienced by Boston Marathon blast survivors in “Running Toward a Cure,” page 30.) But you can then take steps to help your ears get healthy and to prevent it from happening again.

AFTER NOISE EXPOSURE

The long-standing, accepted course of treatment for sudden hearing loss has been steroids (prednisone) taken orally within six weeks of a noise event. However, it has come under recent scrutiny because there is lack of evidence that it is successful, and because of the side effect risks. Another treatment commonly used is steroids injected into the middle ear, but both treatments require further study. Neither treatment has been clinically shown to help with tinnitus due to noise.

Act quickly: Less controversial is the use of the antioxidants I discussed previously. If you act quickly enough, the oxidative stress caused by noise damage can be reduced even after the fact. Talk to your primary care doctor about taking NAC and ALCAR right after the noise exposure, and then again for the next few weeks. Rest as much as possible, and make sure to keep hydrated.

Let your body heal: While noise may be the primary

cause of hearing damage leading to tinnitus, the two things that exacerbate tinnitus more than anything else are stress and fatigue. Do all you can to treat your body well so that your ears can heal as much as possible.

Plan for next time: Use prior experience to help prepare effectively for your next known exposure. Will custom earplugs work better? Should you purchase concert tickets a few rows back? Did you forget to pre-program your iPod at a lower volume?

Every time you depart a loud music concert with ringing ears, you have done damage. The tinnitus may be temporary at first, but the more noise

exposure, the more likely

you are to experience long-lasting tinnitus in the future.

Avoid noise: If you find your ears are now more sensitive to loud noises, carry earplugs with you—and use them. There are specialized earplugs that still allow you to enjoy the full range of frequencies, such as for hearing or performing live music. Limit time in noisy environments such as crowded bars or open-plan restaurants decorated with hard surfaces such as glass and steel, and choose more ear-soothing settings for social outings.

Remember that one-third of tinnitus cases are due to noise damage. Almost all of these cases could have been prevented. You can now take preventative measures to protect your ears from tinnitus or to prevent your tinnitus from getting worse. No matter what you’ve been told about tinnitus, I’ve never seen a case where there wasn’t something we could do to help a patient take protective steps or successfully manage it after the fact.

While you may not be able to stop tinnitus that is a result of other factors, preventing tinnitus due to noise is possible. Be proactive, and be prepared. 🧠

Staff writer Barbara Jenkins, Au.D., BCABA, is Colorado’s first board-certified doctor of audiology. She 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, see advancedaudiology.info.

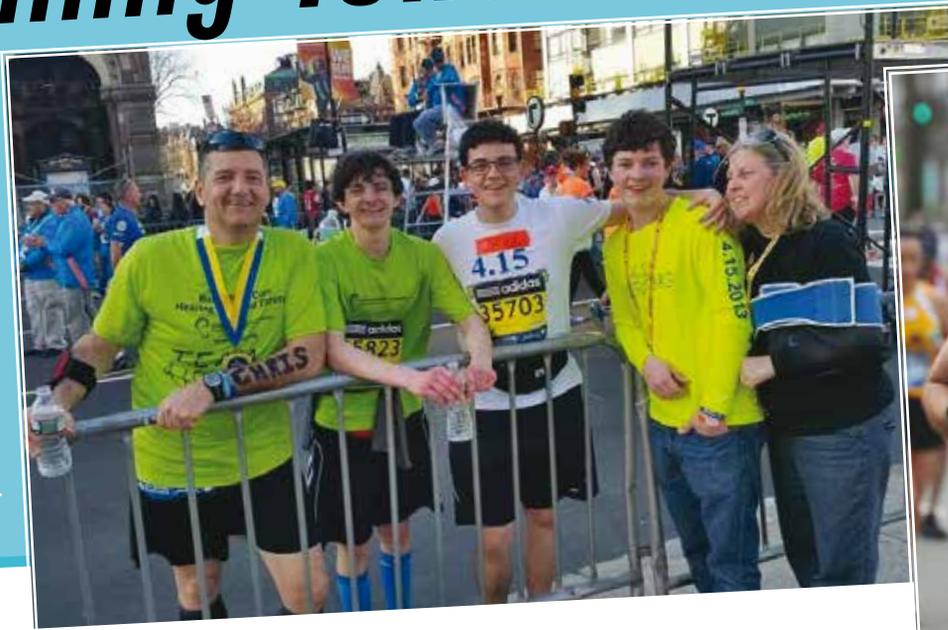
The two things
that exacerbate tinnitus
more than anything else are
stress and fatigue.



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Running Toward a Cure

The Campbell family at the 2014 Boston Marathon (near right); Dave Fortier before the blasts at the 2013 race.



A Family Bonds (and Runs) Together

By Tara Guastella

Like thousands of others on the morning of April 15, 2013, the Campbell family—mom Jean, dad Christopher, and three sons Corey, Trevor, and Mitchell—came to Boston to watch friends run the Boston Marathon, a sporting event that has attracted runners and spectators from around the world for over a century.

“We grew up in Massachusetts and always had Patriots Day off,” Jean says, referring to the Massachusetts holiday that coincides with the running of the historic race. “We wanted the boys to have that experience, of watching the marathon in person.”

Since the sons attended different schools, the family split into two groups and arrived at the race at separate times. Jean and Mitchell, now age 16, made up one group, and Christopher and Trevor, now age 19, met up with Corey, who was in college in Boston and is now 20.

The two groups ended up on opposite sides of the corner of Hereford Street and Commonwealth Avenue to watch the marathon. After a friend they’d come to see ran by, both groups started to head to the finish line on Boylston Street. While Jean was busy taking photographs of other runners, Mitchell, like any teenage son, urged

his mother to hurry up, and the two began to bicker. Mitchell was eager to get to the finish line and was starting to get impatient.

As it turns out, their disagreement may have saved their lives, Jean says. “If we hadn’t been bickering, we would have been closer to the explosions,” she says.

Minutes later the first bomb exploded. “That blast felt like a hurricane, and immediately it looked like a war zone,” Jean says. With sensorineural hearing loss in both ears, Jean instinctively leaned her “better ear”—the left one—toward the blast. “I knew immediately my hearing loss had worsened,” she says. As a result of the bombings, she also lost discrimination in her hearing and her existing tinnitus became exacerbated.

Jean also instinctively knew the sound was a bomb. Clinging to each other, she and Mitchell ran for their lives. “I felt like we were in a movie,” Jean says. To get off the street, they ran into a Crate & Barrel store. “The very competent staff helped us escape through a back door,” she says. “They were incredibly kind and helpful. It was almost as if they were trained for it.” Mitchell remained very calm and collected throughout the day’s events, Jean



Last year, the Boston Marathon bombings killed three people and injured 264. More than half of those injured sustained permanent hearing loss and tinnitus, some severe. Now Boston Marathon blast survivors are running to raise funds for Hearing Health Foundation and the promise of a cure for hearing loss and tinnitus.

These runners are encouraged by the strides HHF and the Hearing Restoration Project consortium have been making toward finding a cure. This includes early success with regenerating sensitive inner ear hair cells in adult mice. In all mammals, including humans, once these hair cells are damaged through noise or age the result is permanent hearing loss, which is often accompanied by tinnitus.

Read on to learn how that day in Boston last April affected the lives of the Campbell family and Dave Fortier.

says, even after getting hit with a piece of shrapnel and feeling his own tinnitus grow much worse.

At the moment the blasts were occurring, Christopher and his two older sons happened to be taking a shortcut through the Sheraton Hotel to get to the finish line more quickly. “I didn’t hear a thing,” Christopher says. “I didn’t even know the bombs had gone off.” But once they learned what had happened, he and his two sons were frantically wondering where the rest of the family was.

Since cell phone service was not available following the explosions, the family members could not contact one another. “We didn’t reunite until 10 p.m. that night,” Christopher says—back at their home in New Hampshire.

As soon as the blasts happened and she realized she could not hear out of her right ear, Jean says she knew she had to see her audiologist at Massachusetts Eye and Ear Infirmary. She says she had a fleeting thought of trying to go to the hospital in Boston, but at the time it was unclear whether the entire city was under attack. “I needed to find the rest of my family and get out of there,” she says.

Jean now wears bilateral hearing aids, and she and Christopher belong to a support group for people who were injured in the Boston blasts. There they’ve met other survivors, including Dave Fortier (see next page).

Although they lived through a traumatic event, the family’s prior experience with hearing loss—besides Jean’s hearing loss, Trevor was born with a moderate to profound hearing loss and uses hearing aids—made

them slightly better equipped to handle the confusion and depression that can come with the sudden loss of hearing, Christopher says. “We think educating people about what to expect, and how to cope, is important,” he says. In fact, the family helped found an oral school for the deaf in New Hampshire when Trevor was diagnosed with hearing loss as a child, and Christopher’s father played a key part in developing the real-time captioning technology used today on televisions and phones.

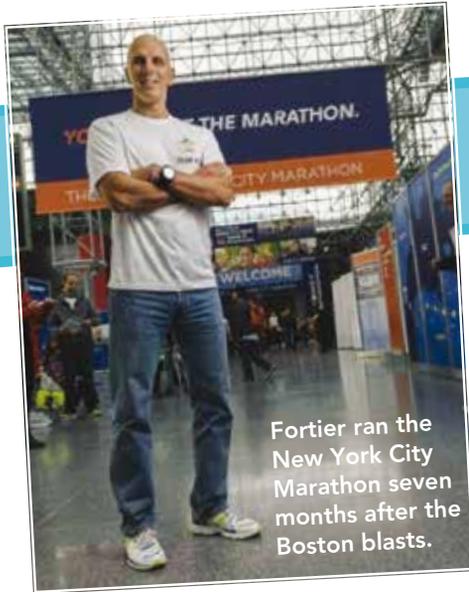
The family’s proximity to the two bombs that day made them all too aware of how circumstances can be dramatically altered in the blink of an eye. But the survivors have shown the world the power of resilience.

And so a year later, in April 2014, the Campbell family returned to the site of the blasts. Christopher, Corey, and Trevor not only ran their first-ever Boston Marathon, but ran it to raise funds for HHF and to make hearing loss and tinnitus a thing of the past.

“Running the Boston Marathon had always been on my bucket list,” Christopher says. “And while I’d had knee injuries, had not run in years, and was out of shape, when my wife asked me if I would consider running it on her behalf, I of course said yes.”

Tara Guastella is the online editor of this magazine as well as the program administrator at HHF.

Please turn the page to read how tinnitus affects another Boston blast survivor, runner Dave Fortier.



Fortier ran the New York City Marathon seven months after the Boston blasts.

'I'm Taking Care of My Hearing'

By Yishane Lee

Last year, Dave Fortier raced the Boston Marathon in honor of a friend who has leukemia and became one of the nearly 300 people who were injured by the bomb blasts. A piece of shrapnel became embedded in his right foot, and the immediate ringing in the ears he experienced is now permanent.

Fortier's foot healed quickly, and he was able to run the New York City Marathon seven months later, again to raise funds for leukemia research. But while supporting his friend will always be a priority, Fortier now has a personal interest in promoting the search for a cure for hearing loss and tinnitus. "On long runs I think about things I want to do, and after finishing Boston again this year, my first thought has been to take care of my hearing," says Fortier, who lives in Massachusetts. "I'm very happy to be supporting HHF."

Fortier plans to raise funds for HHF when he and other Boston Marathon survivors race the New Hampshire Reach the Beach Relay in September. The relay spans 200 miles and 24 hours, with everyone on a 12-person team taking separate legs (including overnight) to run nearly 17 miles each.

The relay builds on the feeling of unity that many of the survivors

felt while training together for the 2014 Boston Marathon. "We had 28 people running the race," Fortier says. "Many were first-time marathoners, like Chris Campbell [whose story is on the previous page]. I could really see we all felt a sense of belonging, and one of my biggest fears was that after the finish line this feeling would end." Fortier says signing up and training for Reach the Beach will help continue the camaraderie and togetherness that the survivors feel. The search for a cure for hearing loss and tinnitus personally affects several who are running the relay, he adds.

Fortier was minutes from finishing up the 2013 Boston Marathon when the first bomb went off. "If you see the videos and photos of when the first explosion happens, I'm the guy with a black hat and black shorts who is right behind the gentleman who falls. I'm reaching up and holding the side of my head," he says.

"The sound—it felt like someone hit me with a brick. I actually thought someone behind me had cuffed my ear with a fist. I just remember that pain. The ringing happened instantaneously."

He continues, "At the medic tent, they literally had to yell at me to get me to hear anything. Everything was just this muffled, slow-motion noise. I was told, 'Don't worry, go home and rest. Your hearing will come back.'" One treatment for sudden hearing loss is steroid injections through the eardrum into the middle ear, but Fortier didn't learn about it until two weeks later, when he opted for steroids taken orally. It did not help tamp down the tinnitus.

"The ringing today is as loud as it

was that day. It's ever-present."

Although his hearing loss in his left ear, which was facing the first blast, is mild so far, Fortier has been taking steps to compensate. "Now I tell people when I'm first meeting them that I will be leaning toward them to hear better, so they don't think I'm getting in their personal space for no reason. I've also learned to look at the speaker's lips for clues," he says.

As the head of his own business, he has made adjustments for client meetings. "What's really become difficult for me is when there are multiple conversations going on," Fortier says. He keeps meetings small and avoids noisy restaurants. He is also more sensitive to loud noises, and carries earplugs.

At night, Fortier uses a combination of white noise and low-volume talk radio to mask the tinnitus. "But I'm lucky if I get three solid hours a night. If something wakes me up—like the dog needing to go out at 3:30 a.m.—well, then, I'm up for the day." In order to avoid disturbing his wife, he uses earbuds. "I wake up all tangled in them," he says.

Overall, Fortier counts himself lucky and is as focused as ever on helping others—and now himself—through running and fundraising toward a cure for hearing loss and tinnitus. "My injuries were so minor compared with everyone else's," he says. "But while the stitches in my foot are long gone, for me hearing is the bigger issue for sure." 

Yishane Lee is the editor of this magazine.

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Protection for All

Although there are federal guidelines for hearing protection, the onus for effective hearing conservation programs in the workplace lies with employers. Here is one company that is going above and beyond.

By Kathi Mestayer

NOISY WORKPLACES HAVE BEEN AROUND

forever. In colonial times, blacksmiths' hammers were so loud that their shops were restricted to designated areas. Now, construction areas may be filled by the noise of jackhammers. Noises change, but the challenges remain.

Despite advances in acoustics, materials, and mechanization, noisy workplaces still exist, with the result often being noise-induced hearing loss (NIHL). And the problem of NIHL in the workplace is not a small one. The U.S. Bureau of Labor Statistics reports that hearing loss is the second most common workplace injury.

When employee noise exposure equals or exceeds the legal standard, or "action level," the Occupational Safety and Health Administration (OSHA) requires implementation of a hearing conservation program. OSHA's action level is an eight-hour average sound level of 85 dBA (dBA is a decibel unit adjusted for the human ear).

Alice Suter, Ph.D., an occupational noise consultant in Portland, Oregon, was the principal author of both the hearing conservation amendment to OSHA's noise standard (implemented in 1981) and the Hearing

Conservation Manual, published by the Council for Accreditation in Occupational Health. The manual is used by audiologists, acousticians, and companies as a reference and for accreditation in hearing conservation.

Suter says about nine million workers in the U.S. are exposed to levels of noise that require hearing conservation programs. (See "The Noisiest Professions," page 35.) She says there are three approaches to mitigating the impact of noise: reducing it through better acoustics and engineering controls, reducing the time workers spend in noise, and using hearing protective devices (HPDs).

So what are companies doing to preserve and protect their employees' hearing? Here is a profile of one that is taking proactive steps.

Praxair, an international manufacturing firm of 28,000 employees (with more than 7,000 in the U.S.), has been focused and innovative in its hearing conservation efforts. Its core manufacturing business is the production of gases such as oxygen, hydrogen, nitrogen, argon, carbon dioxide, and helium for manufacturing, medical, scientific, and other uses. It also specializes in applying thin, protective,

metal coatings to high-performance materials used in such machines as aircraft engines, turbines, and gears.

Praxair's manufacturing processes are fairly loud. To produce gas, Praxair has to separate pure gases from air, or what it calls "harvesting the air." That air separation process is done at high pressures, which is noisy. How

noisy? Exposures can be more than 100 dBA, according to Peter Griffin, M.D., Praxair's corporate medical director. At 100 dBA, OSHA limits the "dose," or maximum exposure, to two hours maximum a day.

The company takes hearing conservation seriously, in some cases exceeding OSHA's requirements. "Many of our workers are unavoidably exposed to loud noise at work, so hearing health and hearing protection are important to us," Griffin says. "We also have the multitude of other, less-noisy work settings you often find in manufacturing, such as truck driving, delivery, and cleaning equipment. We are actively implementing all of OSHA's hearing conservation program elements in every activity that meets the noise criteria."

In its efforts to minimize hearing loss in the workforce, Praxair has identified a few areas for special emphasis.

Building awareness: A big challenge in hearing conservation is creating—and sustaining—awareness of the potential for hearing loss. "In most cases, hearing loss is both long-term and gradual, so it doesn't get people's attention," Griffin says. "The employee level of concern is often lower than it should be. We have to stay vigilant. Our safety staff are always on the lookout, reminding people to wear HPDs like earplugs and earmuffs."

There are a number of reasons that employees in many companies give for leaving HPDs in their pockets instead of putting them in their ears. "When it's hot, earmuffs can be very uncomfortable," Suter says. "And sometimes workers will not insert the earplugs all the way because they feel they can communicate better without them," which renders the earplugs much less effective.

She adds, "Special-purpose hearing protection devices are available for people with hearing loss, to reduce noise inside the protector, or to turn down the volume when it reaches a certain threshold. But you still have to wear them."



Praxair has taken steps to safeguard its workers' hearing. Reducing noise levels also prevents stress, high blood pressure, and insomnia.

Acoustics: For its metal-coating process, many Praxair facilities have acoustically fitted cubicles, or "spray booths," to house the machinery. The size of the booths varies according to what is being coated—up to 80 feet long, to handle large rolls for the steel industry. All of the surfaces, except the door, are covered with sound-

absorbing material. Within the booths, noise levels can reach 130 dBA, but the booths' sound insulation means outside noise measurements are under 85 dBA. From outside the booths, employees can start and stop the spray process as well as insert additional parts to be coated by placing them in special shuttles.

Engineering: Praxair's research and development center, in Buffalo, New York, also tackles the noise issue. "Our engineers are always looking for quieter devices," Griffin says. "They never stop thinking about how to reduce noise." New plant facility installations are required by Praxair standards to reduce noise in air-separation production areas to below 95 dBA, mostly through the installation of protective walls and the use of quiet motors.

The latest hearing health innovation at Praxair is taking hearing conservation beyond the workplace, with a new video (created with input from Hearing Health Foundation, the publisher of this magazine) in which Griffin talks about the importance of hearing. "No matter where you get hearing damage, it affects your whole life. We'd like to see the number of people with hearing loss be as low as possible, regardless of the cause," he says.

Another challenge for international companies like Praxair is accommodating the worker health and safety requirements in other countries. "Because of OSHA's work on this issue, our country has well-defined standards, definitions, and requirements," Griffin says. "Some of the other countries we operate in lack an established, clear definition of hearing loss and don't require hearing conservation safety programs like OSHA does."

Suter points out that some countries are ahead of the United States in terms of their emphasis on noise reduction through the kinds of engineering and acoustic improvements that Praxair is exploring and implementing. "For example, better equipment maintenance can reduce noise from vibration," Suter says. "Audiometric testing is

important—it can be an awareness-raising tool because it’s a real, visual representation of hearing loss—but reducing noise levels works across the board, and it doesn’t rely on people wearing hearing protective devices.”

Companies are increasingly seeing the long-term benefits of preventing hearing loss. “Studies have shown that we can prevent hearing loss, stress, high blood pressure, and insomnia with lower noise in the workplace,” Griffin says. “Add to that the benefit of fewer safety incidents and lower worker’s compensation costs, and you’ve got a strong case to make for being proactive.”

In the August 2013 issue of the journal *Seminars in Hearing*, Suter reviewed research on the impacts of workplace noise exposure. She found strong correlations between noise at work and absenteeism, injuries, fatalities, and job performance, especially on complex tasks.

The value for companies that decrease workplace noise is long-term, and goes beyond a simple cost/benefit analysis, Griffin says. “Preventable hearing loss is tragic in middle age or older workers,” he says. “Instead of fully enjoying their retirement, they may suffer all of the social and physical effects of hearing loss: social isolation, depression, and even accelerated cognitive decline, all of which have been associated with advanced hearing loss.”

Companies, regulators, and researchers are using the full array of tools now available, while pushing the envelope to find and implement new ones. “In fact,” Suter says, “while visiting plants on behalf of OSHA, we saw employees on the factory floor come up with some of the best ideas for reducing noise,” such as a simple, low-tech way of reducing the sound of an aluminum saw.

“Employees have in-depth knowledge of the process and equipment, and a strong incentive to find ways to turn down the volume,” Suter adds.

As the world seems to get noisier every day, the workplace may actually be getting quieter. The benefits could last a lifetime. 

For more about workplace noise and hearing conservation, including efforts by the international aluminum company Alcoa, see Winter 2014’s “Caution: Noise at Work.” To learn how to overcome workplace challenges when you have a hearing loss, see Fall 2013’s “Office Space.” Both are at hearinghealthmag.com.

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.

The Noisiest Professions

The Centers for Disease Control and Prevention (CDC) estimates that 30 million workers are exposed to hazardous noise on the job, with an additional nine million at risk for hearing loss from other agents, such as solvents and metals. NIHL is one of the most common occupational diseases and the second most self-reported occupational illness or injury.

Although any worker can be at risk for NIHL in the workplace, workers in many industries have higher exposures to dangerous levels of noise, the CDC says. It says the noisiest industries include agriculture, mining, construction, manufacturing and utilities, transportation, and the military.

Industry-specific studies show:



44 percent of carpenters, and



48 percent of plumbers

reported that they had a perceived hearing loss.



49 percent of male, metal/nonmetal miners

will have a hearing impairment by age 50 (vs. 9 percent of the general population), rising to 70 percent by age 60.



60 percent of military members

returning from Iraq and Afghanistan experience hearing loss and/or tinnitus, two conditions that have consistently been among the top-reported war wounds.

(Sources: The CDC, which oversees the National Institute for Occupational Safety and Health, and the U.S. Department of Defense Hearing Center of Excellence.)

(For the military’s efforts to protect hearing, see “A Fight for the Long Haul,” page 20.)



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Showstoppers



Florida's Orange County Convention Center hosted the American Academy of Audiology's AudiologyNOW! 2014 conference in late March. More than 6,200 attendees traveled to Orlando to learn about the latest products and technology to help with hearing loss and tinnitus. One growing trend: better connectivity between hearing instruments and other devices.

By Nannette Nicholson, Ph.D., and Clifford Franklin, Ph.D.

The ReSound LiNX (see page 38)

HEARING AIDS

Noise-induced hearing loss (NIHL) is a permanent hearing impairment caused by loud sounds with concentrated energy in a narrow frequency range, such as gunfire, power tools, or nightclub music. Damage to the ears can be from exposure that is brief or continual.

NIHL is the most common cause of tinnitus. People who experience tinnitus may also have a history of noise exposure. Tinnitus refers to ringing or buzzing sounds that have no external source. The impact of tinnitus ranges from mild and barely noticeable to severe and chronic.

One in four hearing aid wearers report that using hearing aids relieves tinnitus symptoms, and by improving communication, hearing aids reduce the stress of being

unable to converse. Hearing aids can also help mask the sound of tinnitus, sometimes through the use of new connectivity options.

Audifon Libra and Miro

The new receiver-in-the-canal (RIC, also known as receiver-in-the-ear, RITE) housing introduced by this German company combines natural sound quality, convenient usability, and flexible fitting. Directly positioned in the ear canal, the receiver produces a very natural perception of sound and is available in its Libra and Miro devices. Audifon also offers Switch, an ear-level masking device to use with Tinnitus Retraining Therapy. (Its devices that combine hearing aids with tinnitus maskers are not yet available in the U.S.) (audifon.com)

Connecting to Those We Love

Men and women returning from service to our country are exposed to continuous noise trauma, and may suffer from hearing loss. Connections to the ones we love are critical for transition back to civilian life.

The **Quattro 4.0 Amplified Bluetooth Neckloop** is perfect for people with or without hearing aids, and those with cochlear implants. The amplifier and removable Bluetooth microphone offer maximum flexibility for hearing loss and difficult listening environments.

With the **Quattro 4.0**, the joy and the laughter shared with those we love is just as wonderful as it was before military deployment.



Visit www.clearsounds.com for more information and to purchase the new Quattro 4.0.

 **ClearSounds**[®]
Moving Beyond the Sound Barrier
www.clearsounds.com

Beltone First

The Beltone First RIC is a sleek “made for iPhone” hearing aid. With the tap of a finger, the hearing aid receives a clear, clean sound streamed from an Apple product. The RIC functions like a tiny wireless headphone that can stream phone calls, music, movies, and audio from games. Beltone’s HearPlus iPhone app allows users to personalize their hearing experience, and its Tinnitus Breaker ear-level masker is integrated into its First, Promise, and True hearing aids. (beltone.com)

Bernafon Carista

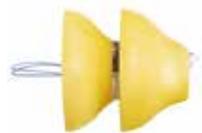
Available in a range of styles, Bernafon’s new Carista 5 and 3 hearing aids can connect via its latest wireless connectivity devices to mobile and landline phones, TVs, computers, GPS systems, and MP3 players. Signals are transmitted to the hearing aids using SoundGate 2 as a wireless bridge, a single interface to control many different audio sources. SoundGate 2 also has an extended battery life and an integrated telecoil for use in theaters and other public places. (bernafon-us.com)



Hansaton AQ Custom and AQ Slim

In 2013, Hansaton launched its super-fast technology called XearA and its rechargeable AQ products. These technologies now have come together with XearA’s integration into AQ Custom in-the-ear (ITE) and AQ Slim behind-the-ear (BTE, pictured) hearing instruments.

The AQ rechargeables each have a five-year rechargeable battery guarantee. (hansaton-usa.com)



Phonak Lyric3

This invisible-in-the-canal device is the world’s first and only 100 percent invisible, 24/7 wearable, sweatproof, showerproof, worn-for-months-at-a-time hearing aid. The latest model, Lyric3, has enhanced sound quality and fit. At only 12 millimeters long, it fits in every ear, no matter the size of the ear canal, and uses the outer ear’s anatomy to direct sound to the device, where it is amplified to the eardrum. Phonak says users experience improved directionality and localization with the smaller size of Lyric3 (a reduction of about 25 percent), and the majority of Lyric wearers report that the sound quality is very natural. (phonak.com)

ReSound LiNX

ReSound’s LiNX mini RIC (pictured on page 36) is a new “made for iPhone” hearing instrument, wirelessly streaming stereo sound from an Apple iPhone, iPad,

or iPod Touch without the need for an additional pendant-like device. The ReSound Smart App allows for the customization of the volume and treble and base levels, and makes use of geotagging to assign and adjust ReSound LiNX to the acoustics of frequently visited locations. (resound.com)



Sonic Flip⁴⁰

Sonic introduced Flip⁴⁰, a basic model that rounds out the Flip family of mini RICs. Also new is the small, discreet Nano RIC (pictured), available in the Bliss and Charm lines and at all technology levels. Nano RIC includes built-in telecoil/auto telephone and wireless connectivity. Both Flip⁴⁰ and Bliss and Charm Nano RICs are built on Sonic’s Speech Variable Processing platform and feature Speech Priority Noise Reduction and easy-to-use controls. (sonici.com)

Unitron Moxi² and Quantum²

Unitron presented Pro, the new premium technology level for its Moxi² and Quantum² product families, whose styles range from BTE to RIC. Pro delivers a number of industry-leading enhancements, including SpeechZone 2. Activated when speech is present in a noisy environment, SpeechZone 2 sensors rapidly determine if speech is coming from the front, back, left, or right side of the listener. SpeechZone 2 then automatically selects a binaural or asymmetric synchronized microphone strategy to ensure the best possible speech understanding in noise. (unitron.com)

STREAMERS

ClearSounds Quattro

For use with and without hearing aids, the ClearSounds Quattro 4.0 Adaptive Bluetooth streamer has a removable Bluetooth mic. Also introduced was QH2 Bluetooth Hub and cordless amplified phones with Bluetooth. These Bluetooth products comprise an “open source” solution for hearing aids, so they work with hearing devices from manufacturers who do not have proprietary streamers and accessories. (clearsounds.com)



Oticon Streamer Pro

Oticon announced its new ConnectLine App that connects to the Apple iPhone through the newly upgraded Streamer Pro 1.2. The Streamer Pro is worn



around the neck and acts as an intermediary device to connect Bluetooth-enabled devices to Oticon hearing instruments. Users can move seamlessly from listening to music and making audio and FaceTime calls to using personal microphones, landlines, cell phones, or the TV. By using Streamer Pro with the app, users can switch to a variety of input sources with just a few taps, and volume can be adjusted individually for each source in advance or in real time. (oticonusa.com)

Widex UNI-DEX

Widex launched UNI-DEX, a neck-worn plug-and-play solution for easy cell phone use. The device streams audio from any device using a mini-jack output that then streams sound directly into hearing aids. UNI-DEX can stream for up to 40 hours and takes only an hour to fully charge. For people with tinnitus, the DREAM hearing aid family continues to be available with Zen. Zen is a

customizable music program plays random, chime-like tones to enhance relaxation as well as provide relief from tinnitus. (widexusa.com) 

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Clifford Franklin, Ph.D., is an associate professor in the Department of Audiology and Speech Pathology at the University of Arkansas at Little Rock. He has a joint faculty appointment at the University of Arkansas for Medical Sciences.

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Implantable Options

Implantable devices continue to be excellent options for people with hearing loss who do not benefit from hearing aids. They can help not only with hearing but also tinnitus. Cochlear implants (CIs), especially if implanted in both ears, have been shown to provide tinnitus relief, sometimes continuing even after the CI has been turned off.

CI manufacturers are well established: Advanced Bionics (advancedbionics.com), Cochlear Americas (cochlear.com), and MED-EL (medel.com). Advanced Bionics' new AquaMic and AquaCase are designed to be used with its CIs during such activities as swimming, skiing, and mountain biking. The AquaMic is the only waterproof microphone for use with a CI.

Cochlear introduced its newly FDA-approved, Nucleus Aqua+ waterproof CI system, a sleeve and integrated coil-cable that provides a smooth, streamlined, and secure

solution for use underwater. Available as of May 2014, it allows users of Cochlear's Nucleus 5 or 6 sound processor to swim for up to two hours.

The new Sports Headband from MED-EL, made from moisture-wicking, ventilating material, is for use with its Rondo processor (pictured, and for the Concert, Sonata, Pulsar, and C40+ CIs) and its Amadé processor (for the Vibrant Soundbridge middle ear implant). The Pulsar, Sonata, and Concert CIs are the only CIs that are now FDA-approved for use with 1.5 Tesla (T) MRI systems without the need to surgically remove the internal magnet.

For bone-anchored devices, Oticon Medical introduced its latest sound processor family: Ponto Plus, Ponto Plus Power, and Ponto Streamer. Ponto Plus is



The MED-EL Rondo

the most powerful ear-level, bone-anchored sound processor on the market. Ponto Streamer connects Ponto Plus to a wide range of wireless options. (oticonmedical.com)

Sophono's Alpha 2 MPO continues to provide a proven option to those interested in an abutment-free bone-anchored device. (sophono.com)

Cochlear's Baha 4 Connect provides patients with the option of a well-established, traditional bone-anchored device, while its Baha 4 Attract provides an abutment-free choice. (cochlear.com)

Middle ear implant device choices continue to be Envoy Medical's Esteem (envoymedical.com), MED-EL's Vibrant Soundbridge (medel.com), and Ototronix's Maxum (mymaxum.com).

—N.N. and C.F.



Data Mining Toward a Cure

As it transitions into its second phase, the Hearing Restoration Project is building on the information and data gathered since its launch to accelerate the search for a cure for hearing loss and tinnitus.

Hearing Health Foundation (HHF) recently announced the third consecutive year of funding new research projects through the Hearing Restoration Project (HRP) consortium. This year is exciting as the HRP scientists are finishing up the first of three phases of the Strategic Research Plan. This plan defines the road map to clinical trials for a cure for hearing loss and tinnitus within a decade.

Many types of hearing loss result from damage to the delicate hair cells of the inner ear. Humans can't regenerate these cells—but in a game-changing breakthrough in 1987, HHF-funded scientists discovered that birds can. Over the past several years, HRP scientists have produced new genomic datasets from fish and birds, which show regeneration, and from mice, which do not.

These datasets now allow us to take the next steps in understanding which genes promote regeneration in some animals and which genes block it in others.

“The 2014 funded projects will continue to move us closer to our goal of inducing hair cell regeneration in people to produce a cure for hearing loss and tinnitus,” says Peter G. Barr-Gillespie, Ph.D., the director of the HRP consortium. “I am incredibly pleased with the outcome of the work the HRP consortium members have been conducting over the past several years.”

“As a person living with hearing loss, I am thrilled with the progress that the HRP consortium is making,” says Shari Eberts, the chairman of HHF's board of directors.

“We are funding the best hearing scientists, conducting groundbreaking research, and are on track to see a cure for hearing loss and tinnitus.”

Three projects have been renewed (see opposite page) and four are being initiated. Each brings us closer to a cure. Here are details about the four new projects.

Bioinformatics and Gene Expression Analysis in Zebrafish, Chickens, and Mice as a Tool to Identify Genes for Future Functional Studies

Led by Andy Groves, Ph.D., Tatjana Piotrowski, Ph.D., and Jennifer Stone, Ph.D., this project is focusing on the bioinformatic analysis of genetic data collected throughout Phase I of the HRP. Over the past two years, the HRP has gathered hundreds of thousands of pieces of genomic data from zebrafish, chickens, and mice. Bioinformatics is a set of sophisticated computational tools that will allow us to compare this genomic data.

Since we know that zebrafish and chickens spontaneously regenerate their inner ear hair cells, we can compare their genetic data to that of mice, which like all mammals do not regenerate hair cells. Once we know which genes, or series of genes (known as pathways), trigger regeneration in zebrafish and chickens, and which inhibit it in mice, we will have better targets for drug therapies that may be able to induce regeneration in humans.

Single Cell Transcriptional Profiling of Chicken Utricle and Basilar Papilla Sensory Epithelium

Cells After Aminoglycoside-Induced Hair Cell Loss

Another new project expanding on work started in Phase I is analyzing the inner ears of chickens. Stefan Heller, Ph.D., Michael Lovett, Ph.D., Jennifer Stone, Ph.D., and Mark Warchol, Ph.D., are using newly developed techniques to study how supporting cells react when neighboring hair cells die and which signaling pathways are activated or deactivated. They are also determining if this new technique, known as single cell resolution, can be used more broadly in analyzing regenerative capabilities.

Characterization of DTR Mouse Model for Hair Cell Regeneration Research

Edwin Rubel, Ph.D., who is known as the co-founder of hair cell regeneration in chickens, is working on the creation of a mouse system in which inner ear hair cells can be reproducibly removed from the the inner ear without doing damage to other components of the inner ear. Rubel's lab has designed and produced a new mouse line in which a toxin can be introduced at any

age and it will reproducibly cause the rapid and complete elimination of all hair cells in the cochlea and most hair cells in the balance organs of the inner ear. This "model system" will allow for the systematic study of hair cell regeneration in live animals, and at any age.

Expression of Wnt Pathway Molecules and Potential to Stimulate Hair Cell Regeneration

Alain Dabdoub, Ph.D., and Albert Edge, Ph.D., are collaborating on a project studying the signaling molecules in the Wnt pathway to better understand its role in regeneration. Wnt signaling has been shown to play a major role in stem cell biology, cell proliferation, and cell fate determination. 

To learn more, see hhf.org/hrp_consortium_projects.



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THREE RENEWALS

These three previously funded projects will continue through 2014 to finish data collection efforts.

What Stops the Inner Ear from Regenerating?

The mammalian cochlea seems to start out with an intrinsic capacity to repair itself, but this disappears as the cochlea matures. Andy Groves, Ph.D., and Neil Segil, Ph.D., discovered that by blocking a specific cell communication method, the supporting cells next to hair cells allow for hair cell regeneration in very young mice.

(See Fall 2012's "What Stops the Inner Ear from Regenerating?" at hearinghealthmag.com. For updates about this project, see hhf.org/hrp-consortium-projects-groves-segil.)

Making a Map

The supporting cells next to hair cells give rise to new replacement hair cells in birds and fish, but not in mammals. However, Albert Edge, Ph.D., Stefan Heller, Ph.D., and Elizabeth Oesterle,

Ph.D., have discovered that in mice, nonsensory supporting cells can retain some normal function for long periods of time, making them promising targets for regeneration therapies.

(See Fall 2013's "Making a Map," at hearinghealthmag.com. For updates about this project, see hhf.org/hrp-consortium-projects-edge-heller-oesterle.)

What Will It Take to Seal the Deal?

Andy Groves, Ph.D., Neil Segil, Ph.D., and Jennifer Stone, Ph.D., figured out how to grow the inner ear utricle in a dish, allowing experimental access for the first time to hair cells and supporting cells in adult mammals. The utricle may be able to teach us about the signals that drive hair cell regeneration in the mammalian ear.

(See Winter 2014's "What Will It Take to Seal the Deal?" at hearinghealthmag.com. For updates about this project, see hhf.org/hrp-consortium-projects-groves-segil-stone.)

Watch Our New PSA

The promise of a cure for hearing loss as well as tinnitus is very real.

And underlying that promise is the discovery that chickens have the ability to spontaneously restore their hearing by regenerating their damaged hair cells after suffering hearing loss. While humans and mammals do not naturally regenerate hair cells, the Hearing Restoration Project is aiming to enable just that.

Watch our new Public Service Announcement (PSA) that highlights these exciting developments on the road to a cure, at hhf.org/curing_hearing_loss.



Meet Les Paul

Ambassador

Jazz Pianist John Colianni



Les Paul was a performer, innovator, and rock legend. He also had a hearing loss and tinnitus. In 2013, the Les Paul Foundation and Hearing Health Foundation (HHF) teamed up to prevent and cure hearing loss and tinnitus, which affects 50 million Americans and 360 million people worldwide.

One of the most common causes of both conditions is frequent exposure to loud sounds. As a result, many who work in the music industry are affected. Guitar great Paul, who died in 2009 at the age of 94, was determined to find a cure for hearing loss and tinnitus.

Now, with his foundation's support of HHF's Hearing Restoration Project, an international research consortium of top hearing researchers, we have the opportunity to find a cure. Together, the Les Paul Foundation and HHF launched the Les Paul Ambassadors program to promote awareness of tinnitus and hearing loss; of the prevalence and warning signs of tinnitus and hearing loss; and of a potential cure through the Hearing Restoration Project.

for a cure for hearing loss and tinnitus. (See "Data Mining Toward a Cure," page 40.) The New Jersey resident speaks about his experience with Les Paul here.

“I was Les Paul's pianist during his last 6 1/2 years of performing activity. I joined his group in the late summer of 2003, and it was a thrill and an honor to work with him. Les had not used a pianist in his combo since the 1950s. In the 2000s he decided to reintroduce the sound of his earlier group. That he chose me as his new pianist was immensely flattering.

Les was a pioneer in electric guitar technology. But his musical artistry on the guitar was just as incredible as his technical innovations. Even at an advanced age, and suffering from ravaged wrists and hands due to arthritis, he always played beautifully when I worked with him.

What he found frustrating at times were the limitations on his playing technique, imposed by the effects of his physical condition. When he was in his 40s, he could play with blinding speed and accuracy, and



“Somewhere Over the Rainbow.” Les was also an ingenious arranger, and this was reflected in the way he put together our routines and songs. Musically, he had it all!

Les was also a remarkable show-biz personality. He was quick-witted and good-naturedly sharp-tongued. He often had the band, the audience, and himself roaring with laughter at his barbs and spontaneous asides, made from his throne-like perch on stage between songs.

At our gigs, celebrities from all professions were summoned to the stage, including musicians and singers who would sit in with the band, but also policemen, astronauts, heads of state, comedians, actors, you name it! Les would engage in funny banter with these people, and in the case of the comedians, Les would always get the biggest laughs. Nobody could top Les!

I personally considered Les a special mentor. Through his remarks and his living example, he taught me

‘We performers risk exposure to high decibels.’

Meet our third Les Paul Ambassador, jazz pianist John Colianni, known as “Johnny Chops” for his virtuoso playing. He joins guitarist Lou Pallo and saxophonist Chris Potter in supporting the search

his articulation was not only swifter, but also cleaner and more accurate than that of other guitarists. And his tone was the sweetest and purest, as can be heard on his ballad renditions of songs like

a lot about my approach to the piano, and to music in general. He was great to converse with, one on one. I remember the many recollections and anecdotes he shared with me backstage.

After I joined the band I soon noticed that Les was experiencing hearing loss issues. As is well known, hearing loss and related issues are closely associated with the music profession. Performers like Les and me are frequently at risk of exposure to high decibels and frequencies, emitted from drums, brass instruments, and all types of sound systems and speakers.

Les fell victim to this kind of occupational hearing impairment over the years, and I remember that he was constantly experimenting with new hearing aids and hearing aid systems. We had multiple visits from hearing aid techs and specialists who would bring products

backstage for him to try.

Les told me about a peculiar phenomenon specific to his own case. When he would hear the note C in the octave above the middle C on the piano—while wearing a certain type of hearing aid that otherwise worked effectively—the C would sound a half note higher, like a C-sharp. I tested this on the piano, playing the C above middle C, and Les said, “That sounds like C-sharp.” Then I played an actual C sharp, and Les said, “That’s also C-sharp!” He wasn’t looking at the keyboard, proving that for some reason he was hearing it a half-tone higher.

He experienced this distortion to varying degrees with other notes in the scale. But Les was a very brave performer, and even when he was having hearing problems, his hands hurt him, or he was recovering from one of his bouts of pneumonia, he seldom missed a gig. He didn’t want

to disappoint his fans or himself, because he loved to play so much. And he loved playing with his group, which I was very proud to be a member of.

I’m very glad to have been asked to contribute some of my thoughts and recollections regarding Les, and to be able to pay tribute to Les while performing as part of the Les Paul Trio. And I’m glad to be part of the Les Paul Ambassadors Program with HHF, especially considering how specifically the issue of hearing health relates to my profession. Hearing health research is of great importance, for musicians and for everyone else. ”

—Andrea Delbanco, Senior Editor

(To read about Les Paul Ambassadors Lou Pallo and Chris Potter, see hearinghealthmag.com.)



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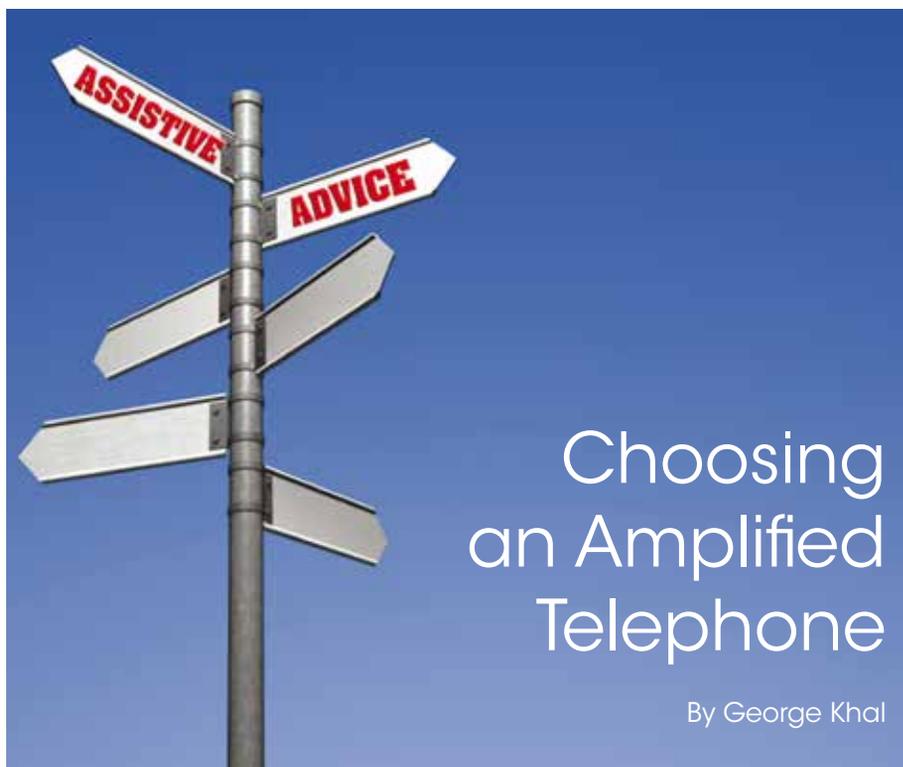
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Choosing an Amplified Telephone

By George Khal

No matter what the reason is for your hearing loss—noise, age, or genetics—you are likely to find that an amplified telephone will improve your hearing experience. This kind of phone raises the volume so you can better hear the person you're talking to.

Deciding which model to get can be a daunting task because of the number of models and features available. The various phone manufacturers strive to make their products appealing to different segments of the population, sometimes all in one model. So the phones are often not just for individuals who have a hearing loss but also for those with vision, dexterity, mobility, cognitive, and speech impairments. As a result,

of phones on the market today. And the options are myriad: cordless, corded, caller ID-equipped, large screen size, speed dial, one-touch emergency dialing, large buttons, speakerphone capability, built-in answering machine, and a jack for a headset/neck loop. Plus there are various choices when it comes to how loud the ringer is, what sound it makes, and whether the ring is accompanied by flashing lights.

While these are all worthwhile features, none are more important than the volume and tone controls.

An amplified phone is advertised to increase volume 30 to 50 decibels. Decibels (dB) are a measure of the intensity of sound. For example, a whisper is measured at 30 dB and

can determine the severity of your hearing loss. The degrees of hearing loss as defined by the American Speech-Language-Hearing Association are mild (26 to 40 dB), moderate (41 to 55 dB), moderately severe (56 to 70 dB), severe (71 to 90 dB), and profound (more than 90 dB).

For a mild hearing loss, I suggest you try a phone with 30 dB amplification; for a moderate or moderately severe hearing loss, try a 40 dB phone; for a severe hearing loss, try a 50 dB phone; and for a profound hearing loss, opt for a captioned telephone.

Warning: Please use caution when using the volume on your amplified phone, especially when wearing hearing aids. Loud amplification, especially for an extended period of time, can cause further damage to your hearing if improperly used. Follow the manufacturer's instructions on proper use.

The second important feature of an amplified telephone is the tone control. Tone control increases clarity by adjusting the frequencies (itches) that are difficult for you to hear.

The Telecommunications Industry Association (TIA) has developed two standards for amplified telephones. The first is the TIA-1083 standard that states that digital cordless phones must reduce interference problems (static and buzz) experienced by hearing aid users, especially those using a telecoil. All amplified digital cordless phones comply with this standard.

The second standard is the new TIA-4953 standard that applies to volume control gain, tone control, simulated use for hearing aid users, and the sound level of the ringer.

Unfortunately, it is very expensive for the manufacturers to have each of their models tested for the new

Volume and tone controls are the most important features on amplified phones.

wading through the many choices to find the best one for your hearing loss can be a bit confusing.

There are approximately 90 models

normal conversation at 60 dB. The model of phone you choose will depend on your hearing loss.

Your hearing healthcare provider

TIA-4953 standard. Manufacturers have their own methods of rating the dB volume level. This is not to say that you cannot rely on the manufacturers' dB ratings. Most amplified phones perform very well and they can be extremely helpful to you when you have a hearing loss.

The only remaining choice is where to buy your phone. When shopping for a vendor, follow these suggestions and guidelines for a better experience:

- Does an actual person answer the vendor's phone, or is it answered by an automated machine? Vendors must be sensitive to your hearing loss, especially if you are using a captioned telephone.
- Internet-only vendors that offer deep discounts may not have the technical support or service you deserve.
- Choosing a vendor that supplies

a printed catalog can make it easier for you to browse models.

- A vendor with comparison charts will help you compare phone features at a glance.
- Use the standard 30-day trial period to fully test the phone. Treat the phone and its packaging carefully to improve your chances for a full refund if you return it.
- Product catalogs are usually printed in the fall, but sales on vendors' websites are plentiful just before the holidays.
- If the cost of a telephone is too high, try an in-line amplifier for a fraction of the cost. This is a battery-operated unit that connects directly between the handset and the base of a corded phone. You may also try a strap-on amplifier to use with any type of phone. These amplify 20 to 45 dB. In addition,

check to see if your state offers assistive listening devices, such as amplified phones, for people with hearing loss. (For details, see my Spring 2014 column, "Take Advantage of State Programs," at hearinghealthmag.com.)

I hope these tips have helped narrow down your choices when it comes to choosing an amplified telephone that fits your needs. 

George Khal founded Sound Clarity, an international retail company for assistive devices, and served as its president from 2000 to 2010. With a severe bilateral hearing loss, Khal was the Hearing Loss Association of America's chapter coordinator for Iowa and chaired its national convention in Cedar Rapids in 1992.



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Hearing Aid Choices for People With Noise-Induced Hearing Loss

By Courtney M. Campbell, Au.D.

According to the National Institute on Deafness and Other Communication Disorders, more than 10 million Americans have irreversible hearing damage from noise. In addition, 30 million to 50 million are exposed to dangerous noise levels each day.

With the exposure to harmful levels of noise increasing, there has been a significant rise in the amount of people coming in for hearing aids to help remedy noise-induced hearing loss (NIHL).

There are several considerations when it comes to choosing hearing aids to help with NIHL. Because of the way noise impacts the delicate sensory hair cells in the inner ear, NIHL is almost always a high frequency (high pitch) hearing loss.

The majority of the hearing loss will fall between 2,000 Hz (hertz) and 6,000 Hz—which is where many important speech sounds are, such as the K, S, F, and TH sounds.



frequencies.

Most people with noise induced/high frequency hearing loss tend to do best with receiver-in-the-canal (RIC) hearing aids, also known as receiver-in-the-ear (RITE) hearing aids. These have a small piece behind the ear (holding the battery, microphones, and amplifier) with the receiver (speaker) sitting deep in the ear canal. This type of hearing aid is usually ideal for a high frequency hearing loss because it does not block the ear. Sound can reach the lower frequencies in the apex (center) of the cochlea, resulting in a more natural sound quality, but it still gives ample amplification in the higher frequencies, which are picked up by the outer cochlea.

The RIC looks like a behind-the-ear aid (BTE, another popular choice for NIHL). But BTE receivers also sit behind the ear, meaning that sound waves must travel through

of sound (such as ringing, buzzing, hissing, pulsing) in the absence of any external stimulus. There are several hearing aids on the market that boost the ability to hear better and more clearly while also acting as a tinnitus treatment device. They can emit a masking sound like white noise to cover the sound of the tinnitus. Using a tinnitus masker can help reduce the user's awareness of their tinnitus over time. As always, it is very important to have tinnitus evaluated before proceeding with any treatment options.

Lastly, it is crucial to continue to preserve the hearing that remains, including after starting to use hearing aids. Being around loud noises, even for a short period of time, necessitates removing the hearing aids completely and wearing ear protection instead. Hearing aids are able to compress loud impulse noises (such as when a firetruck drives by with its alarms blaring) so that they're not uncomfortable sounds to hear, but hearing aids cannot sufficiently reduce dangerous levels of noise for extended periods of time. 

NIHL almost always affects the ability to hear the high frequencies, where many important speech sounds are.

For English speakers, these consonants are crucial for hearing speech clearly since they are often at the beginning and ends of English words. So it is important that the hearing aid has sufficient gain (amplification) specifically in those

tubing to reach the eardrum, which can affect the sound quality. The RIC eliminates that potential problem.

Another factor to consider when choosing a hearing aid is that many people who have NIHL often also have tinnitus. This is the perception

An audiologist at A&A Hearing Group in Chevy Chase, Maryland, Courtney M. Campbell, Au.D., earned her degrees at the University at Buffalo in New York. She has a hearing loss and has been wearing hearing aids for over a decade.



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Hearing Health Foundation aims to educate Americans about safe listening levels and how to prevent noise-induced hearing loss. Nearly 50 million Americans, including 1 in 5 teenagers, suffer from hearing loss.



How Loud Is Too Loud?

Sound level is measured in decibels (dB). As the number of decibels increases, so does the risk of harm to hearing, as shown in the guide below.

140-165 Firecracker, shotgun firing



140 Jet taking off



120 Ambulance siren, thunderclap

110 Jackhammer, rock concert, symphony orchestra

Regular exposure of more than 1 minute at or above 110 decibels risks permanent hearing loss.

105 MP3 players at maximum volume

No more than 15 minutes of unprotected exposure at or above 100 decibels is recommended.

95 Subway platform



85 Heavy city traffic, school cafeteria

Prolonged exposure to any noise at or above 85 decibels can cause gradual hearing loss.



75 Dishwasher

70 Hair dryer, vacuum

60 Normal conversation

40 Refrigerator

30 Whisper

0 Smallest sound a person with normal hearing can detect.

NAME:

Ning Zhou, Ph.D.
East Carolina University

BIO:

Zhou is a faculty member in the Department of Communication Sciences and Disorders at East Carolina University. She received a master's degree in linguistics and a Ph.D. in hearing sciences, both at Ohio University, and was a postdoctoral fellow at the Kresge Hearing Research Institute in the Department of Otolaryngology at the University of Michigan. She is a 2013 Hearing Health Foundation (HHF) grant recipient.

IN HER WORDS:

What we are trying to understand is how the physiological conditions in a deafened ear affect the perception of electrical stimulation via a cochlear implant and how that knowledge can help us provide better speech recognition with the device. In the past few years, we have shown that customized mapping of the device—which takes advantage of the healthier parts of the ear or adjusts the stimulation parameters on the less healthy parts of the ear—can help implant users hear better in a noisy environment. My first experiment on this project started in the first year of my postdoctoral training. It has been four years since then and I am still working on new experiments.

The healthiness of the ear can be assessed in many ways, by measuring its sensitivity to amplitude changes, frequency changes, or the detection of sounds. We are trying to understand the mechanisms underlying these measures and find out how important they are for speech understanding.



I was studying linguistics when I first got interested in speech. A professor from the Hearing and Speech Department came to our department for a talk, and I was fascinated by the quantitative acoustic analysis of speech sounds. Everything made sense. You can see how the distribution of acoustic energy of a sound changes with time in a simple spectrogram plot. But I didn't know where to begin to understand "universal grammar," one of the most important theories in linguistics.

I was raised in a family of smart people. It was not the most fun experience a kid could hope for! My father was a physicist. My brother is a spine surgeon with a Ph.D., and I have tried to understand his research but I never could. I was born in a city near Shanghai. I've always preferred mountains over ocean. Luckily, I am not far from the mountains or the ocean now that I have moved to North Carolina.

I plan to work as a scientist, although my recent research may have direct clinical implications. I hope to work with patients and hopefully provide them with better hearing.

—Andrea Delbanco, Senior Editor

We need your help to continue funding promising hearing researchers like **Ning Zhou, Ph.D.** To donate today to Hearing Health Foundation and support groundbreaking research, visit hhf.org/donate.

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Wearable technology can tell us how many steps we take, track our health and fitness, and monitor blood pressure and blood sugar levels. Reading glasses help millions of people read fine print or a menu in a restaurant, or do close work like needlepoint.

There are hundreds of audio products that allow users to adjust sound levels, including in-ear earphones and Bluetooth® headsets. Today's smartphones perform many functions, from playing music to using an app to control amplification of sounds in the world around us.

Many high-quality, less expensive sound amplifiers look like and have similar performance capabilities to those of more expensive ones. That's good news for consumers. Personal sound amplifiers help people hear the soft sounds of a conversation, sermon, play, or TV dialog.

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