

## Silicosis: A Review with Special Concerns Related to 9/11

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### Abstract

**Introduction:** Silicosis refers to an occupational fibrotic pulmonary disease associated with the inhalation of silica dioxide dust or respirable silica. While the use of personal protective equipment (PPE) has been shown to decrease the risk of the disease, the condition still remains one of the most common occupational lung diseases globally. A review was conducted to provide an overview of the disease, its presentation, treatment, and prevention. The review examined special concerns of silica exposure with relation to World Trade Center Dust.

**Purpose:** The main purpose of this review was to provide practitioners with information on silicosis relating to occupational and environmental health and the events of the World Trade Center collapse.

**Methodology:** A literature search of Medline and Google Scholar was conducted to locate peer-reviewed studies that discussed the disease and its presentation. Further information was obtained through the use of public health programs.

**Conclusion:** The disease has no known cure at this time and causes significant mortality and morbidity, particularly in regions that do not routinely use PPE. While first responders utilize PPE routinely, events such as the destruction of the World Trade Center on September 11, 2001, may result in rapid conditions in which proper PPE is not readily available. However, in the weeks following the event, PPE should have been utilized consistently by workers. Improved use of PPE is recommended to reduce the mortality and morbidity of the condition.

### INTRODUCTION

Silicosis refers to an occupational fibrotic pulmonary disease associated with the inhalation of silica dioxide dust. The disease is one of the most common occupational lung diseases in the world. Despite the significant incidence and prevalence of the condition, it is preventable with the use of proper personal protective equipment (PPE). Crystalline silica is a common mineral of the Earth's crust and is used in a wide variety of manufacturing capacities. Silica dust refers to respirable crystalline silica which occurs when crystalline silica is broken into a particulate matter that can be inhaled into the lungs. The breakdown into particulate matter normally occurs during glassmaking, sandblasting, drilling, and sawing. Particulate matter may then enter the airways and the lungs where tissue damage occurs. Silicosis is the most common disease associated with the inhalation of respirable silica. However, other conditions associated with the occupational hazard include lung cancer, pulmonary tuberculosis, and reactive airway diseases. Exposure to the dust may also lead to the development of autoimmune diseases and chronic kidney disease (CKD). While there are treatments available for silicosis, there is no known cure. For this reason, prevention of the condition remains a crucial aspect in protecting global health (Centers for Disease Control and Prevention [CDC], 2013). This paper will offer a short review of the condition, including the etiology, pathophysiology, and epidemiology.

### Presentation

Silicosis refers to an occupational fibrotic pulmonary disease that results from inhaling respirable silica. The condition may develop as an acute disease or a chronic manifestation. The disease is noted for the development of scarring in the lungs, as well as the development of nodules in the upper lobes. The primary symptom of silicosis is dyspnea or shortness of breath. As such, the condition may be misdiagnosed as any number of other pulmonary conditions if a complete occupational health history is not obtained by the health care practitioner (Leung *et al*, 2012).

Chronic silicosis develops after years of occupational exposure. This condition is considered to be the classical presentation of the disease and is also the most common form of silicosis. The development of the chronic form may take up to forty-five years after the environmental exposure. Furthermore, repeat exposures to high levels of silica dust are required for the condition to appear. Accelerated silicosis may develop in individuals with exceptionally high levels of exposure over approximately fifteen years. Simple silicosis or uncomplicated silicosis is asymptomatic and is discovered with pulmonary function testing and chest radiographs. Simple silicosis may progress into complicated silicosis. Complicated silicosis is noted by the presence of conglomerate nodules. These nodules must be larger than 1 centimeter in diameter. Most nodules appear in the upper and middle lungs. Individuals normally present with respiratory complaints, including dyspnea, cough, and respiratory impairment. (Greenberg, *et al*, 2007).

Acute silicosis is a much rarer presentation of the condition. Acute silicosis has different pathophysiology than chronic silicosis. The condition may develop after a short exposure to an extremely high level of silica dust. The particles tend to be less than 5 micrometers in diameter. Occupational exposures that are associated with the development of acute silicosis include tombstone blasting, surface drilling, and silica flour processing. Individuals with this condition may appear acutely ill. Dyspnea, cough, pleuritic pain, fatigue, and pulmonary edema may all occur. Fever and weight loss may also develop. Hypoxia may be noted upon the physical examination, and respiratory failure may develop quickly. Death may occur within one to two years. This condition is likely to be mistaken for multiple other conditions due to its presentation. These conditions may include pneumonia, tuberculosis, and congestive heart failure. A thorough history and physical examination are required to differentiate the possible diagnosis. (Greenberg *et al*, 2007; Witschi, *et al*, 2008).

### Pathophysiology

Silicosis develops after the inhalation of respirable silica. The initial response of the body to inhaled silica is an immune response marked by inflammation. Once the silica particles are inhaled into the lungs, the body responds with macrophages to ingest the particles. Once ingested by the macrophages, the inflammatory response occurs in the lungs. Fibroblasts respond by producing collagen, which results in fibrotic tissue changes in the lungs. Nodules develop as a result of the inflammatory and fibrotic response (Pollard, 2016).

### At-Risk Population

As discussed, silicosis is an occupational disease associated with many manufacturing jobs. In the United States, there are approximately 2.3 million individuals who are at risk for exposure to respirable crystalline silica. OSHA Standard 29 CFR 1926.1153 requires employers to protect their employees from respirable crystalline silica through the use engineering and work practice control methods, as well as respiratory protection. Employers are allowed to utilize a control method which determines the required respiratory protection for various activities. Employers may also choose to measure the levels of silica dust and to utilize protection based upon the measured levels. The permissible exposure limit (PEL) is 50 mcg/m<sup>3</sup>. OSHA has set the action level at 25 mcg/m<sup>3</sup> (Occupational Safety and Health Administration, 2017).

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In recent years, several industrialized countries have discussed the risk of silicosis among manufacturing workers. Recently, the Workplace Health and Safety Agency in Queensland, Australia identified serious lapses in workplace controls to prevent silicosis. A screening program of 799 workers identified 98 cases of silicosis (Rep, 2019). In developing countries, it has been estimated that thirty to fifty percent of employees in high-risk occupations may have silicosis or other forms of pneumoconiosis (World Health Organization, 2007).

### World Trade Center Dust

On September 11, 2001, the Twin Towers of the World Trade Center in Manhattan, New York, collapsed as a result of a terrorist attack. The collapse of the Twin Towers and adjacent buildings resulted in a catastrophic release of dust referred to as "World Trade Center Dust" (WTC dust) (Lioy *et al*, 2002). Cleanup of the site took nine months to remove the 1.8 million tons of debris. Respirable silica was one component of WTC dust

In the immediate aftermath of the disaster and during the first few weeks of cleanup, forty-five percent of workers indicated that they used no respiratory protection for part of their time at the site. Furthermore, many individuals worked twelve-hour shifts for seven days a week. Occupational health standards routinely use an eight-hour workday to determine acceptable levels of exposure. While silicosis tends to be a chronic condition that requires exposure over several years to decades to develop, there is evidence that one significant exposure may lead to the development of the condition (Cocco, 2003). The events of September 11, 2001, did indicate the need to emphasize the diligent use of PPE during any potential exposures (Pavilonis *et al*, 2017). Furthermore, even in the absence of silicosis, the respiratory ailments associated with exposure to WTC dust have been well documented and may continue to develop in the future. Continued medical surveillance for respiratory conditions is required (Friedman *et al*, 2016).

### Treatment

Silicosis is a potentially fatal disease with no known cure. Individuals who are at risk for silicosis should receive medical monitoring. Individuals should also notify their health care providers that they are at risk for the development of occupational lung disease. Treatment of the condition involves oxygen, inhaled steroids, and bronchodilators (American Lung Association, 2019).

### CONCLUSION

Silicosis is an occupational lung disorder that develops after exposure to respirable silica. Silica is a common mineral of the Earth's crust and is frequently used in a wide range of manufacturing capacities. Inhalation of respirable silica results in an immune and inflammatory response of the body. Fibroblasts produce collagen, eventually leading to fibrosis. There is no known cure for silicosis at the current time. The use of engineering and work practice control methods remains vital to preventing this condition.

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