I Wish I Had Been Wearing Earplugs

By Daniel Fink, M.D., with Bryan Pollard and John Howard, M.D.

I AM A 67-YEAR-OLD, SEMIRETIRED DOCTOR. ABOUT nine years ago, I developed tinnitus and hyperacusis after a one-time exposure to loud noise on New Year's Eve. We were in a restaurant. As midnight approached, the music kept getting cranked up louder and louder. My wife could tell that I was uncomfortable and suggested we leave, but I didn't want to offend our friends who had made the arrangements.

I wish I had listened to her. I wish I had been wearing earplugs. We left as soon after midnight as was socially acceptable, but it was too late. My ears were ringing when we did, and the ringing never stopped. Loud noise began to bother me, too.

For eight years I suffered silently, but after reading an article about hyperacusis (heightened sensitivity to loud sounds) in late 2014, I became an advocate for quiet. Noise isn't just a nuisance; it causes hearing loss and other health problems. The World Health Organization estimates that 1.1 billion people are at risk for hearing loss. Numerous research papers have shown an association between untreated hearing loss and various serious health conditions, including dementia, depression, and falls.

How Do You Measure Sound?

Decibels, abbreviated dB, indicate a sound's volume. The decibel scale describes the amount of energy contained in a sound. It is logarithmic, like the Richter scale used to measure earthquake strength. This means that an 80 dB sound has 10 times more sound intensity than a 70 dB sound, and an 85 dB sound has 31.6 times (3,160 percent!) more sound intensity than a 70 dB sound.

The human ear adapts to loud noise, so the 80 dB sound is perceived as only twice as loud as the 70 dB sound—even though it is actually 10 times more powerful. But hearing damage is caused by sound energy, not perceived loudness.

Another complicating factor is that the human ear doesn't perceive low frequency sounds being as loud as higher frequency sounds. To account for this, scientists created a weighted decibel scale.

The industry standard became the A-weighted scale—dBA—which significantly reduces the sound pressure levels for low frequencies (under 1,000 Hz) for the total sound pressure calculation. In measuring sound levels, A-weighting is typically used, although you may just see the "dB" unit and not the more technically correct "dBA."

What Is a Safe Noise Level?

Results of my online searches showed the most common safe noise level cited to be 85 dB—about the sound level inside an airplane or from heavy traffic—without giving a time limit for exposure. I also found 70 dB mentioned by the Environmental Protection Agency (EPA).

But when I wanted to learn where the 85 dB standard came from, it took me a year. Eventually my inquiry was forwarded to John Howard, M.D. (one of my coauthors), the director of the National Institute for Occupational Safety and Health (NIOSH).

It turns out the 85 dB number is an *occupational* noise exposure level, calculated by NIOSH to protect workers' hearing. At an 85 dB noise exposure over 8 hours for 40 years, about 15 percent of workers develop hearing loss.

But the 85 dB limit is *not* a safe noise level for the public. Noise is different from other occupational hazards. For workplace exposures like solvents or radiation, exposure stops when the worker leaves work. But we hear noise all the time.

After learning that 85 dB is an occupational standard, I searched for the exact source of the 70 dB standard from the EPA. I finally found it buried in Appendix C of a 1974 EPA report. It is the *only* evidence-based safe environmental noise exposure level for the public that I have been able to find.

To determine the safe noise level for the public, the EPA started with the 85 dB occupational noise exposure standard. It then adjusted this for greater noise exposure, all day long for every day of the year, instead of only 8 hours at work for 250 days a year. The EPA calculated that 71.4 dB, rounded down to a very quiet 70 dB average noise level for 24 hours, is a safe listening level.

Earplugs, the New Sunglasses

Sunglasses protect eyes from the sun's harmful rays. Would earplugs have protected my ears in the restaurant? A study in the April 2016 issue of the journal JAMA Otolaryngology–Head & Neck Surgery says yes.

In this study, researchers in the Netherlands recruited 51 volunteers. Twenty-five were randomly assigned to wear earplugs at a music festival and 26 weren't. The Occupational Safety and Health Administration's Permissible Exposure Limit for 100 dB is only two hours. However, the music festival lasted 4 ½ hours at 100 dBA. That's very loud.

After the festival, the researchers measured hearing loss (temporary threshold shift, TTS) using audiograms, along with more sophisticated hearing tests (distortion product otoacoustic emission measurements, DPOAE). They also asked questions about perceived tinnitus, and measured tinnitus through tinnitus matching tests.

The results were dramatic. TTS changes were evident in 42 percent of ears in the no-earplug group, versus 8 percent of ears in the earplug group. There were also changes in the DPOAE measurements in the unprotected group. New tinnitus was present in 40 percent of the unprotected group versus 12 percent of the earplug group.

The researchers concluded that earplug use is effective in preventing temporary hearing loss that can occur after exposure to loud music.

When Temporary Is Actually Permanent

It's important to note that while "temporary threshold shift" is used to measure the effect of sound on hearing, recent research indicates that there is no "temporary" auditory damage. TTS and tinnitus show that permanent auditory damage has occurred.

In an August 2015 article in Scientific American, Harvard Medical School's M. Charles Liberman, Ph.D., calls this a "hidden hearing loss"—damage to auditory nerve synapses that cannot be detected by a standard audiogram, but which "aggravates our ability to understand speech and other complex sounds."

The earplug used in the study was the MTV Soundkeepr. New to the market, it is rated as providing an 18 dB Noise Reduction Rating (NRR), a measurement required in the U.S. by federal law to indicate how much sound is blocked by hearing protection such as earplugs or earmuffs.

Most basic earplugs start at 22 NRR. Studies show that in actual use, earplugs may be only 50 percent as effective as their rated NRR. We might now see why some people in the protected group were impacted. (And yes, MTV was one of the funders of the research.)

However, 18 NRR earplugs approximate musician's earplugs, which do not degrade the perception of the music. And the study showed that even earplugs with a low NRR protected most users.

Noise Causes Hearing Loss

Noise damages the ears like sun damages the skin. The effect of exposure is cumulative. Just as a bad sunburn raises your risk of skin cancer, one loud noise exposure can cause lifelong hearing loss, tinnitus, and hyperacusis.

What can you do? For one thing, carry earplugs, and use them when you think it is too loud. Ask and advocate for quiet. Forty years ago many of us couldn't avoid secondhand tobacco smoke. Enough people complained because smoke harms health, and that eventually led to today's largely smoke-free environment.

Let's do the same about noise, which is also damaging our health. Let's keep noisiness from becoming the new normal. Together we can make the world a quieter and more hearing-healthy place.

Daniel Fink, M.D., is an internist in Los Angeles and the interim chair of the Health Advisory Council at Quiet Communities Inc. Bryan Pollard is the founder and president of Hyperacusis Research Ltd. Both serve on the board of the American Tinnitus Association. John Howard, M.D., is the director of the National Institute for Occupational Safety and Health. See "Turn Down the Noise, Turn Up the Quiet" in the Summer 2015 issue at hearinghealthmag.com. For references, see hhf.org/summer2016_references, which includes a related story, "How Is Sound Measured?" by Bryan Pollard.

Share your story: *Has noise affected your health or hearing? Tell us at editor@hearinghealthmag.com.*

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The *Music* Issue

Summer 2016, Volume 32, Number 3

Hearing loss and tinnitus are serious threats to the hearing health of music professionals, amateurs, and fans. These enthusiasts are taking steps to protect their hearing for a lifetime of music enjoyment.

12 *Pete Townshend supports H.E.A.R. (Hearing Education and Awareness for Rockers), cofounded by Kathy Peck.*

46 *2015 Emerging Research Grant scientist Xiping Zhan, Ph.D., was awarded the Les Paul Foundation Award for Tinnitus Research.*

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