March 10, 2015

2013
Annual report
Tracking Silicosis & Other work-related Lung Diseases in michigan

2013 ANNUAL REPORT TRACKING SILICOSIS & OTHER WORK-RELATED LUNG DISEASES IN MICHIGAN

Silicosis & Other Work-Related Lung Disease Surveillance Program

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There are many resources available to help employers, employees, health care professionals and others understand more about work-related lung disease. Links to these resources can be found at: **www.oem.msu.edu**.

Acronyms

AB Asbestosis

COPD Chronic Obstructive Pulmonary Disease

ED Emergency Department

LARA MI Department of Licensing & Regulatory Affairs

MIOSHA Michigan Occupational Safety & Health Administration

NAICS North American Industrial Classification System

NIOSH National Institute for Occupational Safety & Health

OLDS Other Work-Related Lung Diseases

PEL Permissible Exposure Limit

This report was funded by the National Institute for Occupational Safety & Health, under cooperative agreement U60-OH008466.

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We sincerely appreciate the commitment of those health care providers who understand the public health significance of diagnosing a patient with an occupational illness, as well as the Michigan employees who took the time to share their experiences about their work and subsequent development of work-related lung disease.

Summary

This is the 22nd annual report on silicosis in Michigan. This is the 3rd year of the expansion of the annual report to include surveillance data on the magnitude and nature of all work-related lung diseases in Michigan. In 2011, we expanded surveillance of silicosis in Michigan to include other lung disease, including asbestosis, work-related hypersensitivity pneumonitis, hard metal lung disease, minor pneumoconiosis, and emerging work-related lung diseases. Work-related asthma has always been covered under a separate annual report.

The annual average incidence rate of silicosis among African American males is 7.5 cases per 100,000 workers. Among white males the rate is 1.4 cases per 100,000 workers. Within specific counties in Michigan, the annual average incidence rates of silicosis range between two to 385 times higher for African American males than the rates for white males.

Part 56 of the Michigan Public Health Code requires reporting of all known or suspected occupational illnesses or work-aggravated health conditions to the Michigan Department of Licensing & Regulatory Affairs *within 10 days of discovery*.

Summary, continued...

- From 1985-2013, 1,151 silicosis cases have been identified through the Michigan tracking system.
- On average since 2000, 24 new cases of silicosis were reported to LARA each year.
- We estimate there were 67-139 adults in Michigan with silicosis who were not reported in 2013.
- Asbestos-related lung changes are the most common work-related lung disease in Michigan, identified through hospital discharge data, B-Readers, the courts and other sources.
- 162 cases of Other Work-Related Lung Disease (OLDS) were identified in 2013; chemical irritation, chemical pneumonitis and smoke inhalation were among the conditions reported.
- MIOSHA enforcement inspections at two of the three workplaces where an OLDS case was reported revealed faulty equipment associated with acute exposures to toxic chemicals resulting in employees seeking medical care at local hospital Emergency Departments and consultation with Michigan's Poison Control Center.

Background

In 1988, the State of Michigan instituted a tracking program for silicosis with financial assistance from NIOSH. In 2011 surveillance was expanded to include Other Work-Related Lung Diseases (OLDS). This is a joint project of MIOSHA (LARA) and Michigan State University (MSU), Department of Medicine, Division of Occupational and Environmental Medicine.

The reporting of an index patient is a sentinel health event that may lead to the identification of employees from the same facilities who are also at risk of developing silicosis or OLDS. The goal is to prevent work-related lung disease through the identification and workplace follow-up of these index patients.

Work-Related Lung Disease Tracking Procedures...

Patients are identified through mandatory reporting of any known *or suspected* occupational illnesses, including silicosis and other work-related lung diseases.

SOURCES TO IDENTIFY PATIENTS

- **Health Care Providers** Private practice, working for industry, NIOSH-certified "B" readers
- **Hospitals** ICD-9 502, 501, 495, 496, 491, 492
- **Workers' Compensation Agency**
- **Poison Control Center**
- **Reports from Co-Workers or MIOSHA Field Staff** confirmed by a health care provider
- **Death Certificates**
- **Michigan 3rd Judicial Court** for asbestos-related disease
- **Mine Safety and Health Administration**
- **Michigan Cancer Registry** for mesothelioma
- **Clinical Laboratories** for specific IgE allergy testing

Work-Related Lung Disease Tracking Procedures in Michigan

IDENTIFY PATIENTS

- **Review Reports**
  -Submitted to LARA
- **Known or Suspected**
  -Work-Related Lung Disease
- **Letter to Patient**

INTERVIEW PATIENTS

- **Telephone Interview**
  -Medical & work history
- **Obtain Medical Records**
  -Breathing test results
  -Chest x-ray
- **Physician Review**
  -Board-certified in occupational medicine

WORKPLACE INSPECTION

- **Inspection Referral**
  -MIOSHA determines inspection, if indicated
- **On-Site Inspection**
  -Assess exposures, conduct air monitoring
  -Injury & Illness Log
  -MSU reviews chest x-rays
  -MSU interviews workers
  -Evaluate medical program

FOLLOW UP ACTIVITIES

- **Inspection Results**
  -Company
  -Workers
  -Reporting Physician
- **Letters to Individual Co-Workers**
  -See doctor if breathing problems reported during interview
- **Analyze Data**
  -Annual Report
  -Other outreach & educational materials

INTERVIEW PATIENTS

A telephone interview with the suspected work-related lung disease patient is conducted, and medical records are obtained, including any pulmonary function test results or chest x-rays.

WORK-RELATED LUNG DISEASE

Physician who is board-certified in internal and occupational/environmental medicine and also is a NIOSH certified B-reader reviews medical evidence which may include interview, medical records, breathing tests and chest x-rays. In addition, for silicosis and asbestosis the following criteria are applied:

SILICOSIS

1) History of silica exposure.

And

2) Chest x-ray interpretation with rounded opacities of 1/0 or greater profusion in the upper lobes.

OR

1) A biopsy report of lung tissue showing the characteristic silicotic nodule.

ASBESTOSIS

1) History of asbestos exposure.

And

1) Chest x-ray interpretation showing linear changes in the lower lobes and/or pleural thickening.

Individuals with silicosis in Michigan have an increase of over 300% in the likelihood of dying from non-malignant respiratory disease, both restrictive and obstructive, and an 80% increase in the likelihood of dying from lung cancer. [1]

Work-Related Lung Disease Tracking Procedures...

WORKPLACE INSPECTION

After the patient interview is completed, a MIOSHA workplace enforcement inspection may be conducted.

During an inspection:

- Co-workers are interviewed to determine if other individuals are experiencing similar breathing problems from exposure to the agent.
- Chest x-rays are reviewed if the company performs periodic x-ray surveillance.
- Air monitoring for any suspected agent is conducted.
- The company's health and safety program is reviewed.

After the investigation is complete, a report of air sampling results and any recommendations is sent to the company and made available to workers. A copy of the report is also sent to the reporting physician.

OTHER FOLLOW UP ACTIVITIES

Outreach, educational activities, and recommendations may be developed. An annual report summarizing the activity is completed.

Results—
SILICOSIS, ASBESTOS-RELATED & OTHER WORK-RELATED LUNG DISEASES

The following sections report results in this order: **silicosis** surveillance in Michigan from 1985-2013, **asbestos-related lung disease and mesothelioma**, and **all other OLDS surveillance** for calendar year 2013.

REPORTS OF SILICOSIS

Table 1 shows that 1,151 people were confirmed with silicosis between 1985—2013. Figure 1 shows the number of confirmed silicosis cases by year, for 1987—2013. Figure 2 shows the overlap of reporting sources.

TABLE 1
Year and Reporting Source for 1,151 Confirmed Silicosis Cases: 1985-2013

	Initial Reporting Source*				
YEAR	PR	HDC	DC	WC	ICFU
85-88	0	123	41	49	0
89-90	12	84	9	10	4
91-92	21	91	7	8	0
93-94	13	67	2	32	0
95-96	54	70	3	2	0
97-98	23	76	2	0	0
99-00	9	57	1	1	0
01-02	9	43	2	0	0
03-04	10	50	0	0	0
05-06	5	43	1	0	0
07-08	6	37	0	2	0
09-10	3	31	1	0	0
2011	0	11	0	0	0
2012**	0	11	0	0	0
2013**	0	14	1	0	0
TOTAL	165	808	70	104	4

*PR– Physician Referral; HDC-Hospital Discharge ; DC-Death Certificate; WC-Workers' Compensation; ICFU-Index Case Follow-Up.

**Reports are still being processed for calendar years 2012 and 2013.

FIGURE 1
Confirmed Silicosis Cases by Year Reported

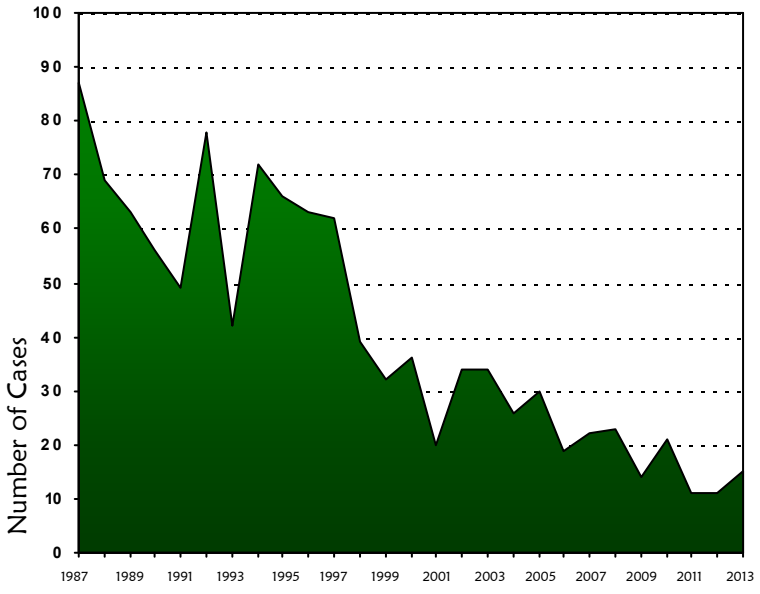
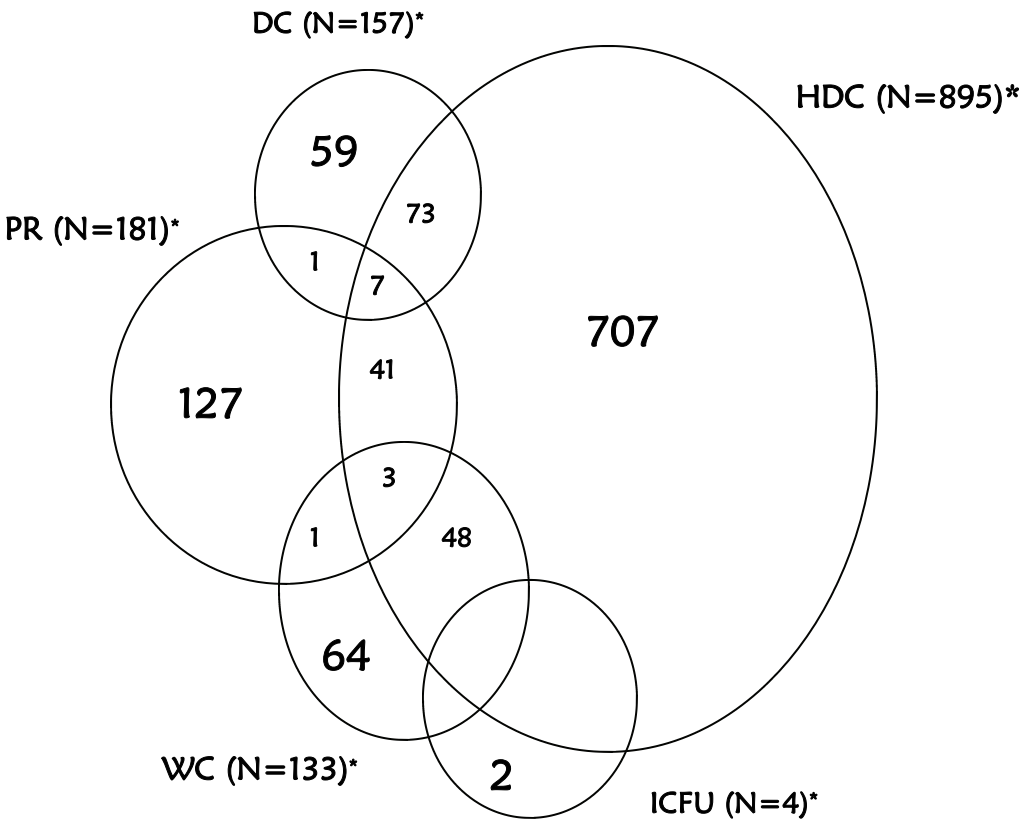


FIGURE 2
Overlap of Reporting Sources for 1,151 Confirmed Silicosis Patients: 1985-2013



*N's represent the total number for that source.
Reporting Source Codes: HDC=Hospital Discharge Data; PR=Physician Referral; DC=Death Certificate; WC=Workers' Compensation; ICFU=Index Case Follow Up.
There was also an overlap of HDC-DC-WC for 13 individuals; an overlap of HDC-PR-WC-DC for one individual; an overlap of HDC-WC-ICFU for one individual; an overlap of WC-DC for two individuals; and an overlap of HDC-DC-ICFU for one individual.

Hospitals are the most frequent reporters of workers with occupational lung diseases.

Based on capture-recapture analysis we estimate that although on average we receive 24 reports of silicosis a year, there are an additional 67-139 cases that are diagnosed each year but are not reported. [2]

Demographics-Silicosis

GENDER

- Women 27, 2%
- Men 1,124, 98%

YEAR OF BIRTH

- Range 1888—1971
- Average 1924

RACE

- Caucasian 662, 58%
- African American 448, 39%
- Alaskan/American Ind. 1, <1%
- Asian 2, <1%
- Other 30, 3%
- Unknown 8

ANNUAL INCIDENCE RATE

- African American 7.5
- Caucasian 1.4

The annual incidence rate for African Americans is 5.4X greater than that of Caucasians.

Numerator is the average number of silicosis cases by race for 1987-2011. Denominator Source: 2000 Census population data by race, age 40 and older.

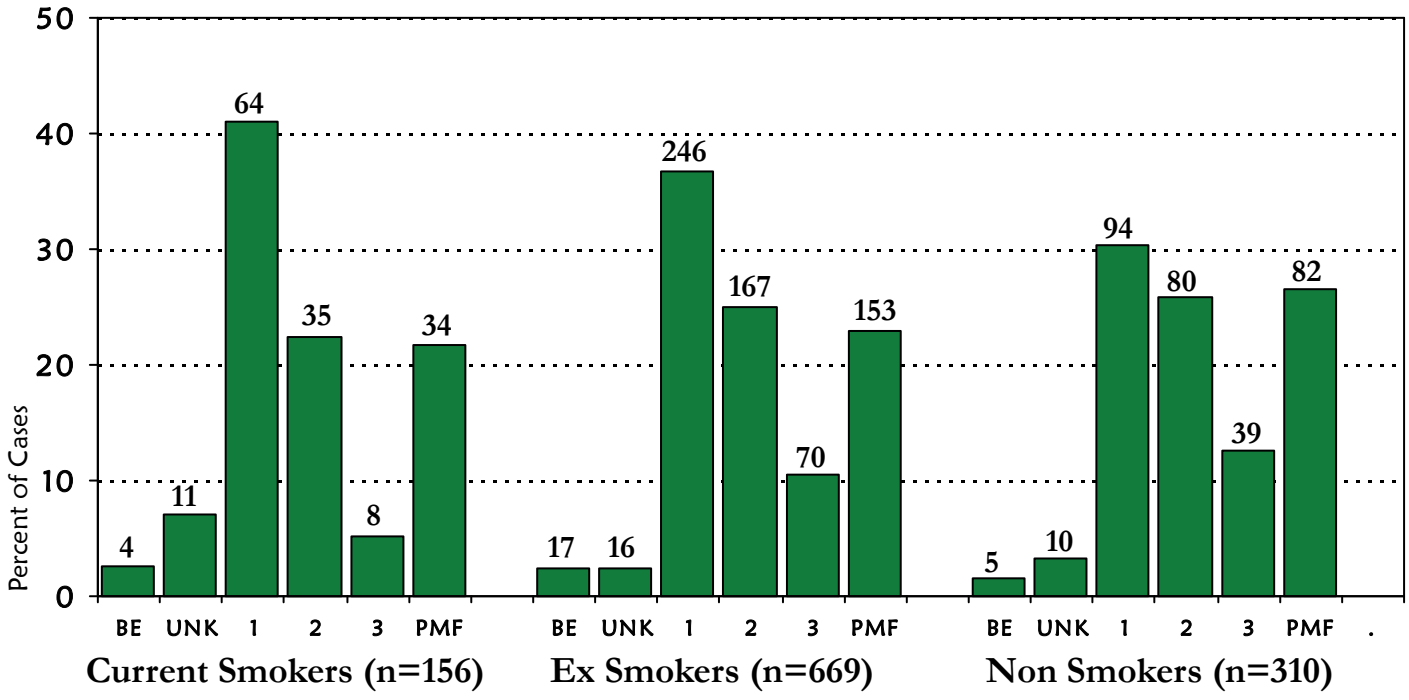
Medical Results-Silicosis

Overall 813 (70.6%) of the people with silicosis had simple silicosis and 273 (23.7%) had progressive massive fibrosis. Twenty-seven (2.3%) silicotics had normal x-rays with lung biopsy evidence. Thirty-eight (3.3%) individuals had x-ray reports which were consistent with silicosis but the actual radiograph could not be obtained to classify.

For the 1,135 silicosis cases with known smoking history, 310 (27.3%) of the people with silicosis never smoked cigarettes, 669 (58.9%) had quit, and 156 (13.7%) were still smoking. No information was available on 16 individuals. Figure 3 shows the distribution of x-ray results according to the International Labor Organization (ILO) classification and smoking status. Non-smokers tended to have more severe silicosis. This latter finding may be an artifact of our reporting system, which is mainly based on reports of hospitalized individuals. Non-smoking individuals with simple silicosis are less likely to be symptomatic and hospitalized and therefore less likely to have been reported to the surveillance system.

Tables 2 and 3 show the distribution of percent predicted forced vital capacity (FVC) and the ratio of forced expiratory volume in one second (FEV_1) to FVC by x-ray and cigarette smoking status. Approximately 60% of people with silicosis had reduced breathing function, either restrictive or obstructive. Obstructive changes (Table 3) were found in two thirds of the individuals who had ever smoked cigarettes and among half of the individuals who had never smoked cigarettes. A more comprehensive analysis of spirometry results was published in 2010. [3]

FIGURE 3
Severity of X-Ray Results* by Smoking Status for Confirmed Silicosis Cases: 1985–2013**



*BE = Biopsy Evidence; UNK = Unknown; 1-3 = International Labor Organization categorization system for grading pneumoconises; Category 1 = 1/0, 1/1, 1/2; Category 2 = 2/1, 2/2, 2/3; Category 3 = 3/2, 3/3, 3/+; PMF = Progressive Massive Fibrosis.

**Total number of individuals: 1,135. Unknown smoking status for 16 individuals.

Medical Results-Silicosis

TABLE 2

Percent Predicted Forced Vital Capacity (FVC) by X-Ray Results and Cigarette Smoking Status for Confirmed Silicosis Cases: 1985-2013

	Percent Predicted FVC***					
	<60%		60-79%		>=80%	
X-Ray Results*	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked
	%	%	%	%	%	%
Biopsy Evidence	7	--	43	67	50	33
Unk Severity	41	40	36	20	23	40
Category 1	24	31	35	29	41	40
Category 2	30	39	35	31	35	30
Category 3	30	68	41	14	30	18
PMF	38	38	33	32	29	30
Total**	29	39	35	29	36	32

*Biopsy Evidence if no x-ray available; International Labor Organization categorization system for grading pneumoconioses: Cat 1= 1/0, 1/1, 1/2; Cat 2= 2/1, 2/2, 2/3; Cat 3= 3/2, 3/3, 3+; PMF=Progressive Massive Fibrosis.
**Total number of individuals: 730. Information was missing for 421 individuals.
***Percentages represent the proportion of individuals in each x-ray result category, within smoking status category.

TABLE 3

Ratio of Forced Expiratory Volume in 1 Second (FEV_1) to Forced Vital Capacity (FVC) by X-Ray Results and Cigarette Smoking Status for Confirmed Silicosis Cases: 1985-2013

	FEV_1/FVC***							
	<=40%		41-59%		60-74%		>=75%	
X-Ray Results*	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked	Ever Smoked	Never Smoked
	%	%	%	%	%	%	%	%
Biopsy Evidence	--	50	14	--	50	50	36	--
Unk Severity	11	--	11	--	22	80	56	20
Category 1	10	2	21	4	36	35	33	60
Category 2	4	4	22	16	39	29	34	51
Category 3	3	5	18	--	13	33	68	62
PMF	16	6	32	22	30	35	22	37
Total**	9	4	23	11	33	35	34	50

*Biopsy Evidence if no x-ray available; International Labor Organization categorization system for grading pneumoconioses: Cat 1= 1/0, 1/1, 1/2; Cat 2= 2/1, 2/2, 2/3; Cat 3= 3/2, 3/3, 3+; PMF= Progressive Massive Fibrosis.
**Total number of individuals: 699. Information was missing for 452 individuals.
***Percentages represent the proportion of individuals in each x-ray result category, within smoking status category.

Location in State

Table 4 shows the annual average incidence rates of silicosis among the working population, by race and county where there was at least one case in that county. Yellow-highlighted rates are for counties where both white and African American cases were reported. The highest rates were among African American males in Shiawassee (308 cases per 100,000), Muskegon (136 cases per 100,000), Saginaw (46 cases per 100,000), and Monroe (24 cases per 100,000). The incidence of African American silicosis cases was approximately 5 times greater than Caucasian males. Figure 4 shows the counties of the companies at which the patients' silica exposure occurred; Muskegon, Wayne and Saginaw were the main counties.

TABLE 4
Average Annual Incidence Rate of Silicosis Among Michigan Workers by Race and County of Exposure: 1987-2011

	Caucasian* Males			African American** Males				Caucasian* Males			African American** Males		
County	County Pop'n	#	Rate	County Pop'n	#	Rate	**County**	County Pop'n	#	Rate	County Pop'n	#	Rate
Allegan	20850	2	0.4	275		—	Lake	2817	2	2.8	251		—
Alpena	7388	22	11.9	8		—	Lapeer	18176	1	0.2	226		—
Arenac	4168	1	1.0	62		—	Lenawee	20192	4	0.8	573		—
Baraga	1815	1	2.2	78		—	Livingston	32610	3	0.4	111		—
Barry	12360	3	1.0	34		—	Mackinac	2761	1	1.4	6		—
Bay	23674	7	1.2	226		—	**Macomb**	**156926**	**22**	**0.6**	**3233**	**7**	**8.7**
Benzie	3898	1	1.0	9		—	Manistee	5999	3	2.0	67		—
Berrien	**30479**	**7**	**0.9**	**3594**	**3**	**3.3**	Marquette	14199	14	3.9	224		—
Branch	9525	4	1.7	288		—	Mason	6683	1	0.6	41		—
Calhoun	**25345**	**25**	**3.9**	**2650**	**13**	**19.6**	Menominee	6054	11	7.3	2		—
Charlevoix	5942	3	2.0	5		—	Midland	16605	1	0.2	128		—
Chippewa	7286	1	0.5	616		—	**Monroe**	**29452**	**7**	**1.0**	**497**	**3**	**24.1**
Delta	9045	3	1.3	5		—	Montcalm	12433	3	1.0	335		—
Dickinson	6419	1	0.6	5		—	Montmorency	2957	1	1.4	3		—
Eaton	20377	3	0.6	781		—	**Muskegon**	**30132**	**113**	**15.0**	**3564**	**121**	**135.8**
Genesee	**69596**	**10**	**0.6**	**13423**	**4**	**1.2**	**Oakland**	**216359**	**13**	**0.2**	**20085**	**6**	**1.2**
Gladwin	6615	1	0.6	8		—	**Ottawa**	**41916**	**4**	**0.4**	**270**	**1**	**14.8**
Gogebic	4353	3	2.8	22		—	**Saginaw**	**36097**	**63**	**7.0**	**5936**	**68**	**45.8**
Gd Traverse	16451	1	0.2	57		—	**St. Clair**	**33209**	**5**	**0.6**	**623**	**1**	**6.4**
Gratiot	8356	1	0.5	371		—	**St. Joseph**	**12266**	**3**	**1.0**	**251**	**1**	**15.9**
Hillsdale	9857	7	2.8	36		—	Sanilac	9753	2	0.8	23		—
Ingham	41166	10	1.0	3987		—	Schoolcraft	2121	1	1.9	18		—
Iosco	7280	1	0.5	30		—	**Shiawassee**	**14737**	**3**	**0.8**	**26**	**2**	**307.7**
Iron	3531	1	1.1	28		—	Tuscola	12334	1	0.3	108		—
Jackson	**31380**	**3**	**0.4**	**2685**	**2**	**3.0**	Van Buren	15129	2	0.5	808		—
Kalamazoo	39985	3	0.3	3004		—	Washtenaw	47535	6	0.5	5758		—
Kent	**93136**	**14**	**0.6**	**6768**	**2**	**1.2**	**Wayne**	**236472**	**122**	**2.1**	**134974**	**157**	**4.7**
Keweenaw	639	1	6.3	1		—	Wexford	6478	2	1.2	6		—

*Rate per 100,000 among Caucasian men age 40+. Numerator is the average number of Caucasian males with silicosis for the years 1987 – 2011; denominator is the 2000 Census population data for Caucasian men age 40 and older, by county. In 2000, there were 1,730,017 Caucasian males 40 years and older living in Michigan.

** Rate per 100,000 among African American men age 40+. Numerator is the average number of African American males with silicosis for the years 1987 – 2011; denominator is the 2000 Census population data for African American men age 40 and older, by county. In 2000, there were 219,076 African American males 40 years and older living in Michigan.

Type of Industry-Silicosis

Table 5 shows the Michigan industries by NAICS codes, where exposure to silica occurred from 1985 to 2013. The predominant industries were in manufacturing (85%), construction (8%) and mining (4%). Most of the manufacturing jobs were in iron foundries. Exposure to silica is still occurring in foundries (Figures 5 and 6). In 2007, MIOSHA began an initiative to identify and inspect all silica-using foundries in the state. Forty-seven foundries were inspected. Personal air monitoring for silica was conducted in 43 of the 47 facilities; 28 companies had silica levels below the MIOSHA PEL and 15 were above the PEL.

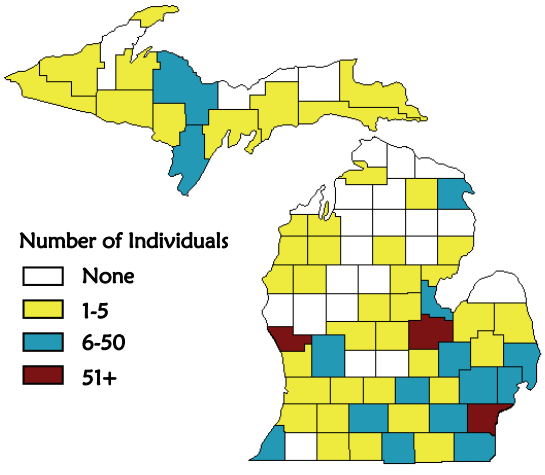
Although silicosis typically occurs after a long duration of exposure to silica, some patients develop silicosis after a relatively short period of time because of the severity of that exposure. The average year of hire is 1950, ranging from 1910 to 2007. Two individuals began working in the 2000s, four began working in the 1990s, 19 in the 1980s, 74 in the 1970s and 174 in the 1960s. The average number of years worked at a silica-exposed job was 27.3 years.

TABLE 5
Primary Industrial Exposure for Confirmed Silicosis Patients: 1985-2013

2002 North American Industry Classification System		#	%
11	Agriculture, Forestry, Fishing, & Hunting	2	0.2
21	Mining	43	3.7
22	Utilities	1	0.1
23	Construction	96	8.3
31-33	Manufacturing	980	85.1
42	Wholesale Trade	2	0.2
44-45	Retail Trade	3	0.3
48-49	Transportation & Warehousing	7	0.6
56	Administrative & Support & Waste Management	2	0.2
62, 81	Health Care & Social Assistance	7	0.6
92	Public Administration	4	0.3
00	Unknown	4	0.3
Total		1,151	99.9*

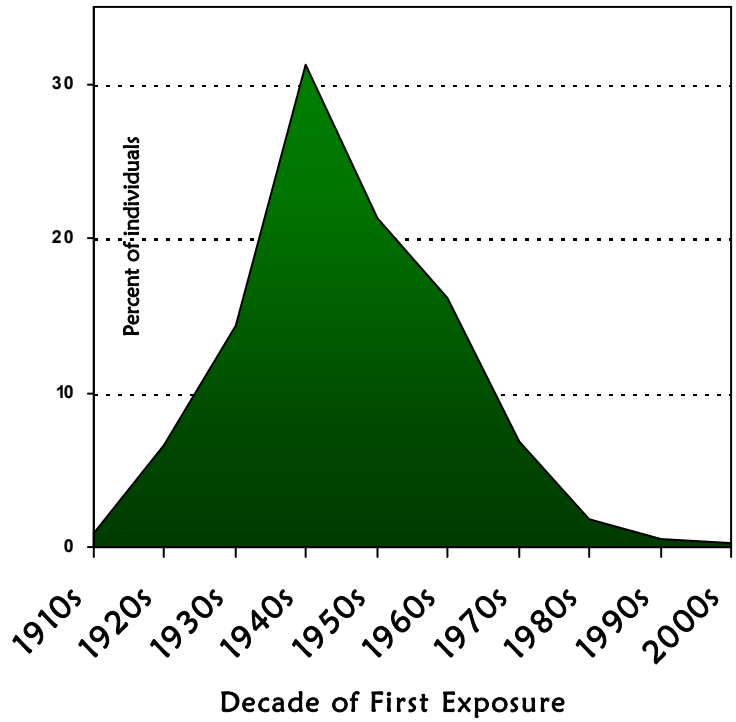
*Percentage does not add to 100 due to rounding.

FIGURE 4
Distribution of Confirmed Silicosis Cases by County of Exposure: 1985-2013*



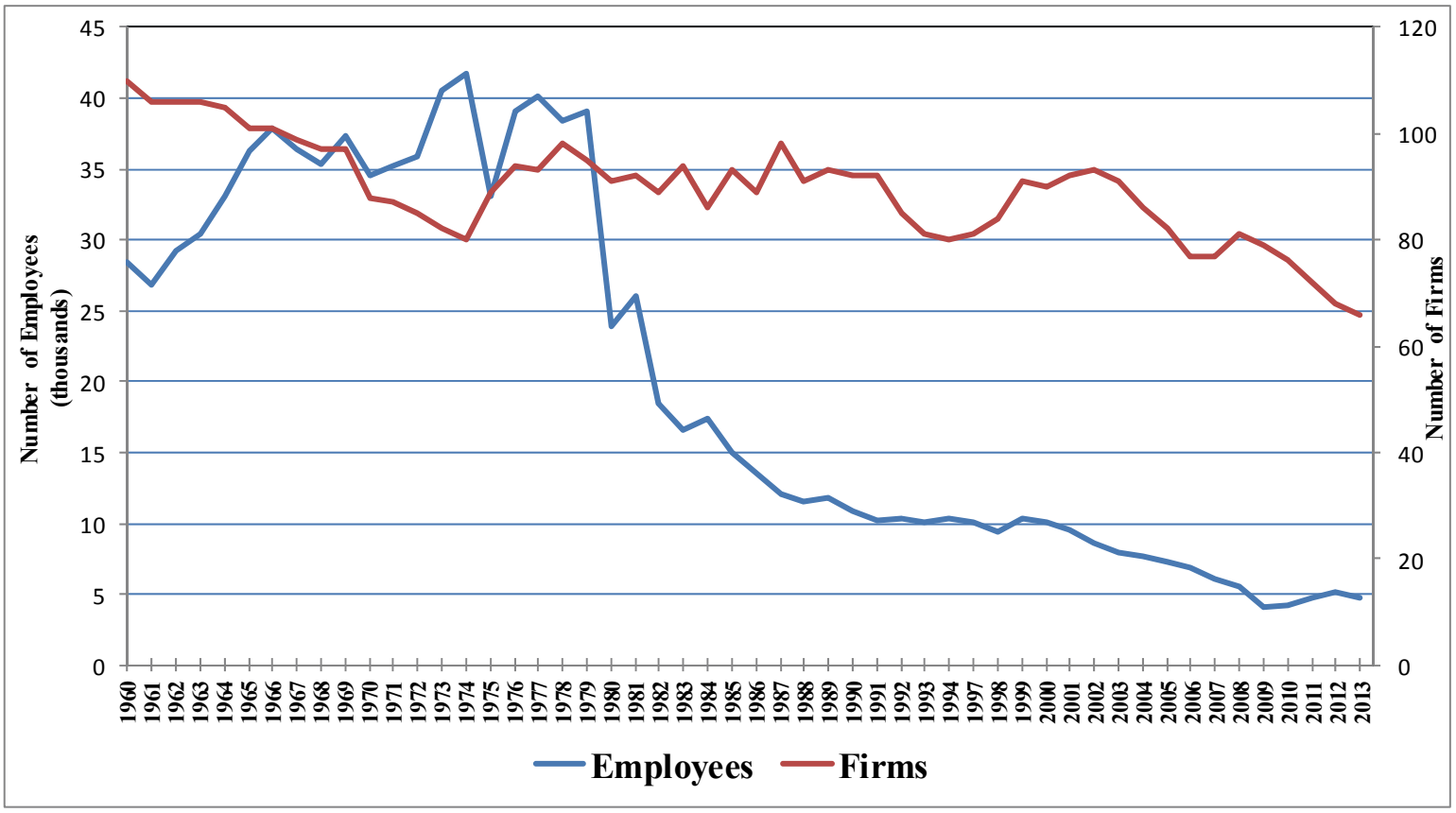
*Seventy-two individuals were exposed to silica out-of-state, and 25 individuals had an unknown county of exposure.

FIGURE 5
Distribution of Decade when Silica Exposure Began for Confirmed Silicosis Cases: 1985-2013*



*Decade of first exposure was unknown for 68 individuals with silicosis.

FIGURE 6
Michigan Ferrous Foundries 1960-2013



Industrial Hygiene Results-Silicosis

The 1,151 individuals with silicosis were exposed to silica in 471 facilities (Table 6). Inspections were performed by MIOSHA at 88 (18.7%) of these facilities. One hundred fifty-two (32.3%) facilities were no longer in operation, 66 (14.0%) were located out of state, 26 (5.5%) facilities no longer used silica, 69 (14.6%) workplaces were in the construction industry, seven (1.5%) were covered by the Mine Safety and Health Administration jurisdiction, and for 62 (13.2%) the specific location where the silica exposure occurred was unknown. There is one facility scheduled for inspection.

Air sampling was conducted in 63 of the 88 facilities inspected (Table 7). Thirty-seven of 63 (58.7%) facilities were above the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit for silica.

Twenty-three of the 63 (36.5%) were above the enforceable MIOSHA permissible exposure limit for silica. Another two (3.2%) companies were above the MIOSHA standard for beryllium and one company was above the MIOSHA standard for silica and silver.

Only eight of the 70 (11.4%) facilities where the medical surveillance program was evaluated provided medical screening for silicosis for its workers that included a periodic chest x-ray interpreted by a "B" certified reader. Three (4.3%) companies provided periodic chest x-rays that were not interpreted by a "B" certified reader. Twenty-one (30.0%) only performed pre-employment testing, 26 (37.1%) provided no medical surveillance, and 18 (25.7%) performed annual or biennial pulmonary function testing without chest x-rays.

Industrial Hygiene Results-Silicosis

TABLE 6
Status of Facilities Where 1,151 Confirmed Silicosis Cases were Exposed to Silica: 1985-2013

	Cases	Facilities	
Inspection Status	#	#	%
Inspection Completed	483	88	18.7
Scheduled for Inspection	1	1	0.2
MSHA* Jurisdiction	16	7	1.5
Facility Out of Business	419	152	32.3
Facility Out of State	70	66	14.0
Facility No Longer Uses Silica	31	26	5.5
Building Trade: No Inspection	69	69	14.6
Unknown	62	62	13.2
Total	1,151	471**	100.0

*MSHA= Mine Safety and Health Administration.

TABLE 7
MIOSHA Inspections of 88 Facilities of Silicosis Cases Exposed to Silica: 1985-2013

	Companies	
	#	%
Air Sampling Performed	63	
Above NIOSH* Rec Std for Silica	37	58.7
Above MIOSHA Enforceable Std for Silica	23	36.5
Medical Surveillance Evaluated	70	
Periodic Chest X-Rays with a B Reader	8	11.4
Periodic Chest X-Rays without a B Reader	3	4.3
Pre-employment Testing Only	21	30.0
No Medical Surveillance	26	37.1
Periodic Pulmonary Function Testing	18	25.7

*NIOSH National Institute for Occupational Safety & Health.
**MIOSHA Michigan Occupational Safety & Health Administration.

Sandblasting-Silicosis

Three hundred nine of the 861 individuals for whom sandblasting history was known (35.9%) stated they had done sandblasting as part of their work.

Proposed Silica Standard

On September 12, 2013 Federal OSHA proposed a comprehensive standard for exposure to silica. The full proposal published in the Federal Register is 232 pages, although the actual proposed standard is only 18 pages (www.osha.gov/FedReg_osha_pdf/FED20130912.pdf). The other 200+ pages cover background, regulatory history, benefits and economic impact. The Review of Health Effects Literature and Preliminary Quantitative Risk Assessment is another 483 pages, which includes 84 pages of references (www.osha.gov/silica/Combined_Background.pdf).

Hearings on the proposed standard were held in Washington, DC for 14 days beginning March 18, 2014. OSHA is currently reviewing all the comments and has not yet proceeded with the promulgation of the standard. See the 2012 Annual Report—Tracking Silicosis & Other Work-Related Lung Diseases in Michigan, for a description of the Michigan data that was submitted as public comment in support of the standard.

Asbestos-Related Lung Disease and Mesothelioma

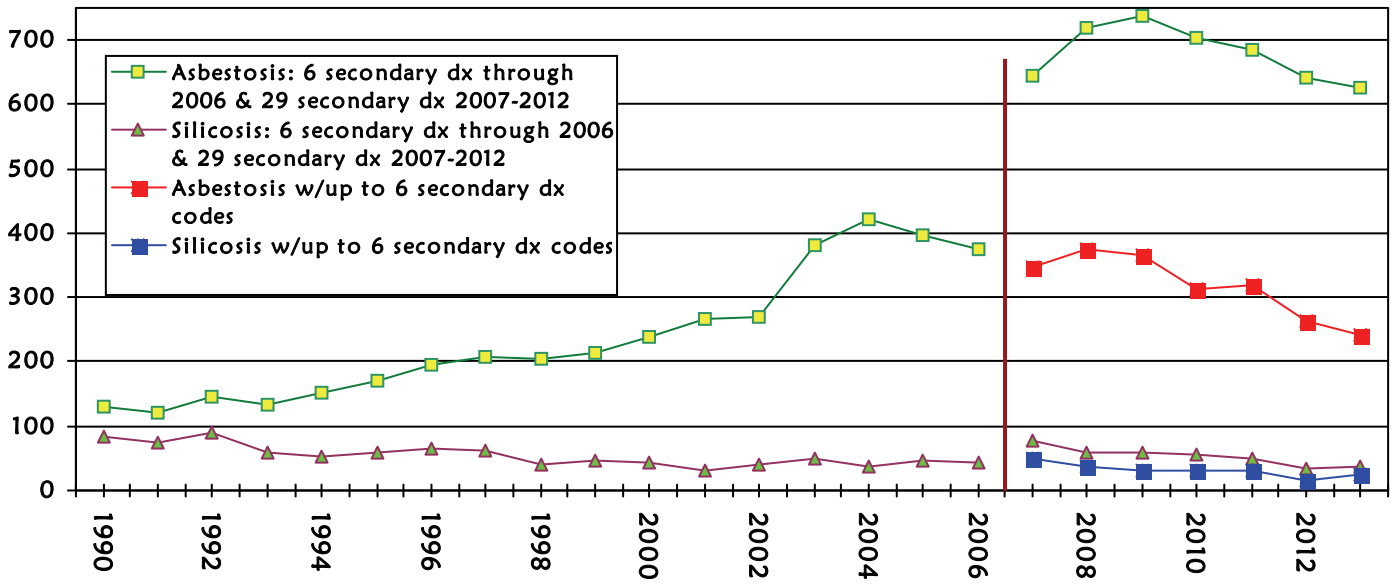
The following section reports the results of **asbestos-related lung disease and mesothelioma**.

Figure 7 shows the number of individuals hospitalized in Michigan with asbestosis and silicosis from 1990 to 2013. Repeat admissions of the same individual within each calendar year are excluded from these counts of inpatient Hospital Discharge Data (HDC). For most of these patients, pneumoconiosis was not the primary discharge diagnosis listed on the discharge record. From 1993 to 2006, there has been a steady increase in the number of hospitalizations for asbestosis; from 2007-2013 the large increase in reports is due to the availability of additional secondary discharge diagnosis codes from up to six secondary codes through 2006 to up to 29 secondary diagnosis codes beginning in 2007 (Figure 7). The horizontal red line in Figure 7 for 2007—2013 shows that the number of asbestosis cases would have decreased if only up to six secondary discharge diagnoses had continued to be used.

Regulations to control asbestos exposure were not promulgated until the early 1970s and were not widely implemented until the 1980s. Given the 25-year or greater latency period from the time of first exposure to the development of asbestos-related radiographic changes, the cases being identified now represent exposures from these earlier less-regulated years. The trend we are seeing in Michigan is consistent with national data published in the NIOSH 2014 eWorld publication: Work-Related Lung Disease Surveillance System (eWorld), refer to the section on Asbestosis at: http://wwwn.cdc.gov/eWoRLD. [4]

Payment source from the Michigan Health and Hospital Association (MHA) is the source of data displayed in Figure 8. Medicare is the primary payment source for hospitalizations for these dust diseases of the lung. WC insurance is very rarely the source of payment, which is consistent with previous reports in both Michigan and New Jersey that the majority of patients with pneumoconiosis never apply for WC insurance. [1,5] It should be noted that if the anticipated payment source was initially Workers' Compensation but then changed to a non-work-related payment source, the record in the MHA file would still indicate the initial source after the patient was discharged, or vice-versa. Again, for this discharge data of payment source, there is increased availability of secondary discharge diagnosis codes since 2007.

FIGURE 7
Hospital Discharges of Inpatients with Asbestosis & Silicosis in Michigan: 1990— 2006 & 2007— 2013

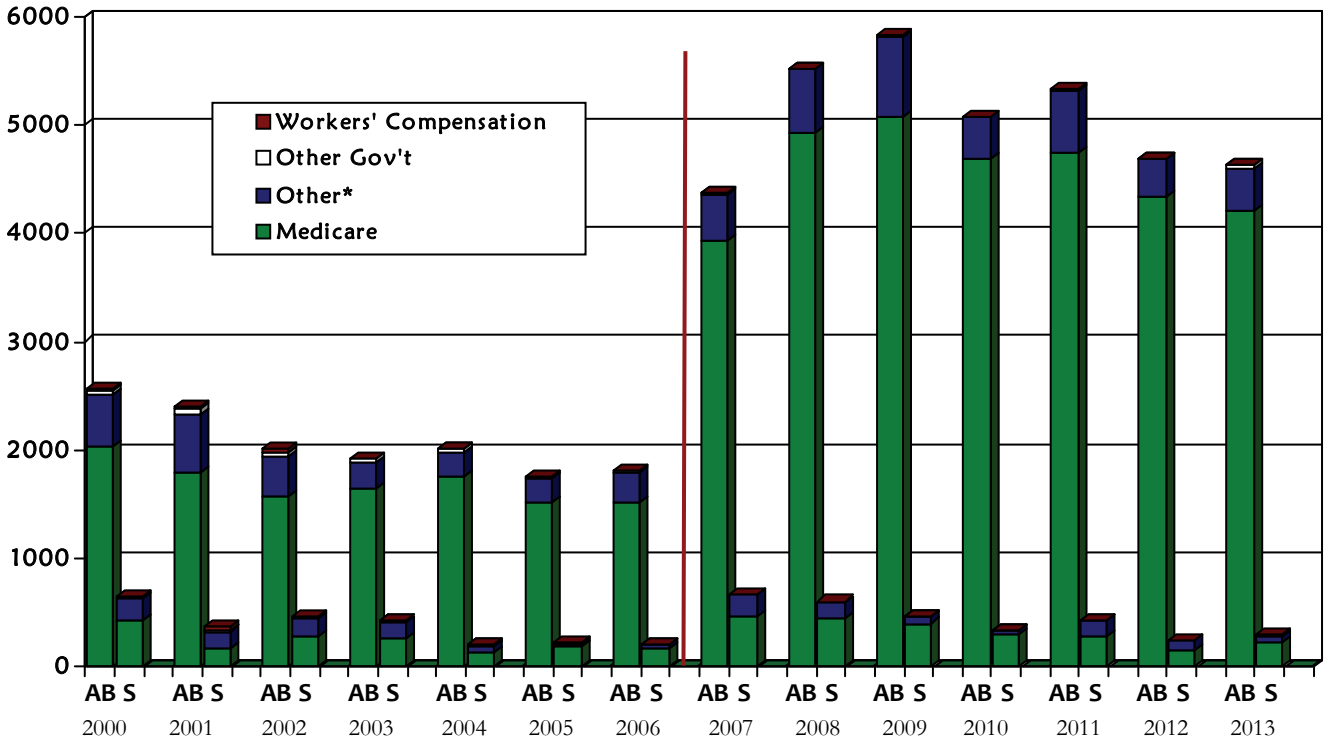


In addition to identifying asbestos-related disease from HDC inpatient data, occupational disease reports submitted to LARA constitute another large source of reports. In fact, asbestos-related lung disease is the most common dust disease reported to LARA (Figure 9), through individual physicians certified as B-Readers, death certificates and the Michigan Courts. The newer OLDS surveillance initiative is yet another source of reports on patients with asbestos-related lung disease (see page 17). In 2013, for example, two cases of asbestos-related lung disease were identified through physician review of medical records. Some of these patients reported may overlap with those reported in the HDC data (Figure 7). The total number of asbestos-related cases would therefore be less than the combined total of HDC cases (Figure 7) along with the cases reported directly to LARA (Figure 9). It should be noted that the asbestos-related cases in Figure 7, Figure 9 and Table 8 may or may not overlap—they each represent a different way to obtain a count of asbestos-related disease from these three different sources.

B-READER SURVEY

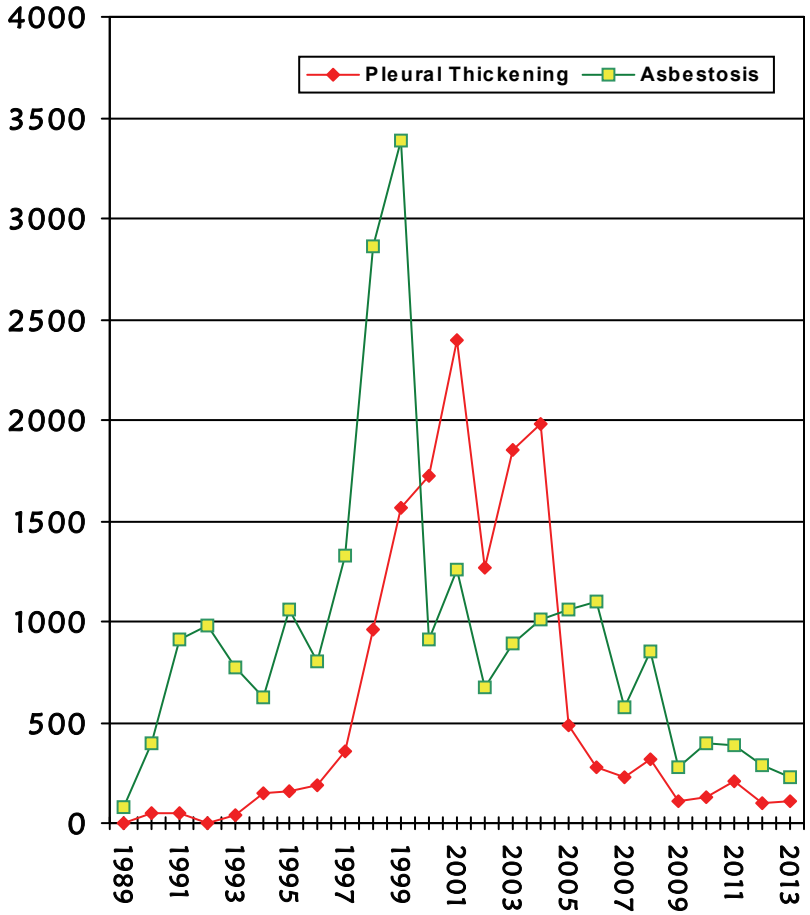
In 1995, there were 16 B-readers in Michigan. Today, there are only six physicians in Michigan who are certified as B-readers. Table 8 shows the number of B-readers, chest x-rays that were reviewed, and x-rays that showed evidence of asbestos-related lung disease, with pleural and parenchymal changes separately and combined. Since 1995, about 20% of the x-rays reviewed showed evidence of occupational disease, ranging from a low of 191 (4%) of 4,419 x-rays reviewed in calendar year 2012, to a high of 3,640 (34%) of 10,575 x-rays reviewed in calendar year 1999. Table 8 is based on an annual survey that the B-readers in Michigan complete. The numbers of reports listed in the survey are greater than the number of occupational disease reports received from B-readers.

FIGURE 8
Days Hospitalized by Payment Source at Discharge for Asbestosis & Silicosis in Michigan: 2000-2006 & 2007-2013



*Other includes: Medicaid, HMOs, PPOs, Other Insurance, Self-Pay and No-Charge payment sources. AB–=Asbestosis, S=Silicosis.

FIGURE 9 Asbestos-Related Cases Reported from B-Readers, Death Certificates and the 3rd Judicial Court: 1989-2013



Mesothelioma

The association between exposure to asbestos and the risk of developing mesothelioma was first reported in the medical literature in 1943. [6] The only other exposure associated with the risk of developing mesothelioma has been the therapeutic, not diagnostic, use of x-rays. The percentage of patients with mesothelioma who have a history of occupational asbestos exposure is lower in studies that are based on review of medical records compared to studies based on a complete work history where 90% of mesothelioma has been attributed to asbestos exposure. [7] Among cohorts of asbestos-exposed workers, up to 10% of deaths have been attributed to mesothelioma.

The Michigan Cancer Registry collects data on the demographics of mesothelioma in Michigan. From 1997 through 2011 there were 1,755 Michigan residents reported to the Michigan Cancer Registry with invasive mesothelioma.

TABLE 8
Results of Annual Survey* of B-Readers in Michigan: 1995-2013

YEAR	# B- Readers	Pleural Changes Only	Parenchymal Changes- W/ & W/out Pleural Changes	Pleural or Parenchymal Changes	Total X-Rays Reviewed	% of Total w/ any Changes
1995	16	--	--	1,406	8,165	17
1996	16	--	--	837	4,825	17
1997	16	446	522	968	6,652	15
1998	16	--	--	3,111	--	--
1999	18	1,045	2,595	3,640	10,575	34
2000	16	532	297	829	10,591	8
2001	17	1,211	1,316	2,527	11,149	23
2002	16	683	905	1.588	7,189	22
2003	11	1,440	1,289	2,729	10,589	26
2004	--	--	--	--	--	--
2005	9	502	343	845	3,060	28
2006	10	391	127	518	5,382	10
2007	9	201	130	331	3,661	9
2008	10	337	320	657	4,757	14
2009	9	247	66	313	4,170	8
2010	6	202	45	247	2,804	9
2011	6	183	46	229	2,862	8
2012	6	139	52	191	4,419	4
2013	6	130	46	176	2,802	6

*Actual chest radiograph interpretations were not submitted with the surveys.

Mesothelioma, continued...

Figure 10 shows the number of men and women diagnosed with mesothelioma by year, from 1985 to 2011. Approximately one quarter of the reports of mesothelioma occurred in women. Mesothelioma occurred predominantly among Caucasians (93.5%) compared to African Americans (5.6%). Approximately 1% were classified as "other" ancestry.

Figure 11 shows the age at diagnosis separately for men and women. The peak age of occurrence of mesothelioma was for individuals 65 years and older for both men and women.

Figure 12 shows the distribution of the number of cases of mesothelioma among Michigan residents, by county. The south-east-and central region of Michigan has the highest number of cases of mesothelioma. Figure 13 shows the average annual incidence rates of mesothelioma among Michigan residents, by county. The counties with the highest rates are: Bay (2.6 per 100,000); Midland (2.1 per 100,000); Marquette and St. Clair (each with 1.9 per 100,000); and Muskegon (1.8 per 100,000). The annual average mesothelioma incidence rate for 1997-2011 in Michigan was 1.1 cases per 100,000.

FIGURE 10
Number of Men and Women in Michigan Diagnosed with Mesothelioma: 1985-2011

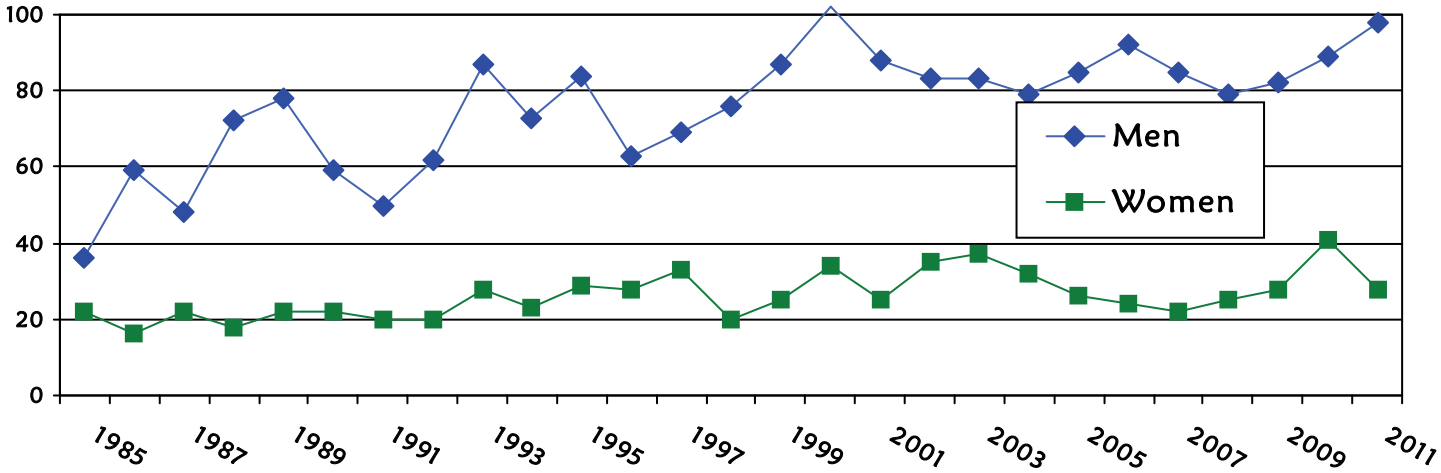


FIGURE 11
Cases of Mesothelioma in Michigan by Gender and Age at Diagnosis: 1985-2011

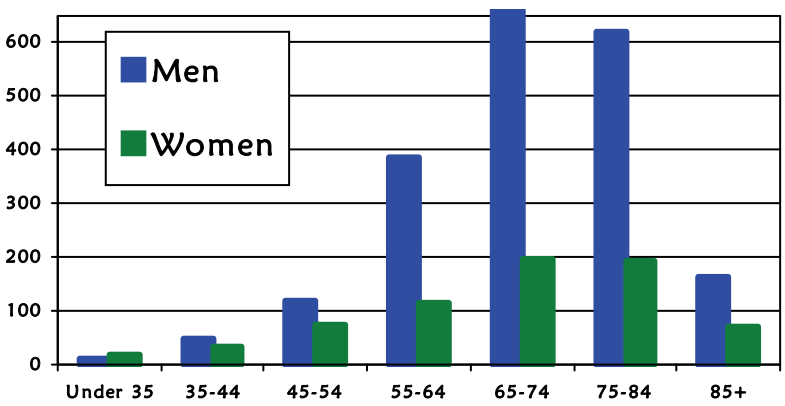


FIGURE 12

Distribution of MI Residents Diagnosed with Mesothelioma by County: 1997-2011

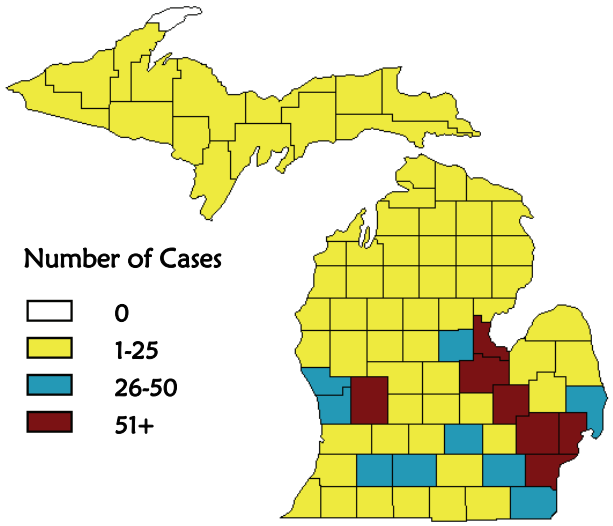
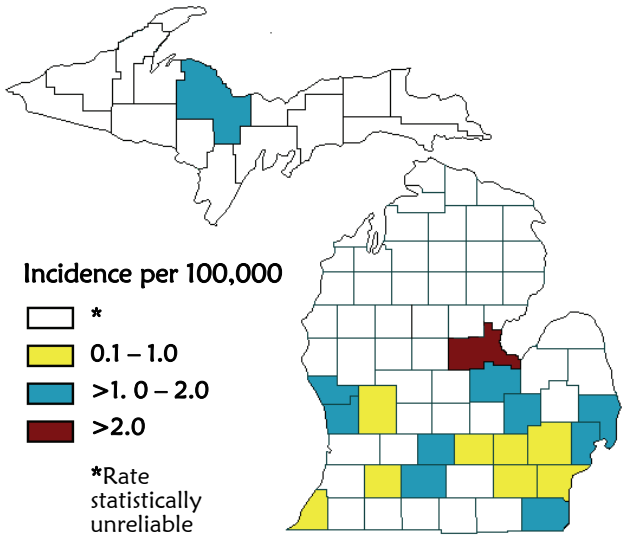


FIGURE 13

Age-Adjusted Incidence Rates of Mesothelioma Among Michigan Residents, by County



Other Work-Related Lung Diseases

2011 was the first year of data collection for other work-related lung diseases (OLDS). Other lung diseases from exposures in the workplace include breathing problems that are not necessarily chronic in nature, in addition to those that are chronic. Conditions that we have identified since beginning OLDS surveillance include acute conditions such as chemical irritation/ irritative bronchitis where an acute exposure results in a health provider visit and limited treatment, with resolution of symptoms. Other conditions covered include smoke inhalation from fires or burning material, infectious agents from exposures at work, and chemical pneumonitis. Chronic conditions are also included in this grouping, with other pneumoconioises, hard metal lung disease and coal workers' pneumoconiosis. A physician board-certified in internal and occupational/environmental medicine reviews all medical records to determine first whether the condition is work-related and secondly the nature of the illness and classification into general categories of disease. In cases where the work-relatedness of the exposure is unclear, additional medical records may be obtained and/or a patient interview completed. In future years of OLDS surveillance we expect to identify additional categories of OLDS as we expand our efforts to identify the best reporting sources for these conditions.

Similar to delays in reporting cases of silicosis, the OLDS reports are incomplete due to delays in hospital reporting. Table 9 shows the primary reporting source of the 162 persons confirmed with OLDS in 2013. In 2013, Poison Control Center (PCC) reports were the primary source of identification of patients, with 59 (36%) of OLDS patients identified, followed by 53 (33%) reported through hospitals, 35 (22%) reported through Workers' Compensation, 10 (6%) reported by physicians, and five (3%) reported through labs. There were no reports of other lung diseases identified through death certificates.

The following statistics are based on the 162 cases of other lung diseases confirmed from 2013.

TABLE 9
Characteristics of 162 OLDS Cases Reported in 2013

DISEASE	#	%	REPORTING SOURCE	#	%
Chemical Irritation/Irritative Bronchitis	104	64	Poison Control Center	59	36
Chemical Pneumonitis	19	12	Hospital	53	33
Hard Metal Lung Disease	3	2	Workers' Compensation	35	22
Infectious Agent	3	2	Physician Report	10	6
Smoke Inhalation	3	2	Laboratory	5	3
Allergies/Allergic Rhinitis	2	1	Death Certificate	0	—
Asbestos-Related Lung Disease	2	1	**TOTAL**	**162**	**100**
Hypersensitivity Pneumonitis	2	1			
COPD	1	<1			
Silo-Related Disease	1	<1		MEAN	RANGE
Respiratory Illness NOS	22	14	AGE in 2013 (years)	37	16-79
TOTAL	**162**	**100**			
			RACE	#	%
SMOKING STATUS	#	%	White	36	75
Ever Smoked Cigarettes	33	51	African American	12	25
Never Smoked Cigarettes	32	49	**TOTAL** (Unknown, n=114)	**48**	**100**
TOTAL (Unknown, n=97)	**65**	**100**			
			VITAL STATUS	#	%
GENDER	#	%	Alive	162	100
Male	99	61	Deceased	0	—
Female	63	39	**TOTAL**	**162**	**100**
TOTAL	**162**	**100**			

Disease Category

One hundred four of the OLDS cases were classified as chemical irritation/irritative bronchitis, 19 had chemical pneumonitis, three each had hard metal lung disease, an infectious agent or smoke inhalation and associated symptoms; two each had allergic rhinitis, an asbestos-related lung disease or hypersensitivity pneumonitis; and one each had chronic obstructive lung disease (COPD) or silo-related lung disease. An additional 22 had definite work-related respiratory illness that could not be classified more specifically.

The following case narratives describe some of the exposures and symptoms related to the OLDS cases reported in 2013:

Hypersensitivity Pneumonitis (HP): A male in his 50s who worked for a restaurant as a general manager developed a cough and shortness of breath after working at the restaurant for over seven years. He was diagnosed with HP from an unknown cause until a blood test indicated a positive reaction to pigeons. He was asked to take a closer look at his workplace and discovered the air vents to the restaurant clogged with pigeons and their associated dander and waste. This exposure had continued for over seven years before he was diagnosed with HP. Upon removal from the workplace, his symptoms continued to persist, almost eight months later. He was an ex-cigarette smoker, having smoked a pack a day for over 10 years, quitting completely in his 30s.

Chemical Irritation/Irritative Bronchitis: (1) A male in his 20s was exposed to chlorine at his job placement through a temporary employment agency as a separator at a chlorine manufacturing facility. He developed a cough and shortness of breath. He did this job for three years until one workday when he sought treatment for his symptoms at the local hospital emergency department (ED). Shortly afterwards, he quit his job upon the advice of his doctor. (2) A male in his 50s had an acute exposure to an accidental mixture of chlorine and a caustic acid cleaner. He worked at a cheese manufacturing facility as a machine maintenance man. He developed a cough and shortness of breath when the line carrying the chemicals was being repaired.

Gender

Ninety-nine (61%) of the persons with OLDS were men; the other 63 (39%) were women.

Race

Thirty-six (75%) of the persons with OLDS were white, and 12 (25%) were African American. The race on 114 individuals was unknown.

Age

The average age of the OLDS cases was 37, ranging from 16 to 79 years of age.

Smoking Status

Thirty-three (51%) of the OLDS cases were current or ever smokers. Thirty-two (49%) individuals had never smoked cigarettes. There were 97 cases with unknown smoking status.

Type of Industry

Table 10 shows the primary type of industry where exposure occurred among the OLDS cases. The predominant industry where individuals were exposed was manufacturing with 33 cases (20%), followed by 12 cases (7%) working in health care and social assistance, 10 (6%) in administration and support, nine cases (6%) in other services, and eight (5%) in public administration.

MIOSHA Inspections-Industrial Hygiene Results

The 162 individuals with OLDS worked at 114 different facilities. Inspections were performed at three of the facilities. The following describes two of the completed inspections. The third inspection has not yet been closed out, at a tool and die shop for a patient with hard metal lung disease from exposure to cobalt.

Silicon Product Manufacture: An inspection for silicon tetrachloride exposure was based on a case of chemical inhalation reported by a hospital and the Poison Control Center. The MIOSHA inspector determined an employee had been exposed to a leakage of silicon tetrachloride when working on a pressure transmitter. Silicon tetrachloride is used to make silicon-containing chemicals. The company processed raw materials (quartz) to make solar-grade and semiconductor-grade silicon products used in the manufacture of solar panels and semiconductor chips for products such as computers

TABLE 10
Primary Industrial Exposure for OLDS Cases Reported in 2013

2002 North American Industry Classification System		#	%
11	Agriculture, Forestry, Fishing and Hunting	7	4
21	Mining	0	—
22	Utilities	0	—
23	Construction	7	4
31-33	Manufacturing	33	20
42	Wholesale Trade	4	2
44-45	Retail Trade	5	3
48-49	Transportation and Warehousing	3	2
51	Information	3	2
52	Finance and Insurance	4	2
53	Real Estate and Rental and Leasing	1	1
54	Professional, Scientific, and Technical Services	0	—
55	Management of Companies and Enterprises	1	1
56	Administrative and Support and Waste Management and Remediation Services	10	6
61	Educational Services	3	2
62	Health Care and Social Assistance	12	7
71	Arts, Entertainment, and Recreation	4	2
72	Accommodation and Food Services	7	4
81	Other Services	9	6
92	Public Administration	8	5
00	Unknown	41	25
TOTAL		162	98*

*Percent does not add to 100 due to rounding.

and cell phones. Acute effects of exposure to silicon tetrachloride include burns and irritation to the skin, throat and lungs, including pulmonary edema. Chronic effects include bronchitis and associated symptoms and nervous system effects.

The MIOSHA inspector determined that an employee sustained burns to both thighs, hypoxemia, and chemical pneumonitis. Proper decontamination procedures were followed at the plant where the exposure occurred, and the employee was later treated at a local hospital. The worker had been wearing appropriate personal protective equipment (PPE) for the task, and had performed the task numerous times before the incident. The inspector determined that the company conducted its own investigation immediately after the incident and retrained all employees on proper work procedures as a result of this incident.

No citations were issued as a result of the MIOSHA inspection.

The second inspection was in response to an incident where six employees at a fruit processing plant were acutely exposed to chlorine dioxide. The employees sought care at a local hospital ED and the Poison Control Center was consulted. Chlorine dioxide, used as a disinfectant at the plant, overflowed from a mixing tank. Employees working in the area experienced upper respiratory irritation, including coughing, chest tightness and nausea.

The MIOSHA inspector conducted air monitoring in the form of grab samples at the point where chlorine dioxide was used; there were no samples with detectable levels of this chemical.

The facility used acids with a pH <1; there was no eye wash station installed within 25 feet of the area where the materials were mixed and pumped to the wash tanks. The company was in violation of the MIOSHA Medical Services and First Aid rule—the employer did not provide suitable facilities for quick drenching or flushing of the eyes and body within the work area for immediate emergency use, where the eyes or body of any person may be exposed to injurious corrosive materials. The company abated the violation before the inspection was closed, therefore, no citations were issued as a result of the MIOSHA inspection.

After this incident, the company installed fail-safe measures to prevent another overflow. The employees affected were all able to return to work the day following their acute exposure to chlorine dioxide.

Discussion

The main characteristics of the individuals reported during Michigan's 25+ years of silicosis surveillance are that they are elderly men who mainly worked in foundries in three counties. The age distribution is similar to that reported in the 1950s.[8] The older age of the patient (average year of birth, 1924) is secondary to the chronic nature of the disease and the typical long exposure to silica required to develop the disease (average 27 years of exposure to silica).

However, we continue to receive reports of individuals with short-term exposure, who began work in the 1970s, 1980s, 1990s and two in the 2000s. Overall, 94 (8.7%) of 1,081 silicosis cases with known duration worked for less than 10 years (data not shown). One hundred (9.2%) of the 1,083 individuals with known decade of hire began work in the 1970s, 1980s, 1990s or 2000s; 28 of them had worked for less than ten years. Individuals with silicosis who began working since the 1970s were more likely to have done sandblasting than those who began working with silica before 1970 (51% vs. 34%). Of the 26 people who first were exposed to silica since the 1980s, five worked in foundries, four worked in auto manufacturing, two were buffing and polishing metal, two did cement work, two worked in auto repair, one worked in mineral processing, one worked in a dental laboratory, one was a heavy equipment operator who did excavating, one was a painter, one worked as a miner in gold fields in the Southwest, one welded, one was in construction, one worked in a boiler fabrication shop, one worked for a small sandpaper manufacturing operation, one worked at a tool and die shop, and one worked at a bronze foundry.

African American men are over-represented (39%), reflecting previous hiring practices in foundries.[9] African American workers consistently had higher incidence rates of silicosis than their white counterparts in the counties where rates were compared between these groups (Table 4). Overall for the state, the incidence of silicosis among African American workers was 7.5 per 100,000 versus 1.4 per 100,000 for white workers (a 5.4-fold greater incidence rate).

The individuals reported generally have advanced disease: 273 (24.5%) with progressive massive fibrosis and another 404 (36.3%) with advanced simple silicosis (category 2 or 3). Approximately two-thirds of the reported patients have reduced breathing tests, including both restrictive and obstructive changes. Obstructive changes, although more prevalent among individuals who had smoked cigarettes, were found in half of the individuals who never smoked cigarettes (Table 3). Twenty-one percent have had tuberculosis (TB) or a positive skin test indicating infection with the mycobacterium that causes TB. Despite the severity of their disease, 62% had not applied for Workers' Compensation.

The reports of Michigan silicotics having obstructive lung changes is consistent with published reports of increased chronic obstructive pulmonary disease (COPD) among silicotics, as well as among individuals without silicosis who have had silica exposure.[10] Individuals with silicosis are at risk of developing pulmonary hypertension, clinically significant bronchitis and chronic obstructive pulmonary disease.[11]

Hospitals are the primary reporting source of the patients identified through Michigan's surveillance system. Hospital discharge reporting is a more cost-effective method for identifying silica problem worksites than physician reporting, death certificates or Workers' Compensation data.[12] A comprehensive surveillance system for silicosis that combines all four reporting sources is as good if not better return for public health dollars invested as most other existing public health programs.[12]

Silicotics have an increased morbidity and mortality for malignant and non-malignant respiratory disease.[1,13] The increased risk for death is found both in patients who ever or never smoked cigarettes.[1] Individuals with silicosis also have an increased risk of developing connective tissue disease, particularly rheumatoid arthritis [14,15] as well as an increased risk of developing chronic renal disease, especially anti-neutrophilic cytoplasmic antibodies (ANCA) positive disease.[16,17,18]

The national employer-based surveillance system was not designed to count chronic diseases such as silicosis. We have previously estimated that there were 3,600 to 7,300 newly diagnosed cases of silicosis each year in the United States from 1987 – 1996.[2] Using the same methodology for the time period 1997 – 2003 we estimate there were 5,586 – 11,674 newly diagnosed cases of silicosis per year in the United States. Using an alternative approach with hospital discharge data we estimate there were 1,372 – 2,867 newly diagnosed cases of silicosis per year in the United States. Although the estimate based on death certificates is approximately fourfold greater than the one based on hospital discharge data, we believe that the true number of new cases of silicosis is closer to these larger estimates than using the actual number of death certificates that mention silicosis (~150 per year) or the Bureau of Labor Statistics estimate based on employer reporting, which in 1999 reported only 2,200 cases for all dust diseases of the lung, including asbestosis and coal worker's pneumoconiosis in addition to silicosis.

Industrial hygiene inspections reveal violations of the exposure standard for silica in 37% of the facilities where sampling was done. However, follow-up inspections of these same companies have shown a significant decrease in silica exposures. Companies not in compliance with the silica standard are requiring their workers to use powered air-purifying respirators or air-line respirators. However, because of an inadequate or absent medical surveillance program in 89% of the facilities, there is no way to monitor the adequacy of these controls in terms of health outcomes.

Silicosis remains an ongoing problem in Michigan with former foundry workers continuing to develop severe disease. Michigan workers continue to be at risk of developing silicosis because of continued use of silica among abrasive blasters and inadequate controls in the construction industry, at foundries currently in operation, as well as in emerging industries with silica exposure including hydraulic fracturing [19] and engineered stone countertop fabrication. [20] Even without the development of silicosis, silica exposure is a risk factor for the development of lung cancer, connective tissue disease, tuberculosis and chronic obstructive pulmonary disease (COPD). [10,13,21] These risks justify tighter work place controls for silica even if the number of new cases of silicosis continues to decline.

OSHA has proposed a new comprehensive standard for silica that includes a lower allowable level of silica in the air, worker education and medical surveillance. The standard is needed despite a decreasing trend of silicosis cases identified in Michigan, since this trend is more a product of more automated work practices with a smaller number of workers at risk than safer workplaces. The major decrease in cases of silicosis in Michigan can be attributed to the decrease in the number of foundry workers.

There was a 75% decrease of foundry workers from 1973 to 1991 (Figure 6) and an 83% decrease in reported cases of silicosis from 1993 to 2011, factoring in a 20-year latency period for the development of silicosis. Additionally, the number of abrasive blasting companies using silica decreased 71% from 1995 to 2011 (2011 Annual Report—Tracking Silicosis and Other Work-Related Diseases in Michigan).

We are optimistic about the downward trend in reported silicosis cases but remain concerned about ongoing silica exposure and the increased risk of lung cancer, COPD, connective tissue disease, and kidney disease associated with silica exposure. The proposed comprehensive silica standard is needed in the foundry industry as well as for newer exposures in highway reconstruction, engineered stone countertop fabrication and hydraulic fracturing; it is too soon to see any ill health effects of these newer silica exposure sources.

Asbestos-related disease, both malignant and non-malignant, is the single most commonly diagnosed occupational lung disease. Asbestos-related disease is tracked from a variety of reporting sources in Michigan, including hospital inpatient discharge data, the 3rd Judicial Circuit Court, B-Readers and other physicians, death certificates, and an annual survey of Michigan B-Readers. Targeting smoking cessation programs and developing guidelines for the use of CT scans for screening for lung cancer in workers with a history of asbestos exposure is a high priority.

The third year of OLDS surveillance resulted in the identification of a variety of respiratory illnesses from workplace exposures, as well as directing interventions through MIOSHA enforcement inspections. Future surveillance of OLDS cases will continue to identify workplaces where MIOSHA inspections are warranted. Other activities will focus on characterizing the nature and extent of the OLDS cases, and the identification of areas where education could benefit individuals who develop OLDS and to help prevent OLDS in others with similar workplaces and exposures.

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