



# Putting Data to Work

Occupational Public Health Program (OPHP)

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## Occupational Noise-induced Hearing Loss (NIHL)

### Introduction

Hearing loss can be caused by occupational and recreational noise as well as genetic factors, diseases (e.g., otosclerosis, Meniere's disease), drugs and medications, trauma, tumors, and aging. Hearing loss that is specifically the result of continuous or intermittent exposure to loud noise over a long period of time is referred to as noise-induced hearing loss (NIHL).<sup>1,2</sup> Of the 40 million Americans who suffer from hearing loss, 10 million can be attributed to NIHL.<sup>2</sup>

Exposure to loud noise is an important and serious issue. Children, teenagers and adults are all at risk for developing NIHL. For instance, some children's toys make noise that is capable of permanently damaging their hearing.<sup>3</sup> Playing instruments, attending concerts and listening to music at a high volume are common activities that can contribute to hearing loss. The use of lawn mowers, power tools and other loud equipment can also permanently damage a person's hearing. Exposure to high levels of noise is also of concern because it can cause other conditions and symptoms including anxiety, chronic fatigue, gastrointestinal problems, high blood pressure, stress, and tinnitus (ringing in the ear).<sup>4</sup>

### Scope of the problem

Work-related NIHL is a significant occupational health issue. Approximately 30 million workers are exposed to hazardous noise on the job.<sup>5</sup> While any worker exposed to loud noise is at risk for developing work-related NIHL, workers in certain industries and occupations are at greater risk. For instance, construction workers, factory workers, police, firefighters, military personnel, farmers, truck drivers, stadium workers and musicians are especially at risk.<sup>6</sup>

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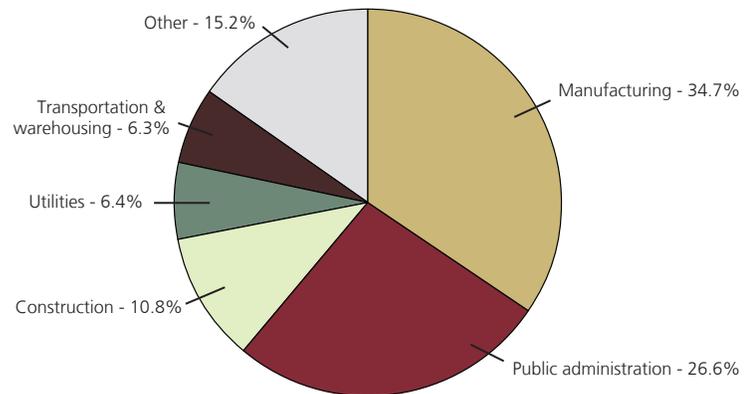
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### Epidemiological data

Using data from the Information Management Division of the Oregon Department of Consumer and Business Services (DCBS), we analyzed accepted disabling Oregon workers' compensation claim data from 2000-2007 for NIHL.

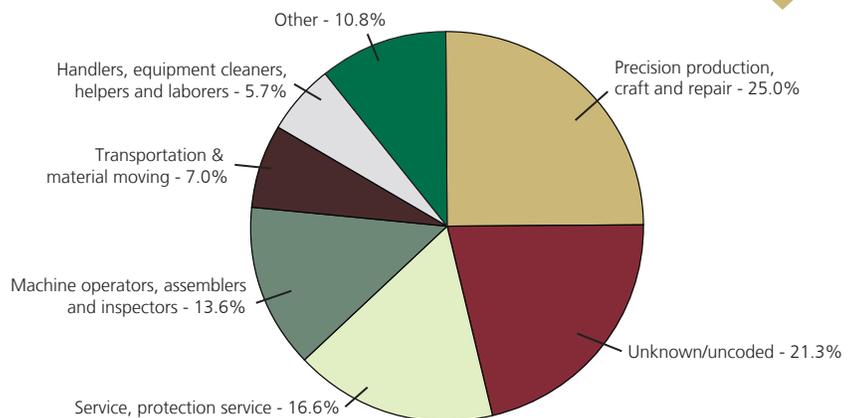
Between 2000 and 2007, there were 719 accepted disabling NIHL claims reported to DCBS. The distribution of NIHL claims by industry is presented in Figure 1. The industry with the highest number of claims for this period was manufacturing (34.7 percent), followed by public administration (26.6 percent) and construction (10.8 percent).



**FIGURE 1. PERCENTAGE OF NIHL CLAIMS BY INDUSTRY (NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM) IN OREGON, 2000-2007.**

Figure 2 shows the distribution of NIHL claims by occupation for the period 2000-2007. Precision production, craft and repair workers had the highest rate of NIHL claims (25 percent), followed by service and protective service workers (i.e., police officers and detectives; 16.6 percent) and machine operators, assemblers, and inspectors (13.6 percent).

**FIGURE 2. PERCENTAGE OF NIHL CLAIMS BY OCCUPATION IN OREGON, 2000-2007.**



Between 2000 and 2007, 96.4 percent of all NIHL claimants were male. Workers 55-64 years of age had the most NIHL claims (51.3 percent), followed by workers 45-54 years of age (29.7 percent). Exposure to noise over time was the most common event that led to NIHL among workers (88.9 percent of all reported claims). The data also show that 43.5 percent of claimants had been at their current job for more than 20 years.

The high occurrence of occupational NIHL among older workers and workers with a longer history of employment in their job may be due to the fact that it takes time for hearing loss to progress to a stage where it interferes with day to day communication or because the longer people are exposed to loud sounds, the more likely their hearing will be damaged. Unfortunately, many workers may not file workers' compensation claims until their hearing has become significantly damaged.

While workers' compensation claims data are excellent sources of information about occupational illnesses and injuries, there is evidence that occupational NIHL is underreported. Possible explanations for underreporting of occupational NIHL include:

- » It takes time for hearing loss to become noticeable;
- » It is difficult to determine whether hearing loss is due to aging, disease, recreational or occupational noise exposure; and
- » Workers may not realize that NIHL is a reportable injury under the workers' compensation system.

## Description and diagnosis of NIHL

A person hears noise when sound pressure waves travel into the ear canal and cause the eardrum to vibrate. Delicate hair cells in the inner ear convert the energy of the vibration into electrical signals. These electrical signals are sent to the brain enabling the person to recognize the sound.

Loud sounds can permanently damage or kill the hairs cells in the eardrum. Once the hair cells are killed, they cannot be repaired. The accumulation of these damaged hair cells eventually leads to noticeable and measurable hearing loss.

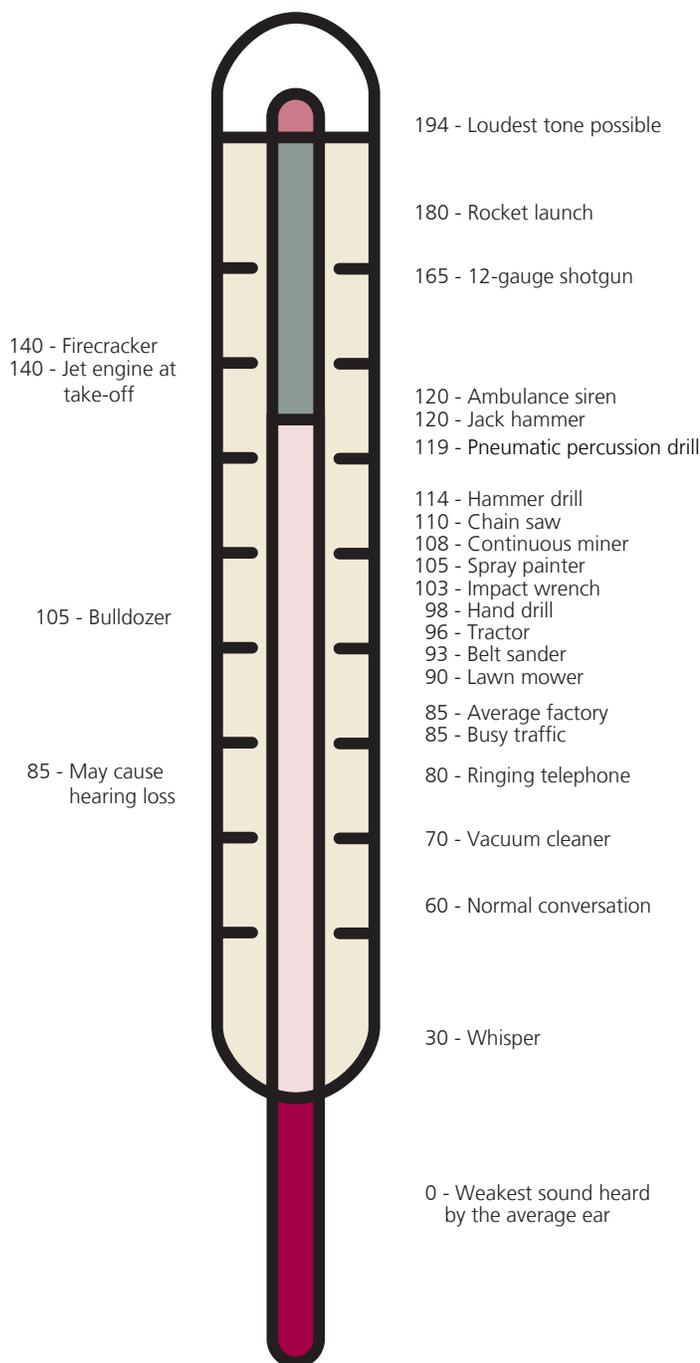
There are several factors that affect hearing loss, or hair cell death, such as age, disease, drug use and exposure to solvents. There are two factors that specifically influence the onset and development of NIHL: intensity and duration of the exposure.

The intensity, or loudness, is measured in decibels (dB). The scale that is used to chart decibel level ranges from 0 dB, the faintest sound the human ear can detect, to over 180 dB, the sound of a rocket launch.<sup>7</sup> Examples of common noises and their decibel levels include a normal conversation (60 dB), busy city traffic (85 dB), and a firecracker (140 dB). See Figure 3 for other sounds by decibel level.<sup>8,9</sup>

Duration refers to the amount of time that someone is exposed to a loud sound. The longer a person is exposed to a loud sound, the more likely their hearing will be damaged.

It is the combination of intensity and duration of exposure that result in NIHL; as the intensity of a sound increases, the amount of time it takes for the hair cells to become damaged decreases.

Table 1 shows the National Institute for Occupational Safety and Health (NIOSH) recommended permissible exposure limit for continuous exposure to noise. For every 3 dBs over 85 dB, the permissible exposure time before possible damage can occur is cut in half.<sup>2,10</sup>



**FIGURE 3. GENERAL ESTIMATES OF WORK-RELATED NOISES.<sup>8,9</sup>**

**TABLE 1. NIOSH DECIBEL LEVEL AND EXPOSURE TIME GUIDELINES.<sup>2</sup>**

<b>Continuous dB</b>	<b>Examples<sup>8,9,11,12</sup></b>	<b>Permissible exposure time</b>
115 dB	Hammer drill (114 dB)	Less than 30 seconds
112 dB		Less than 1 minute
109 dB	Chain saw	Less than 2 minutes
106 dB	Chop saw	Less than 4 minutes
103 dB	Impact wrench	7.5 minutes
100 dB	Circular saw	15 minutes
97 dB	Metal shear	30 minutes
94 dB	Belt sander	1 hour
91 dB	Orbital sander	2 hours
88 dB		4 hours
85 dB	Average factory	8 hours

Therefore, a 2-hour exposure to a 90 dB sound such as a lawn mower can be just as dangerous as a 1-minute exposure to a 110 dB sound such as a chain saw. Permanent damage is likely to begin when a person is exposed to sounds 85 dB or higher over prolonged period of time.<sup>1-3,7,13,14</sup> Hearing loss can also be caused by a single exposure to a very intense sound (130-140 dB), like an explosion.<sup>1,13</sup>

Diagnosing work-related NIHL is difficult. There are two main warning signs of NIHL: tinnitus and temporary threshold shift. Tinnitus is ringing in the ears, and temporary threshold shift is a temporary change in hearing sensitivity that often occurs after noise exposure. Both of these signs can be mild and disappear relatively quickly, such as after walking out of a very loud room, or they can be severe and permanent. These signs do not automatically indicate a NIHL diagnosis, because they do not always occur in NIHL cases and they are not unique to NIHL. Diagnosing work-related NIHL is complicated even further by the fact that hearing loss can also be caused by aging, diseases, recreational exposure to noise, and other factors. In order to properly diagnose NIHL, it is necessary to visit an audiologist, give a detailed account of noise exposure in and out of the workplace, and get an audiogram to measure hearing sensitivity.

## About OPHP

The Occupational Public Health Program (OPHP) in the Oregon Department of Human Services Public Health Division has been identifying and preventing work-related illnesses, injuries and deaths for nearly 20 years. Through funding from the Centers for Disease Control and Prevention National Institute of Occupational Safety and Health, the program conducts surveillance to identify patterns of illness or injury. OPHP also works with partners to address concerns related to priority conditions, populations, occupations and industries.

OPHP focuses on burn injuries, acute pesticide poisonings, work-related asthma, musculoskeletal disorders and other illnesses and injuries. The program is currently collecting data on 19 occupational health indicators, which are measures of work-related illnesses, injuries or factors associated with worker health. Examples include counting the number of work-related deaths and work-related pesticide poisonings. OPHP is also conducting work-related burn injury surveillance and working with partners to reduce the number of burn injuries in the workplace.

## Case summaries

### **CASE 1: HEARING LOSS IN MANUFACTURING INDUSTRY**

Retirement at last! After 56 years of foundry work, three years in the Navy, and owning his own casting company, Fred was eager to begin fulfilling the dreams of his retirement. About a year before this time, Fred had his first-ever hearing test with an audiologist. It was at this appointment that he discussed the hearing protection devices he wore at work: foam plugs, pre-molded plugs and earmuffs, and explained that he only wore them for the past five years. Due to a requirement for his job, Fred had one final appointment with the audiologist the week of his retirement.



It was at this appointment that Fred received news that he had developed work-related high frequency hearing loss. According to the audiologist, Fred should have been wearing hearing protection throughout his entire career. The good news is that he may have prevented further damage by wearing hearing protection devices during the five years leading to his retirement.<sup>15</sup>

### **CASE 2: HEARING LOSS AND INTERVENTION**



While in his 30s Trevor was employed at a wood manufacturing company where he ran an electrical saw. He worked in this job for nearly 10 years, during which he developed hearing difficulties and sought medical attention. After an evaluation by an audiologist he was told that he had developed high frequency hearing loss. It was determined that Trevor's work may have exposed him to potentially hazardous levels of noise without adequate protection. As a result of this finding, Sherry, an enforcement officer, made a site visit to investigate the workplace noise levels. Sherry discovered that every employee at

the company was exposed to noise in excess of 90 dB, throughout the entire work day! The company also did not have a hearing conservation program. As such, the company was cited with a serious violation. Within 90 days, the company established a hearing conservation program that included engineering controls to reduce the noise levels at work.<sup>16</sup>

## Prevention recommendations

NIHL is entirely preventable by eliminating exposure to loud noise(s) or protecting one's ears from being exposed to loud noise(s).

Measures to minimize noise exposure and use ear protection in the workplace should be taken whenever sound levels exceed those outlined in Oregon OSHA's noise code (Table 2). The noise code specifically shows that for every 5 dBAs over 90 dB, the amount of time a worker can be exposed to a continuous level of noise is cut in half.<sup>17</sup>

**TABLE 2. OREGON OSHA DECIBEL LEVEL AND EXPOSURE TIME RULES.<sup>17</sup>**

Permissible noise exposure		
Sound level dBA slow response	Examples <sup>8,9,11,12</sup>	Duration per day, hour
115 dBA	Hammer drill (114 dB)	15 minutes or less
110 dBA	Chain saw	30 minutes
105 dBA	Bulldozer/spray painter	1 hour
102 dBA	Tile saw	1 hour and 30 minutes
100 dBA	Circular saw	2 hours
97 dBA	Metal shear	3 hours
95 dBA	Table saw	4 hours
92 dBA		6 hours
90 dBA	Lawn mower	8 hours

Oregon OSHA requires employers to establish a hearing conservation program whenever an employee is exposed to noise levels equal to or greater than 85 dB on the A scale (slow response) for an 8-hour time-weighted average (TWA).<sup>17</sup> This program is an important part of preventing and reducing the risk of NIHL among workers. A hearing conservation program can vary from employer to employer; however an effective hearing conservation program, according to Oregon OSHA, should include the following components:

- » Noise exposure monitoring,
- » Audiometric testing,
- » Hearing protection devices ,
- » Worker training, and
- » Record keeping.<sup>17</sup>

More information about the rules cited in this section and others pertaining to occupational noise exposure can be found in section 1910.95 of the General Occupational Safety and Health Rules (Division 2), Occupational Health & Environmental Control (Subdivision G).

Hearing conservation programs may also include instituting engineering and administrative controls as well as conducting routine evaluation of the program.

Measuring workplace noise exposure is a necessary part of identifying overexposed workers and selecting the appropriate hearing protection devices. Exposure monitoring should be conducted if there is the potential for employee noise exposure to reach or exceed 85 dBAs within an 8-hour work shift and should be repeated whenever there is a change in production, process, equipment or controls.<sup>17</sup> Not all employees need to be sampled; however, the noise monitoring must be representative of each affected employee's job.<sup>17</sup> If noise monitoring results equal or exceed 85 dBAs, then the employer must develop a hearing conservation program, notify all employees of the noise monitoring results, and provide baseline hearing tests to those workers who are exposed to noise at or above 85dBAs for an 8-hour work shift.

A baseline hearing test must be completed within six months of the employee's initial noise exposure to 85 dBAs.<sup>17</sup> Follow-up audiometric testing should be routinely done to monitor for hearing loss.

The most effective way for employers to prevent hearing loss is through engineering and administrative controls. Engineering controls are used to dampen or prevent the transmission of noise through the use or substitution of engineered machinery or equipment.<sup>18</sup> Examples of engineering controls include switching to lower decibel equipment or ensuring that machines are well-lubricated to minimize noise from rattling or friction. Administrative controls (or safe work practices) incorporate changes in work procedures, such as reducing the amount of time workers spend with loud equipment by rotating employees in shifts.<sup>19</sup> If a worker's noise exposure is found to exceed 90 dBAs, then the employer must evaluate the feasibility of using engineering or administrative controls.<sup>17</sup>

The use of hearing protection devices is also a necessary and effective way to minimize exposure to loud noise. Hearing protection devices are available in two forms: earplugs or earmuffs (see Figure 4). Earplugs are small inserts that fit into the ear canal, whereas earmuffs fit over the entire outer ear to form an air seal so the entire circumference of the ear canal is blocked.<sup>7</sup> Properly fitted earplugs and earmuffs reduce sound intensity by 15 to 30 dB.<sup>7</sup> Both types of hearing protection devices can be worn simultaneously to reduce noise by an additional 5 dB. No matter which hearing protection device a worker wears, these devices provide adequate protection when they fit properly and are used correctly.

Employers are required by Oregon OSHA to:

- » Make a variety of hearing devices available, at no cost, to all employees exposed to an 8-hour TWA of 85 dBA or greater;
- » Provide training in the use and care of hearing protection devices; this includes a proper initial fitting of the device;
- » Ensure employees exposed to noise greater than 90 dBA use hearing protection devices; and
- » Ensure employees exposed to noise equal or greater than 105 dBA use two types of hearing protection simultaneously, if engineering or administrative controls are not effective at reducing noise exposure below 90 dBA.<sup>17</sup>

For information about selecting and fitting hearing protection, visit the National Hearing Conservation Association at [www.hearingconservation.org/rs\\_pracGuides.html](http://www.hearingconservation.org/rs_pracGuides.html).

Employers are also required to educate employees about hearing loss and the health effects that are associated with exposure to loud noise. Employers should consider hazards associated with employees not being able to hear important warning sounds and messages while working with hearing protection devices on the job.

**FIGURE 4. TYPES OF HEARING PROTECTION DEVICES**

**Earplugs**



**Earmuffs**



Those who oversee the hearing conservation program are also required to keep a detailed record of program elements and activities. In addition, efforts should be made to conduct program evaluations and use the results of these evaluations to make program improvements.

For help identifying and preventing workplace hazards, contact the Consultation Services section of the Oregon OSHA at [www.orosha.org/forms/consufm.html](http://www.orosha.org/forms/consufm.html) for a confidential and free consultation. Workers' compensation insurance companies or private safety and health professional firms may also be helpful.

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## Conclusions

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Work-related NIHL is a common and serious occupational health issue that is completely preventable. Employers can make strides toward protecting the health of their employees by establishing a hearing conservation program that entails identifying sources of hazardous noise in the workplace, conducting annual audiometric testing, instituting appropriate engineering and administrative controls, using hearing protection devices, training employees, and keeping records. In addition, employers can provide and encourage the use of hearing protection devices that fit properly, educate their workers about hearing loss and ways to prevent NIHL. Workers can take steps to protect their hearing by wearing well-fitted hearing protection in noisy environments and reporting cases of hazardous noise exposure. The combined use of these strategies can prevent and reduce the risk of developing work-related NIHL or its progression.

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## Additional resources

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### General resources

#### **Dangerous Decibels®**

This Web site is provided Oregon Museum of Science and Industry and the Oregon Hearing Research Center at the Oregon Health & Science University. The Web site provides a tremendous amount of information on hearing loss. It includes a virtual exhibit that educates visitors about hearing loss in a hands-on way.

Available at [www.dangerousdecibels.org/](http://www.dangerousdecibels.org/)

#### **Hearing Protector Device Compendium**

A searchable electronic database created by the National Institute for Occupational Safety and Health that enables the user to look up various types of hearing protection by product type, manufacturer, desired Noise Reduction Rating (NRR), and noise level.

Available at [www2.cdc.gov/hp-devices/hp\\_srchpg01.asp](http://www2.cdc.gov/hp-devices/hp_srchpg01.asp)

#### **National Hearing Conservation Association Web site**

The National Hearing Conversation Association Web site provides various resources to educate and motivate employees to prevent hearing loss. The Web site also provides information about hearing conservation regulations and guidelines in the United States.

Available at [www.hearingconservation.org/](http://www.hearingconservation.org/)

#### **NIOSH: Noise and hearing loss prevention Web site**

The National Institute for Occupational Safety and Health Web site provides information about preventing work-related hearing loss. The Web site specifically offers information about the decibel level of commonly used power tools, resources for supervisors, tools for professionals, audiologists, and occupational safety professionals, and so much more.

Available at [www.cdc.gov/niosh/topics/noise/](http://www.cdc.gov/niosh/topics/noise/)

#### **Occupational Noise & Hearing Conservation**

This Web site is provided by the School of Public Health and Community Medicine at the University of Washington. The Web site provides numerous trade-specific training booklets for supervisors about preventing work-related hearing loss. Trade-specific brochures geared toward employees are also provided at their Web site.

Available at <http://depts.washington.edu/occnoise/index.html>

#### **OSHA: Noise and Hearing Conservation Web site**

This is an Occupational Safety & Health Administration Web site. It presents information about measuring noise exposure, workplace standards, and prevention (i.e., workplace controls and hearing conservations programs).

Available at [www.osha.gov/SLTC/noisehearingconservation/](http://www.osha.gov/SLTC/noisehearingconservation/)

#### **Oregon OSHA: Noise Web site**

The Oregon Occupational Safety and Health Division Web site on noise provides current guidelines for Oregon employers about protecting workers from noise exposure. The Web site provides a series of links to current and applicable rules and forms as well as fact sheets, guides, and videos about hearing loss and noise safety.

Available at [www.orosha.org/subjects/noise.html](http://www.orosha.org/subjects/noise.html)

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