

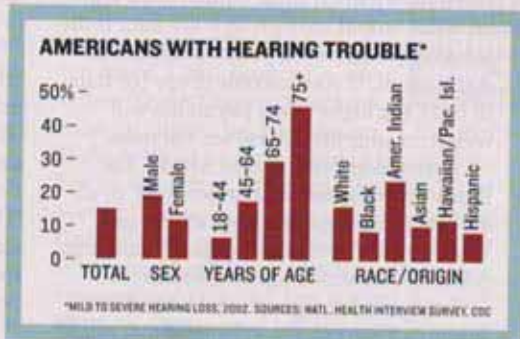
More than 28 million Americans have some degree of hearing loss, a number that could reach 78 million by 2030. The latest science, new treatments—and how to protect yourself.

A Little Bit Louder, Please

BY DAVID NOONAN

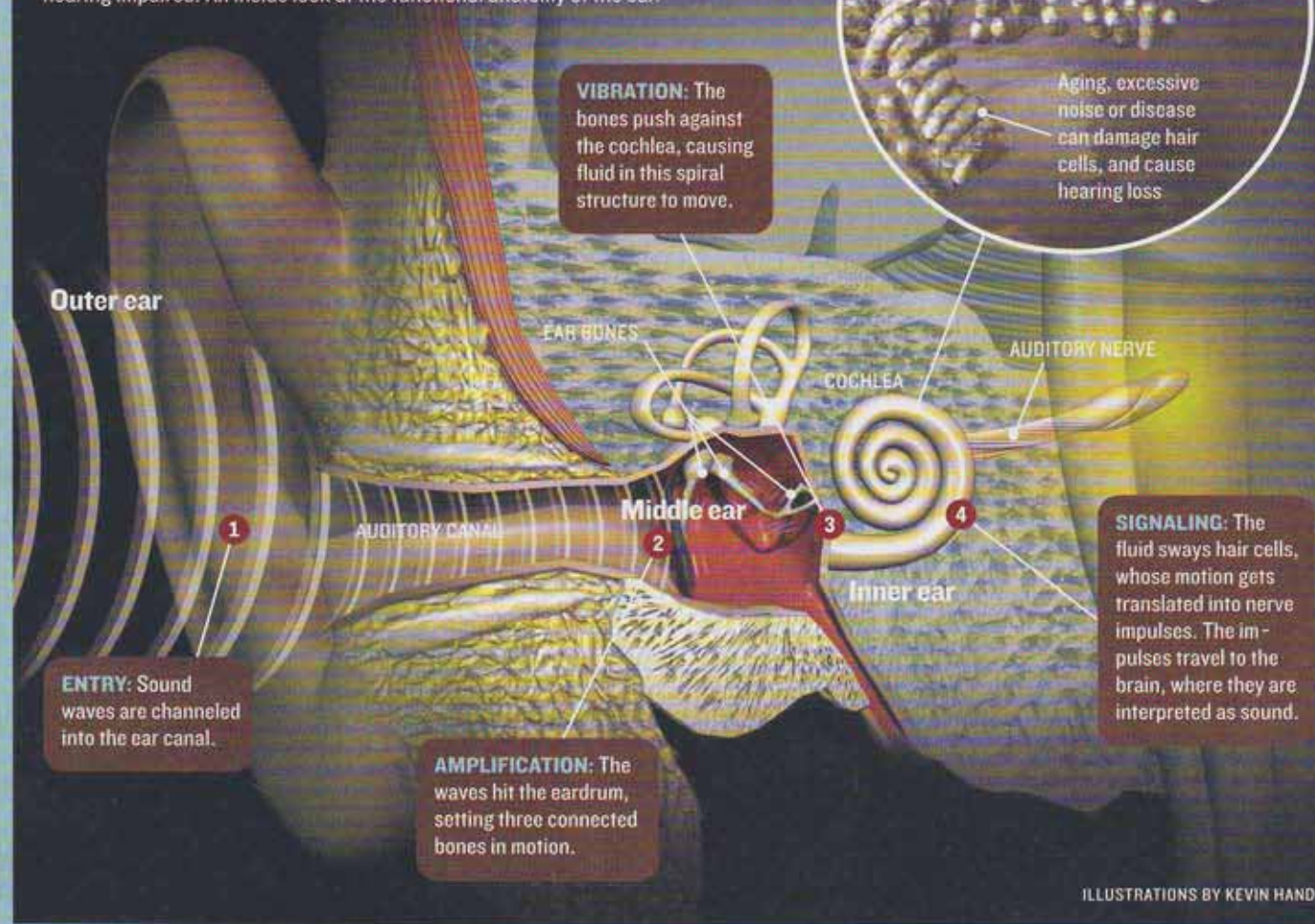
KATHY PECK HAS SOME GREAT MEMORIES OF HER days playing bass and singing with The Contractions, an all-female punk band. The San Francisco group developed a loyal following as it played hundreds of shows, and released two singles and an album between 1979 and 1985. Their music was fun, fast and loud. Too loud, as it turned out. After The Contractions opened for Duran Duran in front of thousands of screaming teenyboppers at the Oakland Coliseum in 1984, Peck's ears were ringing for days. Then her hearing gradually deteriorated. "It got to the point where I couldn't hear conversations," says Peck, now in her 50s. "People's lips would move and there was no sound. I was totally freaked out."

Peck the punk rocker lived out one of her generation's musical fantasies two decades



How Hearing Works

The ear is a complex system of moving parts prone to infection, damaged by loud noise and often weakened by age. More than 28 million Americans are hearing impaired. An inside look at the functional anatomy of the ear.



ILLUSTRATIONS BY KEVIN HAND

ago; Peck the hearing-impaired has been living out one of its fears ever since.

Over the years she has battled her problem, a combination of noise-induced hearing loss and a congenital condition (diagnosed after the traumatic concert), with a variety of strategies and interventions, including sign language, lip reading, double hearing aids and, eventually, surgery on the tiny bones in her middle ears. Today Peck, who used to cry with frustration at movies because she couldn't hear the dialogue, still has ringing in her ears (tinnitus) and mild hearing loss, but gets by without help.

Aging rockers aren't the only ones struggling with dimin-

ished hearing these days. More than 28 million Americans currently have some degree of hearing loss, from mild to severe, and the number is expected to soar in the coming years—reaching an astounding 78 million by 2030. While that looming surge is mostly a baby-boomer phenomenon, the threat of hearing loss—and the need for prevention—isn't limited to a single age group. We are all caught in the constant roar of the 21st century. It's the rare kid today who doesn't have wires snaking out of her ears as she rocks through the day to her own personal soundtrack. Televisions are bigger and louder than ever, and so are movie theaters. One study estimates that as many as 5.2 million chil-

dren in the United States between 6 and 19 have some hearing damage from amplified music and other sources. If they don't take steps to protect their hearing, the iPod Generation faces the same fate as the Woodstock Generation. Or worse.

Thanks to their years of living loudly, many boomers are ahead of schedule when it comes to hearing loss, showing symptoms in their late 40s and 50s. (In the past, patients usually weren't diagnosed until their 60s or later.) "We're seeing hearing loss from noise develop at an earlier age than we used to," says Dr. Jennifer Derebery, immediate past president of the American Academy of Otolaryngology-Head and Neck Surgery.

Thanks to their years of living loudly, many boomers are ahead of schedule when it comes to hearing loss.



Cochlear Implant

WHO IT'S FOR: Patients with damaged cochleas who don't benefit from traditional hearing aids. Cochlear damage can be inherited, or caused by noise, aging, head injuries or infections. The devices have been available for about 20 years and have been implanted in 90,000 people worldwide.

WHAT IT DOES: Channels sound around damaged parts of the cochlea to directly stimulate the hearing nerve.

HOW IT WORKS: **1** An external earpiece picks up sound, and converts it to digital signals. **2** A transmitter sends the signals to an implant under the skin. **3** Signals are sent to an array of electrodes coiled inside the cochlea. **4** The electrodes directly stimulate nerve endings, bypassing damaged hair cells that normally pick up sound signals. Nerves relay the sound information to the brain.

SOURCE: COCHLEAR, INC.



ILLUSTRATIONS BY KEVIN HANG

"It's a huge problem." The good news: though hearing loss can't be reversed, reducing exposure to excessive noise, like quitting cigarettes, can improve your health and quality of life, no matter your age.

Of course, noise isn't the only culprit. "Even if you spent your life in the library, you wouldn't hear as well when you're 70 as you do when you're 20," says Dr. Robert Dobie, professor of otolaryngology (ear, nose and throat) at the University of California, Davis. But who spent their lives in the library? Not Kathy Peck and her fans; not the folks riding jackhammers on road crews, and not the firefighters and cops dashing to the rescue with their sirens screaming. Even pediatricians have been known to develop hearing problems after years spent around

MIND YOUR EARS: Coal miner Ernie Morgan of West Virginia lost some hearing on previous jobs and now wears ear protection

crying babies. When you combine the excessive noise they have experienced at work, home and play with the natural effects of aging, boomers end up on the receiving end of what Dr. Peter Rabinowitz at the Yale School of Medicine calls a "double whammy that makes people much more symptomatic."

But progress is being made on many fronts. Awareness and prevention efforts—community-based, state and nationwide programs—are gaining support around the country as hearing loss is increasingly recognized as a public-health issue. Advances in digital technology have dramatically improved hearing aids; they are smaller than ever, with far better sound quality. And clinical trials are now underway on permanent, implantable hearing

aids for the middle ear which will offer sound that is superior even to the best external aids. On the biological front, scientists are busy trying to unlock the genetics of hearing to find a way to regenerate the sensitive hair cells, essential for hearing, that line the cochlea, the spiral, seashell-like structure located in the inner ear. And way out on the horizon of the cutting edge, researchers have created an experimental brain-implant system that bypasses the ear altogether and sends sound from an external receiver to the part of the brainstem that processes sound (page 49).

The product of extraordinary, even beautiful, anatomy, hearing is a natural wonder and exactly the sort of gift we tend to take for



Join David Noonan for a Live Talk on hearing Wednesday, June 1, at noon, ET, on Newsweek.com on MSNBC.

granted. "Unfortunately, a lot of people do not value their hearing," says Dr. William Slattery, director of clinical studies at the House Ear Institute in Los Angeles. Hearing may also be too good for its own good. Human ears were originally meant to pick up the faintest sounds of predators stalking our long-ago ancestors—the snap of twigs in the forest, the rustle of grass on the savanna. The crash and racket of modern life, both urban (motorcycles, subway trains, car alarms) and rural (chain saws, snowmobiles, shotguns), assault and insult these gorgeous instruments.

Most common types of hearing loss occur at the higher frequencies and are caused by damage to hair cells. Slattery describes the cochlea as "a piano, with 15,000 keys rather than 88." Different parts of the cochlea process different frequencies of sound, so when you have hearing loss at a certain frequency, it's as if that part of the keyboard is not functioning. Various levels of noise affect hair cells in various ways. If a rocket-propelled grenade goes off right next to you, you can experience "acoustic trauma" that kills hair cells and causes the instant loss of a great deal of hearing. (Hearing loss is the third most commonly diagnosed service-related ailment, according to the Department of Veterans Affairs.) Hanging out directly in front of the speakers at a Green Day concert could result in a less serious "temporary threshold shift," in which the hair cells are stressed but not permanently damaged. Such stress is often accompanied by ringing in the ears that can last for hours or even days. (Derebery notes that repeated threshold shifts can lead to permanent hearing loss.) And then there's what might be called noisy-world syndrome. While an individual's noise exposure may not reach the official danger zone, the worry is that the chronic din of daily life could lead to deterioration over time. "There's not a lot of data about it," says Rabinowitz, "but our concern is that there is less and less time for the ears to rest, and so the

hair cells are going to be prematurely exhausted."

Protecting your hearing starts with understanding how noise works. The classic "formula" for assessing the risk of hearing loss is the intensity of the noise, measured in decibels (the danger starts at 85 decibels, roughly the sound of a lawn mower), multiplied by duration, the time of exposure. In other words, the louder the noise, the less time you should be exposed to it. Prolonged exposure to any noise above 85 decibels can cause gradual hearing loss. According to what experts call the

MUSIC MAKER:
Karhy Peck's hearing was hurt during her bass-playing years in a popular—and loud—San Francisco punk-rock band

"five-decibel rule," for each five-decibel increase, the permissible exposure time is cut in half. So one hour at 110 decibels is equivalent to eight hours at 95 decibels. And sound levels above 116 decibels (snowmobiles are about 120, rock concerts about 140)

are unsafe for any period of time.

For millions of Americans, excessive noise in the workplace is a daily threat. Angelo Iasillo, 45, has worked in road construction since 1989, operating jackhammers and a "road grinder" to tear up Chicago's streets. He first noticed a problem with his hearing



If they're not careful, the iPod Generation could face the same fate as the Woodstock Generation. Or worse.

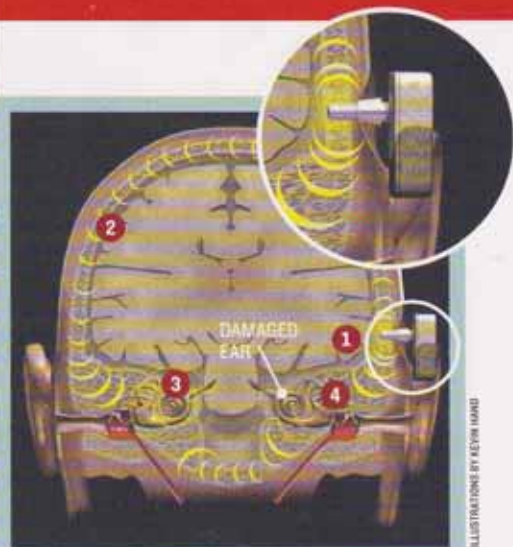


when he was in his early 30s and found himself asking more and more people to repeat themselves. He also demonstrated another classic symptom. "I was always putting the TV up louder," he recalls. Worried, he went to the doctor and was told, at 32, that he had the hearing of an 80-year-old. Today, Lasillo wears a hearing aid, uses a vibrating alarm clock that he keeps under his pillow and has his doorbell rigged to a lamp—it blinks when someone rings.

While the Occupational Safety and Health Administration (OSHA) has made great headway against noise-induced hearing loss in the past 20 years, compliance with federal regulations can be a problem in some occupations. Earplugs would certainly help protect road workers like Lasillo, but to be safe at busy work sites they also need to hear what is happening around them. And some professions are louder than we think. Truck-

drivers, for example, have a high incidence of hearing loss in their left ears from traffic noise, says Hinrich Staecker, professor of otolaryngology at the University of Maryland School of Medicine.

The National Institutes of Health runs a campaign against noise-induced hearing loss, called "Wise Ears," that emphasizes basic steps like wearing earplugs when operating power tools and moderating the volume on personal listening devices. The ubiquitous music players, which send sound directly down the ear canal, are a potential problem for millions of Americans, young and old. In a recent informal study at the House Ear Institute, researchers found that the new generation of digital audio players, with their exceptional clarity, allow listeners to turn up the volume without the signal distortion that occurs with traditional analog audio. Without distortion, which



ILLUSTRATIONS BY KEVIN HANCO

BAHA BONE ANCHORED HEARING APPLIANCE

WHO IT'S FOR: Patients with single-sided deafness, and those with damaged middle or outer ears. Available in U.S. since 1996.

WHAT IT DOES: Channels sound vibrations from the damaged ear to the working one, making it easier for patients to hear sounds coming from both sides of their heads.

HOW IT WORKS: **1** A processor implanted behind the deaf ear picks up sounds and transmits their vibrations to the skull. **2** The vibrations travel around the skull to the healthy ear. **3** Here, they stimulate the cochlea, which sends auditory signals to the brain, providing sound information from the deaf side. **4** The device can also restore hearing in the deaf ear itself—if that side's cochlea still functions. Sound vibrations are channeled around damaged portions of the deaf ear so they can directly stimulate its cochlea.

SOURCE: ENTIFIC MEDICAL SYSTEMS

serves as kind of natural volume governor, listeners may be exposed to unsafe sound levels without realizing it. In preliminary observations, the music at the eardrum topped 115 decibels. Exposure to noise that loud for more than 28 seconds per day, over time, can cause permanent damage.

Kathy Peck, who learned the hard way about the dangers of loud music, has dedicated herself to helping other musicians avoid her fate. Along with Dr. Flash Gordon, the physician from the Haight Ashbury Free Clinic who helped with her hearing loss 20 years ago, Peck cofounded Hearing Education and Awareness for Rockers (HEAR). Since its inception in 1988 (with seed money from the Who's Pete Townshend, whose hearing was also trashed by loud music), the group has helped thousands of young rockers, distributing free earplugs at clubs, concerts



Help: Hearing Aids and Prevention

HOW LOUD IS TOO LOUD?

Prolonged exposure to sounds above 85 decibels (motorcycles, lawn mowers or hair dryers) can cause hearing loss. The louder the sound, the less time it takes to cause permanent damage. Wear earplugs or earmuffs around loud noises.

HELP WITH HEARING: Today's hearing aids are more discreet, have less distortion and are better at blocking background noise than earlier models.

But cutting-edge technology comes at a cost: between \$2,000 and \$3,500. Some of the latest options:

- 1 the Widex Senso (\$2,195),
- 2 the Senso Diva (\$3,000–\$3,400),
- 3 the Phonak Claro (remotely controlled by a watch, \$2,300–\$3,500) and
- 4 the ReSound Air (\$2,000).

FOR MORE INFORMATION:

NIDCD: nidcd.nih.gov/health/wise/
 NIOSH: cdc.gov/niosh/topics/noise/
 Alexander Graham Bell Assoc.: agbell.org



and music festivals, and providing free screenings by audiologists.

For more than 6 million Americans, hearing aids are the best available solution for everything from mild to profound hearing loss. Today's digital devices, like the analog instruments that preceded them, amplify sound and transmit it down the ear canal to the eardrum. But the similarities end there. Thanks to digital technologies, modern aids offer better sound quality (above). Top-of-the-line models feature "directional" or "high definition" hearing. These devices use two microphones and an algorithm to enhance sound coming from the

front (the person you are talking to), while tuning down sound coming from behind (the rest of the noisy party).

Despite such encouraging technical advances, there are about 21 million people in the United States who could benefit from hearing aids, but don't use them. Many simply can't afford them. Their costs range from a few hundred dollars for a basic analog device to \$3,500 for high-end instruments, and are rarely covered by insurance. Another reason some folks eschew aids is discomfort—they simply don't like the feeling of walking around with a

MIRACLE WORKER: Without the experimental PABI system (graphic, above right), Molly Brown of Lynden, Wash., wouldn't hear at all

plugged ear canal. And even with digital technology, people can still have difficulty separating speech they want to hear from the background noise, a common hearing-aid problem. Yet another obstacle to wider use is stigma—many people associate

hearing aids with aging, Slattry says, and would just as soon cup a hand behind their ear. "They're afraid to look old, but they don't mind looking dumb."

A new generation of implantable and semi-implantable hearing aids, currently being developed and tested, could solve

Human ears were originally meant to pick up the faintest sounds of predators stalking our ancestors.





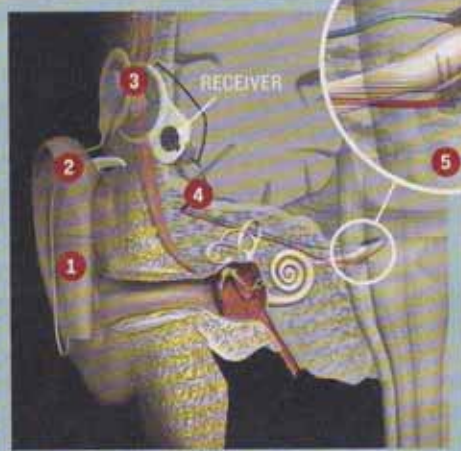
PABI PENETRATING AUDITORY BRAINSTEM IMPLANT

WHO IT'S FOR: Patients with damaged auditory nerves (these carry signals from the ear to the brain). Damage can be caused by surgery to remove brain tumors, meningitis, skull fractures or birth defects.

WHAT IT DOES: These experimental implants bypass the damaged auditory nerve and send aural information directly to parts of the brain that process sound.

HOW IT WORKS: **1** A microphone on the ear picks up sound. **2** A processor converts the sounds to electric signals. **3** The signals are sent via radio waves through the skin to a receiver. **4** Wires carry the signals to two electrode pads surgically implanted in the auditory area of the brainstem. **5** The electrodes are positioned to selectively stimulate different brain cells that respond to distinct frequencies, allowing the implant to reproduce a range of sounds.

SOURCE: HOUSE EAR INSTITUTE



Segil, with the calm that often masks excitement in scientific circles.

"If you are going to have a hearing loss, this is the best time to do it," says Char Sivertson, who began to lose her hearing without discernible cause when she was a teenager. Sivertson is downright enthusiastic about things like closed captioning. "It's incredible; now I'm not left out of TV," she says, and ticks off other high-tech advances, such as digital hearing aids and phones that can be "tuned" to improve the clarity of the caller's voice.

But Sivertson, an activist member of the Association of Late-Deafened Adults (ALDA), a support group, wasn't always so gung-ho. "I was in denial for years and years," she says.

"I tried to pass for hearing, which was ridiculous." Sivertson was using hearing aids by the age of 24, but it was another 20 years before she fully accepted her fate. And there were some dark days in between. Every few years, her hearing would suddenly get worse. After one such drop, "I was very depressed," says Sivertson, now 57. "I wasn't exactly suicidal, but I was thinking, 'I'm not sure life is going to be very meaningful for me from this point on.'"

Sivertson faced a myriad problems while raising her two sons, Dak and Matt. When there was a school matter or some other issue to discuss, her sons tended to bypass her and go to their dad, Larry, who has normal hearing. "Kids don't want to repeat themselves and stuff like that," says Larry Sivertson. "It's up to the hearing spouse to make sure that the person with hearing loss is involved." Char Sivertson found peace of mind through her association with ALDA. Joining such a group, she says, "is the No. 1 thing you can do for yourself" if you develop hearing loss later in life.

And here's something you can do before you reach that point—learn to appreciate what you already have. Says Yale's Rabinowitz: "If you are watching your diet, if you are exercising, then protecting your hearing should be part of your lifestyle." Sounds good to us.

With JOSH ULICK, KAREN SPRINGEN and JULIE SCELFO

many of these problems. Unlike conventional aids, the new devices transmit sound vibrations directly to the bones in the middle ear, bypassing the eardrum and improving speech perception. "You can amplify the higher frequencies without feedback problems," says Slattery, "and that gives a richness to the sound. It's the high frequencies that help you localize sound and hear better in noisy situations." Other pluses: no clogged ear canal and no visible sign of infirmity. But until insurance companies start paying for hearing aids (they are under increasing pressure to do so), the \$15,000-to-\$20,000 devices—intended for those with moderate to severe hearing loss—will remain out of reach for most.

A more permanent solution to hearing loss—regenerating damaged cochlear hair cells—is the shared goal of a scattered

band of researchers around the country. Unlike birds and other lower vertebrates, which can regenerate hair cells, humans and other mammals get one set, and that's it. If scientists can discover a way to grow new hair cells in humans, exciting new treatments could be devised. Already, researchers at the University of Michigan have used gene therapy to grow new hair cells in guinea pigs. At the House Ear Institute, Andrew Groves and Neil Segil are studying the embryonic development of hair cells in genetically engineered mice. If they can unravel the process, figure out how it starts and why it stops in mammals, they may eventually be able to reactivate the cells and have them make new hair cells. In a related experiment, they have managed to coax some embryonic cochlear cells in mice to restart and become hair cells. "This is new stuff," says