Silicosis: Emerging Trends and How to Screen for Early Detection

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ABSTRACT

Background: National investigations are finding silicosis in young workers. We developed a silicosis case-finding process and conducted follow-up interviews to identify emerging exposure sources.

Methods: Probable cases were identified through Wisconsin hospital discharge and emergency department data and Wisconsin lung transplant programs. Interviews were attempted with case-patients under age 60.

Results: We identified 68 probable silicosis cases and interviewed 4 case-patients. Occupational exposures for cases under age 60 included sandblasting, quarry work, foundry work, coal mining, and stone fabrication. Two stone fabrication workers were diagnosed before age 40.

Discussion: Prevention is critically important to eliminate occupational silicosis. Clinicians should obtain the occupational and exposure history to identify cases of occupational lung disease and notify public health to identify and prevent workplace exposures.

BACKGROUND

Silicosis is an incurable occupational lung disease caused by inhaling respirable crystalline silica dust.[1] There are 3 forms of silicosis: chronic, accelerated, and acute.[2] Chronic silicosis is a slowly progressive disease and manifests as scarring of the lung tissue, which can be identified on chest imaging after 10 or more years of exposure. Accelerated silicosis can develop within 5 to 10 years after exposure to high concentrations of crystalline silica. Acute silicosis is a less common form of the disease, manifesting as an alveolar filling process that can become evident within weeks or months of very high silica exposure. Death from acute silicosis can occur within a few years of disease onset. Silica exposure also is associated with an increased risk of developing renal disease and autoimmune conditions, and the International Agency for Research on Cancer (IARC) has determined that silica is a lung carcinogen.[1]

Industries that place workers at high risk for silica exposure include construction, foundries, mining, and glass manufacturing. An emerging source of silica exposure in the United States is the cutting, grinding, and polishing of engineered stone products.[3] Engineered stone made from quartz has become a popular countertop for personal kitchens and bathrooms across the country. Engineered quartz imports have risen over 700% in the US during 2010 and 2019 (from $140 million to $1.2 billion).[4] There are an estimated 96,000 employees in the stone fabrication industry in the United States.[3] Because engineered quartz is more than 93% silica compared to granite (10%-45% silica), its fabrication can lead to higher airborne levels of silica dust.[5] Investigations conducted by 4 states during 2017–2019 identified 18 cases of silicosis—including 2 fatalities—among stone fabrication workers, all of whom were under 60 years of age. Prior to this study, only 1 case had been identified among engineered stone fabricators in the United States.[6]

To prevent silicosis, employers are required to comply with the Occupational Safety and Health Administration's (OSHA) comprehensive silica dust standard.[7] This includes using dust controls, such as wet methods that apply water at the point where dust is created (eg, cutting, grinding, sanding); using local exhaust ventilation that removes silica dust; using an enclosure to isolate the

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worker from the work process; providing effective respiratory protection; and conducting medical monitoring. Medical monitoring, per OSHA standards, involves offering medical exams every 3 years for workers who are exposed to silica dust above the action level or workers required to wear a respirator over 30 days per year. Exams include thorough medical and work history, physical exam, lung function testing, and chest radiography.

In January 2018, Wisconsin added silicosis to the state administrative code of reportable conditions.[8] The Wisconsin Department of Health Services (DHS) developed a silicosis case-finding process and conducted case follow-up interviews to identify emerging sources of exposure. We describe the methods and outcomes, present a case study of a stone fabrication worker, and provide an evaluation tool that physicians can use to facilitate early silicosis detection.

METHODS

DHS classifies silicosis cases according to the Council of State and Territorial Epidemiologists case definition.[1] A probable silicosis case is defined as a listing of silicosis or pneumoconiosis due to silica exposure in the death certificate, hospital discharge record, workers' compensation claim, or health care professional's report. Probable cases were identified by searching Wisconsin hospital discharge and emergency department visit data with principal or contributing diagnoses codes of J62 (International Classification of Diseases, Tenth Revision, Clinical Modification) and by requesting records from lung transplant programs in Wisconsin for any patients with diagnosed silicosis. We reviewed medical records for each case, including history and physical examination, emergency department documentation, and discharge summaries. Records were reviewed for mention of silicosis, exposure to silica, and occupations where exposure may have occurred. In order to identify cases caused by emerging sources of silica exposure, we attempted interviews with all case-patients under 60 years of age. Data collected during interviews included employment history, social history, occupational and exposure history, symptoms, diagnostic information, and history of other lung diseases.

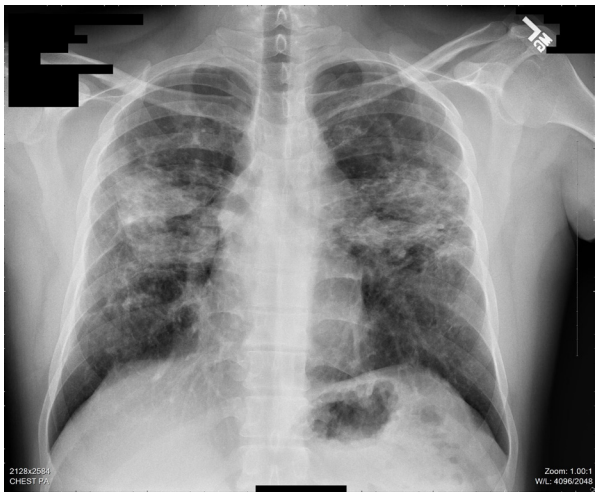
RESULTS

During January 2016 through March 2019, we identified 95 hospital or emergency department records with a diagnosis code of J62, representing 66 unique probable silicosis cases.[1] Two additional cases from a transplant program were identified (see Table). Of the 68 cases, 93% were male. Race and ethnicity were reported as 78% White, 10% Black, 10% Hispanic, and 2% American Indian. One case was under 40 years of age, 8 cases (12%) were 40–59 years, 39 cases (57%) were 60–79 years, and 20 cases (29%) were ≥80 years. We completed interviews with 4 of 9 individuals under age 60 (44%). Occupational exposures identified from case interviews included sandblasting, quarry work, coal mining, and stone fabrication. The medical records for 2 case-patients who could not be reached indicated a history of foundry work and stone fabrication.

Table. Characteristics of Persons With Silicosis in Wisconsin, January 2016-March 2019

	Number	%
Total N	68	100
Sex		
Male	63	93
Female	5	7
Race/Ethnicity		
Hispanic	7	10
American Indian	1	2
Black	7	10
White	53	78
Age		
<40	1	2
40-59	8	12
60-79	39	57
80+	20	29
Occupation for Persons Under 60 Found Through Interviews or Medical Record Searches (n=6)		
Coal mining	1	17
Foundry work	1	17
Sandblasting	1	17
Stone fabrication	2	33
Quarry work	1	17

Figure. Worker A: Chest Radiograph Demonstrating Bilateral Perihilar Airspace Opacities



Worker Case Study

Worker A is a nonsmoker under 40 years of age who began working in the stone fabrication industry at age 20 during the early 2000s. For the first 5 years of Worker A's career, the only respiratory protection provided was a dust mask, which was worn repeatedly during a work week then discarded. During this time period, the operation did not employ wet methods for cutting stone and engi-

Box. Clinical Evaluation Tool for Silicosis

1. Take an occupational history.
   - ☐ What is your job (what kind of work do you do)?
   - ☐ Tell me exactly what you do at work.
   - ☐ Is there usually visible dust in the air when you are working?
   - ☐ How many years have you done this type of work?
   - ☐ Name and address of current employer
   - ☐ What does your company make or do?
2. Observe for symptoms of silicosis and ask about symptom onset (eg, respiratory review of systems).
   - ☐ Cough
   - ☐ Dyspnea (shortness of breath)
   - ☐ Fatigue
   - ☐ Chest tightness
   - ☐ Myalgia or arthralgias (autoimmune diseases)
3. Use past medical history as indicators when considering silicosis. Such medical conditions include:
   - ☐ Rheumatoid arthritis or other autoimmune diseases
   - ☐ Recurrent pneumonia
   - ☐ Tuberculosis (TB)
   - ☐ Interstitial lung disease
   - ☐ Sarcoidosis (egg-shell lymphadenopathy also seen in silicosis)

If silicosis or significant occupational silica exposure is suspected based on history, consider additional clinical evaluation, as below.

4. Conduct a silica medical exam and screening.
   - ☐ Lung exam
   - ☐ Pulse oximetry
   - ☐ Chest x-ray with B-Read
   - ☐ Spirometry
   - ☐ TB test
5. Refer patient to a specialist (Occupation Medicine or Pulmonology) for any of the following indications:
   - ☐ B-Read is 1/0 or greater
   - ☐ Restrictive pattern on spirometry
   - ☐ Respiratory symptoms

6.Confirmatory testing is then needed to make a diagnosis. Specialist consultation recommended. Testing includes:
   - ☐ Full Pulmonary Function Tests (PFTs)
   - ☐ Chest CT scan
   - ☐ Bronchoscopy
   - ☐ Autoimmune testing (ANA and Rheumatoid Factor initially)
   - ☐ In some cases, biopsy by Video-Assisted Thorascopic Surgery may be required to obtain appropriate sampling of lung tissue.
7. Treatment of silicosis:
   - ☐ Remove the patient from continued silica exposure
   - ☐ Cough medication
   - ☐ Bronchodilators
   - ☐ Supplemental oxygen
   - ☐ Patients may eventually require a lung transplant.
8. Follow-up on patients with silicosis:
   - ☐ Conduct an annual chest x-ray and spirometry.
   - ☐ Inform the patient that they should file a workers' compensation claim.
   - ☐ File a case report with the Wisconsin Department of Health Services, required by Wisconsin Administrative Code Chapter DHS 145. You can do this four different ways.
     1. Report electronically through WEDSS.
     2. Fax a case report to the Bureau of Environmental and Occupational Health (BEOH): 608-267-4853
     3. Call BEOH: 608-266-1120
     4. Mail the report to: Wisconsin State Epidemiologist (BEOH)
1 West Wilson St, Room 150
Madison, WI 53703
9. Prevention for other workers:
   - ☐ Consider contacting OSHA if you suspect a workplace isn't providing respiratory protection and workplace controls to keep workers safe. Visit the Wisconsin OSHA contact page to find the office nearest you.

neered quartz, and the worker noted that there was dust contamination throughout the worksite, including the cafeteria.

After Worker A's first 5 years, the employer switched to wet cutting and provided workers with a respirator of unknown type. Worker A had only 1 respirator fit test during employment, despite OSHA requirements for annual fit testing (1910.134[f][2]).[9] Fit testing did not occur until the workers had been wearing respirators for an unknown period of time, and Worker A reported dust inhalation even after being fit tested. Worker A's employer did not conduct required medical clearance for respirator use (1910.134[e][1]).[9]

Worker A had 1 medical evaluation after 12 years of work. During this evaluation, breathing problems were identified and the worker was laid off. Worker A had wedge biopsies of the right middle and lower lobes at age 32. Prior to the surgical biopsy, Worker A had evidence of moderate expiratory flow limitation and hyperreactivity on pulmonary function testing (total lung capacity 5.99 L [94% predicted], diffusing capacity of the lungs for carbon monoxide [DLCO] 28.6 [99% predicted], forced vital capacity [FVC] 3.52 L [71% predicted], forced expiratory volume in the first second of expiration [FEV1] 2.63 L [64% predicted], and FEV1/FVC 75%). Preoperative computed tomography of the chest showed extensive consolidative changes in both lungs, with diffuse micronodular pulmonary infiltrates and multiple large blebs. Lung tissue pathology showed mixed dust pneumoconiosis (siderosilicosis) with massive fibrosis and emphysematous changes. Postoperative chest radiograph demonstrated stable perihilar airspace opacities extending into the upper lobes consistent with progressive massive fibrosis (Figure).

Worker A filed a claim and received workers' compensation benefits for medical treatment and impairment. DHS identified an additional silicosis case from the same worksite as Worker A. This coworker was diagnosed with silicosis in his 30s and had a lung transplant at age 38.

DISCUSSION

Silicosis among stone fabrication workers is occurring in persons under 40 years of age and is highly preventable with appropriate control measures. Enhanced public health surveillance of silicosis cases, including detailed interviews of workers, can identify industries and occupations that expose workers to hazardous levels of crystalline silica.

Prevention and early intervention is critically important to eradicate occupational silicosis. OSHA requires that industries with hazardous silica exposures provide effective engineering controls and, where necessary to further limit exposure below permissible levels, respiratory protection for their workers. New uses of silica continue to emerge, including countertop manufacturing, finishing, and installation and hydraulic fracturing in the oil and gas industry. Taking occupational histories on all patients is critical to identifying cases of occupational lung disease and creates opportunities to identify and prevent workplace exposures through collaboration with public health agencies.

We believe silicosis is more prevalent than current data suggest, but greater clinician awareness could help close that gap. Diagnosis of silicosis relies on a combination of occupational history, chest imaging with compatible findings, and exclusion of other diagnoses such as tuberculosis, sarcoidosis, or idiopathic pulmonary fibrosis. A brief work history, with focus on emerging sources of silica exposure, can help identify workers who might be at risk. Based on that brief screening, the clinician can gather more detailed information through clinical evalution. See Box for a clinical evaluation tool for silicosis, adapted from OSHA.[10] DHS will continue to conduct occupational lung disease surveillance and will develop outreach programs for workers and employers on silica hazards and exposure prevention

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