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FOUNDRY WORKER’S SILICOSIS:
EPIDEMIOLOGY AND SENTINEL HEALTH EVENT FOLLOW-BACK
OBJECTIVES

- Case Description
- Brief Review of Silica Exposure and Silicosis
- Regulatory Issues
- Foundry Process
- Results of Occupational Sentinel Health Event follow back
CASE DESCRIPTION

- 65 year old, never smoking, foundry worker with worsening shortness of breath and cough
- Referred by pulmonologist to clarify diagnosis and assess work-relatedness
- Pulmonary function testing: mixed restriction and obstruction (FVC 62%) with decreased diffusion capacity (50%) and hypoxemia with exertion
High resolution chest CT findings

- Bilateral upper lobe conglomerate opacities
- Narrowing of segmental bronchi
- Profuse smaller nodules
- Calcified hilar and mediastinal lymph nodes
- Pulmonary hypertension
Tranbronchial lung biopsy showed silicosis

- Grayish discoloration of airways
- Nodules and macules with polarizable silicates and dust
- Cultures and stains for organisms were negative.
OCCUPATIONAL HISTORY

- 42 years of work in a mid-western foundry manufacturing pumps for irrigation systems
- Core room worker
- Exposure to respirable silica, iron and brass fumes, and chemical binders
- High dust levels and poor ventilation in early years; improved over the past 15 years
- No respiratory protection
- Knows of no co-workers with silicosis – “We just did not talk about it.”
- It was clear from these results that our patient met the criteria and indeed had occupational complicated silicosis.
**WHAT IS SILICA?**

- Crystalline silica occurs naturally in the earth’s crust
- Earth’s most abundant mineral
- Three most common forms
  - Cristobalite
  - Tridymite
  - Quartz

HEALTH EFFECTS OF SILICA EXPOSURE

- Health hazards of silica all involve crystalline silica that is respirable

- Respiratory Diseases
  + Progressive pulmonary fibrosis
  + Chronic obstructive pulmonary diseases
  + Lung cancer
  + Increased risk for TB
  + Silicosis
SILICOSIS CLASSIFIED ACCORDING TO SEVERITY

- Chronic simple - 10+ years of exposure to low-medium dust levels (nodules<10mm)
- Accelerated - 5-10 years of higher dust exposure
- Acute (silicoproteinosis)
  + Less than 1 year but up to 3 years exposure to extremely high levels of free crystalline silica
- Complicated – “complicated” by the development of severe scarring called progressive pulmonary fibrosis, as well as other lung diseases
3 DIAGNOSTIC CRITERIA

- History of silica exposure
- Radiographic evidence consistent with silicosis
- Absence of other illnesses that mimic silicosis
PRESENTATION AND SEVERITY

- Concentration of free silica dust exposure
- Physical characteristics and innate fibrogenic properties of the dust
- Host factors such as cigarette smoking, underlying disease and genetic characteristics
- Duration of dust exposure
Inhalation of silica particles of respirable size (0.5 – 5.0 micrometers in diameter).
Gathering full-shift dust samples in the breathing zones of workers, using personal dust samplers.

Limits have been established for exposure to dust containing crystalline silica.
OSHA REGULATORY EFFORTS

- OSHA has established Permissible Exposure Limit, or PEL - maximum amount of crystalline silica that workers may be exposed to during an 8-hour work shift
- Required hazard communication training for workers exposed to crystalline silica
- If the PEL is exceeded they require a respirator protection program until engineering controls are implemented
- National Emphasis Program (NEP) for Crystalline Silica exposure to identify, reduce, and eliminate health hazards associated with occupational exposures
To better understand our patient’s exposures we researched the foundry process.

FLOW CHART OF PRODUCTION PROCESS
The silica sand is mixed with the other ingredients in a muller.

After mixing, the sand is placed in storage bins or silos and when required it is mechanically transferred to delivery bins at the molding positions.

MOULD AND CORE MAKING

- Patterns provide the exterior or interior shape of the finished casting
- Produced in wood, metal, or resin
- The pattern is designed so that it can be withdrawn after the sand has been packed around it.

The casting is removed from the mold at the shakeout position.

Small to medium sized castings are placed on a vibrating screen; the molding sand drops to a hopper through the screen for return by conveyor for reconditioning.

Exposures include heat, respirable particulates, gases, vapors, noise, and vibration.

WHAT HAVE WE LEARNED SO FAR

- Health effects of exposure to respirable crystalline silica
- Causes and patho-physiology of silicosis
- Regulatory interventions
- Foundry Process
OCCUPATIONAL SENTINEL HEALTH EVENT

“A disease, disability, or untimely death which is occupationally related and whose occurrence may:

1) provide the impetus for epidemiologic or industrial hygiene studies; or

2) serve as a warning signal that materials substitution, engineering control, personal protection, or medical care may be required”  

[Rutstein et al, 1983]

http://www.cdc.gov/niosh/topics/SHEO/
An occupational sentinel health event (OSHE) should trigger an investigation that would identify both current and previous workers who have had exposure to silica and are at risk for the development of silicosis.

The term “follow back” refers to our efforts in “following back” the patient to his work place to contacting the employer, and their response to our recommendations.
METHODS

- We divided our methods into two categories:
  - The medical management of our patient after his diagnosis
  - Our efforts in contacting the patients employer in the hope of establishing a surveillance program
**Methods: Medical management of patient**

- Informed patient of diagnosis and treatment (oxygen, pulm rehab, flu vax, etc.)
- Removal from work
- Counseling for worker’s compensation benefits
- Informed employer of the patient’s work-related diagnosis
Methods: Follow back

- Contacted foundry employer to request MSDS for core room exposures
- Discussed exposure monitoring efforts at the worksite
- Discussed implementing a medical surveillance program for other employees
- Contacted OSHA for information on sampling
- Reviewed silicosis epidemiology
Results: Review of Core room MSDSs

- Crystalline silica
- **Tertiary amine catalyst:** N,N-dimethylethylamine
  - corneal damage, pulmonary irritation, cellular necrosis of the liver and kidneys, and skin irritation
- **Urethane resins:** irritation to the eyes and lungs
- **Isocyanate-based urethane resin:** occupational asthma and other lung problems, as well as irritation of the eyes, nose, throat, and skin
Results: Medical surveillance

- Further contact with the patient’s employer resulted in the foundry employer exploring ways to implement a silicosis medical surveillance program
- We recommended one based on American Foundry Society Guidelines
- We also contacted a local pulmonary provider to explore collaboration for program implementation.
Results: OSHA WEBSITE TO INVESTIGATE MONITORING OF THE COMPANY

- Based on osha.gov website (Chemical Exposure Health Data site), the foundry was inspected twice in November 2009.
- Employees were exposed to respirable silica but not at levels that exceeded the OSHA PEL (around 30% of the OSHA standard).
- The foundry company declined to share results of its own worksite monitoring with us.
Results: Epidemiology Research

- 113,000+ current US foundry workers in 2200 foundries nationwide with potential exposure to crystalline silica.
- 58% of reported silicosis cases from Michigan, New Jersey, and Ohio occurred in workers in primary metal industries (NIOSH SENSOR 1997)
Follow up of this sentinel case led to workplace prevention efforts including preliminary implementation of a medical surveillance program for foundry co-workers.

We learned that besides respirable silica, foundry workers are potentially exposed to other inhalation hazards.

New cases of silicosis continue to occur.

Each new case is a potential sentinel health event.
We have taken care to educate the employer on what a proper medical surveillance program entails.

Education also needs to take place among the company’s workers through open channels of communication and outreach.

The successful reduction in the incidence of occupational silicosis will rely on the recognition and diagnosis of cases by physicians, and the development and implementation of surveillance, prevention, and control programs.
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What are we willing to give up to protect the industry’s most valuable resource – its’ workers?