Occupational Noise-Induced Hearing Loss Surveillance in Michigan

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Occupational noise-induced hearing loss (NIHL) is an important yet often overlooked illness that can affect an individual's safety and performance at work. This article describes a state-based surveillance system for occupational NIHL. The Michigan surveillance system enables us to describe the magnitude of occupational NIHL among Michigan workers and direct public health interventions in the form of enforcement workplace inspections. The data presented are based on interviews of individuals with occupational NIHL reported to the Michigan Department of Consumer and Industry Services (MDCIS) by Michigan's audiologists and otolaryngologists from 1992–1997. From 1992–1997, 1378 individuals with occupational NIHL were reported to the MDCIS and interviewed about their exposures to noise at work. Over 70% of the workplace noise exposures were in manufacturing. At the most recent company where these individuals were exposed to noise, approximately 46% were not provided regular hearing testing. Regular hearing testing was more likely to occur in the larger companies and in industries covered by regulations requiring such testing to be performed. There were improvements over time in the percentages of companies providing regular hearing testing and hearing protection. Construction workers are employees among a group of industries that are not adequately protected from excessive noise exposures by occupational regulations. Regular hearing testing was not provided for over 96% of construction jobs, although hearing protection such as earplugs or earmuffs was provided for approximately half of these jobs. Forty-three state enforcement inspections were conducted at the companies reported by the patients interviewed, because these companies were reported to provide no regular hearing testing or no hearing protection despite exposures to excessive levels of noise. During the 43 inspections, 23 companies had noise levels above 85 dBA, and 17 of those had either no hearing conservation program (HCP) or had one that was cited as being incomplete. The inspections potentially protected 758 similarly exposed workers in the companies with the high noise levels that lacked an HCP or that had a deficient HCP. The number of patients with occupational NIHL is likely a gross underestimate of the true magnitude of the disease. However, the surveillance system has identified workplaces with hazardous levels of noise and no HCP, thereby protecting similarly exposed coworkers of the index patients from further exposures to noise and hearing loss.

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Occupational noise-induced hearing loss (NIHL) is irreversible yet is entirely preventable. Further, the consequences of occupational NIHL can be serious, causing accidents, increased job stress, and decreased job performance.[1] The effects permeate beyond an employee's working life and can decrease the quality of one's social and home relationships. Despite well-defined federal and state regulations and control methods, hearing loss from exposure to noise at work continues to occur. Nationally, one million workers are estimated to have work-related hearing loss, primarily from manufacturing-related industries.[2]

Since 1993, Michigan has had a special emphasis program for surveillance of work-related NIHL. The surveillance program for hearing loss is part of Project SENSOR (Sentinel Event Notification System for Occupational Risks). It identifies sentinel cases of workers with NIHL, interviews those individuals to determine the working conditions when they were exposed to high levels of noise, and conducts enforcement inspections at the facilities where the workers were exposed to excessive levels of noise, if the facility has no known hearing conservation program (HCP). Michigan's surveillance efforts seek to prevent other workers from developing NIHL from their jobs. This article will describe the results of Michigan's ongoing surveillance and intervention efforts.

Methods

Reporting of Cases

Under Part 56 of Public Act of 1978, any Michigan hospital, clinic,

physician, or employer who knows or suspects that an individual has a work-related illness must report it to the Michigan Department of Consumer and Industry Services (MDCIS), formerly called the Michigan Department of Public Health. Occupational NIHL is covered under this law.

To inform and encourage reporting of work-related hearing loss by Michigan's private-practice audiologists and otolaryngologists, mailings were conducted to those groups in 1993 and again in 1995. Other outreach efforts to these groups included updates on the surveillance efforts in their professional newsletters, presenting at the groups' annual conferences, exhibiting an educational and informational display booth at these same conferences, and speaking at their membership business meetings. The project also developed an advisory board, consisting of six audiologists, an otolaryngologist, and an occupational health nurse who are well-known and respected in Michigan, that has addressed the questions and concerns of their peers and members of which have acted as role models to their peers in the profession. The most recent outreach efforts in 1998 involved the creation of a quarterly newsletter about NIHL and the state's surveillance efforts and the hiring of an audiologist who visits Michigan clinics as well as the four Michigan university graduate audiology programs to educate and consult with these groups. Michigan State University's Human Subjects Review Board approved the protocol for this surveillance.

Case Definition

An individual is considered to have occupational NIHL if a hearing-health professional determines the individual has the following: (1) audiometric findings consistent with NIHL, and (2) a history of exposure to noise at work sufficient to cause hearing loss. The minimum amount of hearing loss required to meet the first criterion above was left to the professional judgment of the hearing health professional. If asked for guidance, we suggested the following minimum hearing loss:

1. A standard threshold shift (STS) of 10 dB or more in either ear at an average of 2000, 3000, and 4000 Hz; or
2. A fixed loss (suggested definitions: a 25-dB or greater loss in either ear at an average of 500, 1000, and 2000 Hz; or 1000, 2000, and 3000 Hz; or 3000, 4000, and 6000 Hz; or a 15- to 25-dB or greater loss in either ear at an average of 3000 and 4000 Hz).

Case Follow-Up

Known or suspected occupational NIHL cases are reported to the MDCIS by companies and private practices. Only the individuals with a fixed loss reported from private-practice hearing-health professionals are targeted for case follow-up. Follow-up consists of a telephone-administered questionnaire that collects demographic information, military history, and detailed information on the case's three most recent noisy jobs. The noise-at-work questions address what the company does, the case's job and department, machinery or equipment used, the manner of the case's exposure to noise at their job, whether the noise was intermittent or continuous, whether the company provided baseline or regular hearing testing, the availability of hearing protection, dates worked in that job, number of employees who work at the company, and whether the company is still in business at that location. The interviewers are trained in standardized interviewing techniques, and the questionnaire takes approximately 5–10 minutes to complete.

Workplace Follow-Up

After the interview is completed, a board-certified occupational medicine physician (KR) reviews the questionnaire and case report and determines whether an enforcement inspection will be recommended. Companies are selected for recommendation for an inspection if the patient worked at the facility in the last few years, if the patient reported there were no baseline or regular hearing tests administered or no hearing protection provided, and if the noise was reported to be continuous. An inspection would not be recommended for any company known to have an HCP; if the case last worked at the company 5 or more years ago; if the noise is intermittent; for companies exempted from full compliance with the noise standard, such as those in construction and agriculture; and for those companies that no longer have operations at the same location, have closed, or have moved out-of-state.

After the physician recommends a company for an inspection, an industrial hygienist checks inspection files to ensure that a recent Michigan Occupational Safety and Health Administration (MIOSHA) inspection has not already identified and addressed a noise problem at that company. If the company has never been inspected for noise, an enforcement inspection is then scheduled.

During a MIOSHA inspection, the industrial hygienist monitors noise levels in the company and assesses the company's compliance with Michigan's noise standard. If a company has noise levels at 85 dBA or greater for an 8-hour time-weighted average, this is referred to as the "action level" and a HCP is required for all employees exposed. If the company has noise levels above 90 dBA for an 8-hour time-weighted average, administrative and engineering controls are required. If these controls are not feasible, the company may use hearing protection devices to decrease their workers' exposures to noise.

The requirements of an HCP include the following: measuring noise levels to determine if workers are exposed to noise at the "action lev-

el"; conducting audiometric testing (baseline and annual) for any employee at or above the "action level"; providing hearing protection for workers at or above the "action level" and requiring hearing protection if the worker is exposed to 90 dBA or above; training workers about the effects of noise, the use of hearing protection, and audiometric testing; keeping records of all noise-monitoring results and audiometric test results; instituting administrative and/or engineering controls to lower noise levels; and evaluating the HCP for its effectiveness. The company is required to institute changes to address any violations of the MIOSHA noise standard for which the company is cited.

Dissemination of Information

Upon completion of the inspection, a copy of the inspector's findings is sent to the company and union representative (or to the company and labor representative, if a union does not exist). The report is also posted on a company bulletin board if any citations for violations of any Michigan regulations are issued. The hearing-health professional who initially reported the case is also sent a copy of the report as feedback on their efforts to report cases to the MDCIS.

All data collected through case interviews and inspections are analyzed and described annually in a summary report. This annual report is distributed to all the targeted hearing-health professionals.

Results

The MDCIS received approximately 103,400 occupational disease reports from 1992–1997, approximately 10% of which were for hearing loss. From 1992 to 1997, 1477 individuals with a fixed hearing loss were reported by private-practice hearing-health professionals to the MDCIS. During this same period, 9178 reports of individuals with an STS were received. Of the individuals with a fixed hearing loss reported by private-practice hearing-health professionals, 1378 have been interviewed. The following section reports the results of the information obtained during those interviews.

Demographics

Ninety-two percent of the interviewed cases with a fixed hearing loss were men. Over 90% were white, 7.0% were African American, 1.1% were Hispanic, and 1.3% were of other ethnic origin. Over 86% of the cases were born between 1920 and 1959, and 7.0% of the cases were born between 1960–1979. Cases include both current workers and retirees.

Industry

The 1378 cases worked at 1862 companies where they were ever exposed to noise. Over 70% of these 1862 companies were in the manufacturing industry. Table 1 shows the most recent industry in which the

TABLE 1
Type of Industry and Performance of Regular Hearing Testing at Most Recent Company Where Hearing Loss Patients with a Fixed Loss Were Exposed to Noise: Michigan 1992–1997

Standard Industrial Classification (SIC)*	Companies (*n*)	No Hearing Test *n* (%)
Agricultural Production and Services (01–07)	37	20 (54)
Mining (14)	5	3 (60)
Construction (15–17)	92	69 (75)
Manufacturing (20–39)		
Food (20)	20	9 (45)
Apparel (23)	3	2 (67)
Wood (24)	11	7 (64)
Furniture (25)	6	5 (83)
Paper (26)	15	7 (47)
Printing (27)	8	6 (75)
Chemicals (28)	16	5 (31)
Rubber (30)	22	10 (45)
Leather (31)	2	1 (50)
Stone/Clay/Glass (32)	23	17 (74)
Primary Metals (33)	56	21 (38)
Metal Fabrication (34)	86	32 (37)
Machinery (35)	62	30 (48)
Electronics (36)	7	4 (57)
Transportation (37)	430	147 (34)
Measuring Instruments (38)	4	2 (50)
Miscellaneous Manufacturing (39)	14	4 (29)
Transportation/Commercial Services (40–49)	104	34 (33)
Trade (50–59)	39	27 (69)
Finance, Insurance and Real Estate (60–67)	7	4 (57)
Services (70–89)		
Personal Services (72)	1	1 (100)
Telemarketing (73)	2	0 —
Automotive Repair (75)	25	16 (64)
Repair (76)	3	3 (100)
Amusement/Recreation (79)	6	4 (67)
Health (80)	19	8 (42)
Education (82)	57	37 (65)
Social Services (83)	4	3 (75)
Parks (84)	1	0 —
Engineering/Management	1	1 (100)
Geology (89)	2	1 (50)
Public Administration (91–97)	104	59 (57)
Total	1294†	599 (46)

* Standard Industrial Classification (1987 Manual).
† There were 84 companies with an unknown SIC.

TABLE 2
Decade Last Worked and Status of Regular Hearing Testing at Most Recent Company Where Hearing Loss Patients* With a Fixed Loss Were Exposed to Noise, by Company Size: Michigan 1992–1997

	Company Size (Number of Employees)							
	<25		25–100		100–500		500+	
Decade	No. of Patients	% With no Hearing Testing	No. of Patients	% With no Hearing Testing	No. of Patients	% With no Hearing Testing	No. of Patients	% With no Hearing Testing
1940s	1	100	1	100	0	—	3	100
1950s	3	100	3	100	3	67	7	86
1960s	2	50	5	60	2	50	12	100
1970s	6	100	10	80	14	86	31	71
1980s	20	75	22	77	24	58	110	45
1990s	126	74	113	76	159	47	333	30

* For 368 patients, either company size or decade last exposed to noise was unknown.

TABLE 3
Decade Last Worked and Status of Regular Hearing Testing at Most Recent Company Where Hearing Loss Patients* With a Fixed Loss Were Exposed to Noise, by Industry Type: Michigan 1992–1997

	Decade Last Exposed to Noise and Hearing Testing Status†											
	1940s		1950s		1960s		1970s		1980s		1990s	
Industry Type (SIC)‡	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Agriculture (01–07)	1	100	1	100	2	50	0	—	3	100	15	87
Mining (14)	0	—	0	—	0	—	0	—	1	100	3	67
Construction (15–17)	0	—	1	100	1	100	1	—	9	89	59	92
Manufacturing (20–39)	7	86	13	77	15	93	59	78	148	48	440	33
Transportation (40–49)	0	—	0	—	1	—	5	40	10	60	75	35
Trade (50–59)	0	—	1	100	1	—	0	—	2	50	29	86
Finance (60–67)	0	—	0	—	0	—	1	100	0	—	3	100
Services (70–89)	0	—	0	—	1	100	0	—	12	83	87	72
Public Administration (91–97)	2	—	3	100	3	100	4	50	10	60	65	65

* For 284 Patients, either industry type or decade last exposed to noise was unknown.
† Number of patients; percentage of patients not provided hearing testing.
‡ Standard Industrial Classification code.

cases were exposed to noise and whether the individual had been provided regular hearing testing. The percentages at which the cases reported not receiving regular hearing testing ranged from 29% to 100% within broad industry categories. Overall, 46% of the individuals reported that the most recent company at which they worked did not provide regular hearing testing. More than one patient may have worked at the same company; therefore, unique companies are not reflected in these statistics.

Workers from the larger companies were more likely to have had regular hearing testing than workers from the smaller companies. Over 70% of the cases who most recently worked in companies with fewer than 100 employees had no regular hearing testing (Table 2). Over time, the percentage of companies with no hearing testing decreased for both small and large companies, although the percentage decreased a greater amount for the larger companies.

Table 3 charts the decades during which cases were most recently exposed to noise at work, by industry. Over time, a greater percentage of individuals were provided with hearing testing in manufacturing and transportation. Industries not required by MIOSHA to provide regular hearing tests had high percentages of workers with no regular hearing testing, such as construction and agriculture.

Table 4 shows the decades during which cases were most recently provided with hearing protection (earplugs or earmuffs), by industry. Over time, the percentage of workers not provided hearing protection decreased in all industries. The percentage of manufacturing workers given hearing protection improved the most of any industry type.

The number of years worked in noisy jobs ranged from fewer than 5 years to greater than 35 years. Over 27% of the noisy jobs worked at

TABLE 4
Decade Last Worked and Status of Hearing Protection Availability at Most Recent Company Where Hearing Loss Patients* With a Fixed Loss Were Exposed to Noise, by Industry Type: Michigan 1992–1997

	Decade Last Exposed to Noise and Percentage with No Hearing Protection†											
	1940s		1950s		1960s		1970s		1980s		1990s	
Industry Type (SIC)‡	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Agriculture (01–07)	1	—	1	—	2	100	0	—	3	33	15	47
Mining (14)	0	—	0	—	0	—	0	—	1	—	3	—
Construction (15–17)	0	—	1	100	1	100	1	100	9	33	59	17
Manufacturing (20–39)	7	86	13	69	15	60	59	42	148	19	440	7
Transportation (40–49)	0	—	0	—	1	—	5	60	10	40	75	29
Trade (50–59)	0	—	1	100	1	100	0	—	2	50	29	41
Finance (60–67)	0	—	0	—	0	—	1	100	0	—	3	33
Services (70–89)	0	—	0	—	1	—	0	—	12	67	87	23
Public Administration (91–97)	2	—	3	—	3	—	4	50	10	10	65	20

* For 284 patients, either industry type or decade last exposed to noise was unknown.
† Number of patients; percentage of patients not provided hearing protection (earplugs or earmuffs).
‡ Standard Industrial Classification (1987 Manual).

lasted for fewer than 5 years; almost 15% were from 5–9 years; over 38% were from 10–29 years; and 19% were for 30 or more years.

Noise in Construction. Of the 1378 interviewed patients with a fixed hearing loss reported to the State of Michigan from 1992–1997, 132 had at least part of their exposure to noise in construction jobs. The following presents the details of those construction-related noise exposures.

The hearing-loss patients exposed to noise in construction were mostly white (99.2%), male (96.0%), and born in the 1930s-1950s (average year of birth, 1945).

At the most recent construction job where these 132 individuals were exposed to noise, over 96% had no regular hearing testing performed at their job; however, approximately half of these individuals (48.1%) were given hearing protection (earplugs or earmuffs). Table 5 presents the decade of most recent noise in construction exposures for these individuals, as well as the status of regular hearing testing and access to hearing protection. The majority of noise exposures in construction were recent; 15% of the 100 individuals with known decade of exposure occurred in the 1980s, and 67% of the most recent noise exposures in construction occurred in the 1990s. The percentages of individuals given regular hearing tests over time differed negligibly. However, the percentage of individuals given hearing protection over time did improve in the most recent decades.

TABLE 5
Most Recent Decade in Which 132 Patients With Noise-Induced Hearing Loss Were Exposed to Noise in the Construction Industry, and Status of Regular Hearing Tests and Use of Hearing Protection: Michigan 1992–1997

Decade*	Total *n* (%)	Not Given Regular Hearing Tests *n* (%)	Not Given Hearing Protection *n* (%)
1950–1959	2 (2.0)	2 (100)	1 (100)
1960–1969	6 (6.0)	5 (100)	4 (100)
1970–1979	10 (10.0)	9 (100)	5 (100)
1980–1989	15 (15.0)	12 (92)	5 (63)
1990–1997	67 (67.0)	62 (97)	15 (33)

* Decade was unknown for 32 individuals.

Sixty-three of the 132 individuals exposed to noise in construction were also exposed to noise in other industries, primarily in manufacturing. For these individuals, the average percentage contribution of noise from construction out of the total duration of years exposed to noise in any job was 49% (standard deviation [SD], 30%; range, 2%–98%). Four of the 63 individuals were not included in these percentages because the duration of years worked by industry type was unknown.

Among the 69 individuals who reported noise exposures only in construction, the same patterns exist as when we examined all 132 individuals exposed to noise in construction and other jobs. Most of the patients exposed to noise only in construction were not given regular hearing testing (96.1%), although over half were provided with hearing protection (57.5%). Further, most of these individuals were most recently exposed to noise in the 1980s (14%) and 1990s (82%). Again, it was in the more recent decades that these individuals were given hearing protection (Table 6). Some individuals had a relatively short duration of exposure to noise, with 25% working for 5 or less years (Table 7). The average number of years worked in construction-only jobs was 18.6 years, with an SD of 12.8 years.

Enforcement Inspections

Upon evaluation of the completed interviews and review of files of

TABLE 6
Most Recent Decade Exposed to Noise for 69 Patients with Noise-Induced Hearing Loss Who Were Only Exposed to Noise in the Construction Industry, and Status of Regular Hearing Tests and Use of Hearing Protection: Michigan 1992–1997

	Total	Not Given Regular Hearing Tests	Not Given Hearing Protection
Decade*	*n* (%)	*n* (%)	*n* (%)
1950–1959	1 (2.0)	1 (100)	1 (100)
1960–1969	1 (2.0)	1 (100)	1 (100)
1970–1979	0 —	— —	— —
1980–1989	7 (14.0)	7 (100)	3 (60)
1990–1997	41 (82.0)	37 (97)	9 (32)

* Decade was unknown for 19 individuals.

TABLE 7
Duration of Years Worked for 69 Patients with Noise-Induced Hearing Loss Who Were Only Exposed to Noise in Construction Jobs: Michigan 1992–1997

Duration*	Number	(Percentage)
1–5	14	(25.0)
6–10	7	(12.5)
11–15	1	(1.8)
16–20	9	(16.1)
21–25	7	(12.5)
26–30	7	(12.5)
31–35	6	(10.7)
36–40	2	(3.6)
41–45	3	(5.3)
Total	56	(100)

* Duration was unknown for 13 individuals.

prior MIOSHA inspections at the facilities where the interviewed cases were exposed to noise, 43 enforcement inspections were conducted (Table 8). Of the 43 companies inspected, 23 had noise levels above the MIOSHA action level of 85 dBA at the time of the inspection, and 17 of those had either no HCP or one which was deficient. Thirty-one of the 43 companies were in manufacturing, four were in the wholesale or retail trade industry, one was in construction, four were in services, one was in transportation, and two were in government. There were 758 workers in areas with similar exposures to noise who were potentially protected from further levels of excessive noise in the 17 inspections lacking an HCP or having a deficient HCP.

Discussion

Prior to 1993, most of the reports of work-related hearing loss were from company medical departments that had HCPs and were therefore reporting workers with STSs as part of those programs. These companies were aware of their noisy work areas and actively working to monitor and reduce exposures to noise. When Project SENSOR's emphasis program for occupational NIHL began in 1993, otolaryngologists, audiologists, speech and hearing clinics, occupational health nurses, and mobile audiometric testing vans were targeted to receive information on the reporting law, with the expectation that they would report a different segment of the occupational NIHL population than that of the companies who had been reporting until that time.

While the number of reports of work-related hearing loss submitted to the state has remained at approximately 2000 each year since 1993, the percentage of reports from the private-practice hearing-health professionals not associated with a particular company has increased each year, from less than 1% in 1993 to 27% of total hearing-loss reports in 1997.

Although the number of reports from the targeted hearing-health professionals has greatly increased since the MDCIS began its special emphasis program, we know that reporting is far from complete. We estimate that there are approximately 450 audiologists and 150 otolaryngologists in the state, representing an esti-

TABLE 8
Forty-Three Companies Inspected at Which Patient Reported He Had Not Received Audiometric Testing: Michigan 1992–1997

			Number of Employees	
Industry (SIC)*	Above MIOSHA Noise Standard†	HCP‡	Total No.	Range
Construction (15–17)	No (1)	No (1)	30	
Manufacturing (20–39)	Yes (8)	No (8)	244	2–75
	Yes (10)	Yes (10); 5 were deficient	2324	1–1250
	No (4)	Yes (4); 2 were deficient	1417	19–1000
	No (9)	No (9)	1021	3–400
Transportation (40–49)	No (1)	Yes (1); deficient	2	
Trade (50–59)	Yes (1)	No (1)	3	
	No (3)	No (3)	728	1–477
Services (70–89)	Yes (2)	No (2)	17	7–10
	No (2)	No (2)	23	8–15
Government (91–97)	Yes (2)	Yes (2); 1 was deficient	18	2–16

* Standard Industrial Classification.
† Number of companies shown in parentheses.
‡ Hearing Conservation Program.

TABLE 9
Estimates of the Number of Blue-Collar Workers in Michigan Exposed to Excessive Levels of Noise, by Industry Type

Industry (SIC)*	Total No. of Workers†	% Exposed to Noise‡	No. of Workers Noise-Exposed
Mining			
Mining (10–12, 14)	7900	66.74	5272
Oil and Gas Extraction (13)	2100	91.25	1916
Construction			
General Building Contractors (15)	26100	87.37	22803
Heavy Construction (16)	11700	81.21	9501
Special Trade Contractors (17)	88700	88.02	78073
Manufacturing			
Food (20)	32300	30.86	9968
Textiles (22)	400	40.94	164
Apparel (23)	16400	16.16	2650
Lumber and Wood (24)	13700	38.38	5258
Furniture (25)	25900	35.77	9264
Paper (26)	15600	33.37	5206
Printing (27)	24900	22.58	5622
Chemicals (28)	22000	17.81	3918
Petroleum and Coal (29)	900	27.12	244
Rubber and Plastics (30)	50700	24.86	12604
Leather (31)	3300	6.48	214
Stone, Clay and Glass (32)	12400	23.76	2946
Primary Metals (33)	28400	44.13	12533
Fabricated Metals (34)	101600	36.89	37480
Machinery, except Electrical (35)	86200	21.32	18378
Electrical Machinery (36)	24500	8.82	2161
Transportation Equipment (37)	198600	22.63	44943
Instruments (38)	10500	12.95	1360
Miscellaneous Manufacturing (39)	5100	17.71	903
Transportation			
Freight (42)	38800	3.86	1498
Trade			
Wholesale (50,51)	169200	23.60	39931
Retail (53–58)	822400	21.09	173444
Services			
Financial (60–67)	188000	0.33	620
Other (70–79, except 75)	573500	21.56	123647
Automotive (75)	49600	50.43	25013
Health (80)	581800	3.40	19781

* Standard Industrial Classification (1987 Manual).

† Source: Bureau of Labor Statistics, Michigan Employment Security Commission, *Current Employment Statistics. 1996 Annual Report of Michigan Production/NonSupervisory Workers.*

‡ Source: National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard, Occupational Noise Exposure Revised Criteria 1996.* [August 12, 1996, DHHS (NIOSH) Publication No. 96-XXX, Table 2-1.] Percentages are estimates based on data collected in the National Occupational Exposure Survey (NOES).

mated 42 individual and 80 group practices. Only 14% of practices or practitioners reported a case in 1997, even though the number of individual or group practices reporting patients with work-related hearing loss increases each year as more of these professionals comply with Michigan's reporting law. Increased support by the state's audiologists and otolaryngologists is needed to fully document the effects of excessive noise on Michigan's workers. To this end, we are continually working on further ways to direct our outreach and education efforts in order to bring about increased reporting.

The potential number of individuals who should be reported is much larger than the number of reports received. In Michigan, we estimate there are currently, at minimum, 176,000 manufacturing production workers, 110,500 construction workers, 7,200 miners, and 213,500 blue-collar workers in wholesale and retail trade exposed to daily noise levels of 85 dBA or greater.[1,3] Table 9 provides estimates of blue-collar workers in Michigan who are exposed to excessive levels of noise, by industry type. Furthermore, based on data from the National Health Interview Survey, we would expect approximately 86,000 workers in Michigan to have work-related hearing loss.[4]

The reports received are mainly of men 30–60 years of age who work in large manufacturing facilities. However, there are a surprising number of younger workers (7% born 1960–1979) and an equally surprising number of workers with short durations of exposures to noise (27% <5 years, 15% 5–9 years). In addition, the reports from the state's private-practice audiologists and otolaryngologists identified some less obvious types of industries in which exposures to excessive noise may occur, such as telemarketing, health services, and education (Table 1).

Interviews of the 1378 cases suggests that 46% of the companies where they were exposed to noise did not provide any HCP or provided an incomplete one, as the individual reported not receiving regular audiometric testing when he or she was working there. Over time, the percentage of companies providing audiometric testing has increased, except for companies with fewer than 100 employees and workers in the construction and agriculture industries. The percentage of companies providing hearing protection has also increased over time for all industry types. This trend is not surprising, because improvements in manufacturing would follow along with amendments in federal Occupational Safety and Health Administration (OSHA) and MIOSHA regulations, while the construction and agriculture industries are industries for which OSHA and MIOSHA are not

able to enforce the federal hearing standard: "Specifically, the Hearing Conservation Amendments do not cover noise-exposed workers in transportation, oil/gas well drilling and servicing, agriculture, construction, and mining,. . . . "[1]

Enforcement inspections of facilities, based on patient interviews, have identified companies with excessive noise levels that lack HCPs or have deficient ones. The resultant citations for violations of the noise standard, therefore, work toward preventing occupational NIHL among similarly exposed coworkers of the index cases we identified and interviewed.

Despite the fact that construction sites can be quite noisy, with, for example, jackhammers and other heavy machinery and equipment operating at 90–130 dB, this is one industry that is grossly underserved by the law and for which our data demonstrate a lack of initiative on the part of the industry to protect its workers. A re-evaluation of the noise standard as it applies to construction and other minimally covered industries is needed.

The primary goal of the surveillance activity was to identify workplaces with excessive noise levels that lacked HCPs for its workers and consequently direct those companies to comply with MIOSHA regulations. However, some factors may have affected our results, including non-occupational exposures to noise; changes over time (both improvements and decrements) in levels of noise exposures; and changes over time in the use of hearing protection.

While it is true that non-occupational noise exposures could have contributed to a patient's hearing loss, it was the professional judgment of the hearing-health professional that noise at work represented a significant contribution to their patient's hearing loss. Indeed, in addition to hazardous noise at work, the hearing-health professional would have evaluated other possible factors that would influence their patient's hearing ability, such as recreational noise, metabolic and circulatory factors, age, ototoxic drugs, illness, and trauma.[5,6] Furthermore, while changes over time in noise levels and hearing protection use may have occurred at the locations where the patients were exposed to noise, our interviews with the patients included questions to address these issues. From a surveillance perspective, the program has provided meaningful interventions in companies that were not adequately protecting their employees' hearing.

Occupational NIHL is an insidious condition that may take years to develop to a stage where it affects an individual's ability to communicate in the workplace, in social situations, and at home.[7] Prevention of deficits in hearing, especially in a workplace where an individual's hearing helps protect them against many types of risks and accidents, is an important public health issue that may often be overlooked or the importance of which may be understated. Through surveillance of work-related hearing loss in Michigan, along with workplace interventions, the state is working to reduce the burden of hearing loss among its workers.

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