

THE OCCUPATIONAL HEALTH HAZARD SILICON DIOXIDE (SiO₂) IN CAUSING SILICOSIS AND AWARENESS

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Abstract:

The occupational lung disease caused by inhalation of crystalline silica dust, and is marked by inflammation and scarring in the form of nodular lesions in the upper lobes of the lungs. It is a type of pneumoconiosis. Silicosis is characterized by shortness of breath (Dyspnea), cough, fever, and cyanosis (bluish skin). It may often be misdiagnosed as pulmonary edema (fluid in the lungs), pneumonia, or tuberculosis. Silica is today known as carcinogen that can cause cancer, including lung cancer. Biomarkers may enable in diagnosis to take timely preventive steps and ensure a prolonged healthy life of the affected person. The change in the values of biomarkers (Serum Cu, Neopterin, Serum selenium, Serum Zn, Angiotensin-converting enzyme, Heme oxygenase-1 and Clara cell protein (CC16) in blood serum can help us to diagnose and in the prognosis of the disease before it is actually diagnosed by the conventional X-ray technique and lung function test used for diagnosis of silicosis and the lung fibrosis has been observed. Because of work-exposure to silica dust, silicosis is an occupational hazard to mining, sandblasting, quarry, ceramics and foundry workers, as well as grinders, stone cutters, refractory brick workers, tombstone workers, pottery workers, flint knappers and others. 700 cases of silicosis disease detected in last two years in Rajasthan. Because no effective treatment for silicosis is available, effective control of exposure to crystalline silica in the workplace is crucial. Therefore, primary prevention (i.e., engineering or other control of exposure) should be maintained or improved to reduce worker morbidity and mortality. Awareness in most of the sandstone workers about causation, sign and symptoms about the silicosis may provide a better way to deal with the deadly disease.

KEYWORDS: Silicon dioxide (SiO₂), Silicosis, Cyanosis, Neopterin, Biomarkers Deadly Disease

Introduction:

Today in some area where mining working is most abundant the persons working in such areas are exposed to crystalline silica (RCS) particles cause irreversible damage to the lungs. The inhalation of the silicon dioxide causing minute scar tissue to form within the lungs. This resulted in decreasing of the breathing capacity gradually diminishing breathing and lungs damage that resulted in death of mine workers. This is a noncommunicable disease (NCD). If we look in to the historical perspectives of the silicosis. Ancient Greeks were familiar with lung disease in quarry workers (Hippocrates) The respirators was known to prevent the disease. Agricola (1566) and Ramazini (1713) reported that this disease is found in stone cutters. The International Agency for Research on Cancer (IARC) in 1997 classified crystalline silica as a group 1 (known) human carcinogen. The increasingly widespread use of pneumatic tools and

automatic machinery, particularly in the mining and stonecutting industries, created very dusty work environments in the late 1800s. Ignorance, few dust controls measure and least respiratory protection by workers, the disease and mortality rates during those years was reported significantly higher among workers in 'dusty trades' compared with other occupations.

As it has been established that crystalline silica is an abundant rock-forming mineral and is present in different forms or polymorphs in the environment. While each form is composed of units of silicon dioxide (SiO_2), the forms differ in their atomic spacing, lattice structure, and angular relation (National Institute for Occupational Safety and Health 2002) is the main causative agent of silicosis.

If we look into the hazardous nature free crystalline silica (in practice, mainly quartz and cristobalite) is highly fibrogenic and leads to the formation of silicotic noduli which lead initially to 'simple silicosis', characterized radiologically by small discrete opacities, and through coalescence they give rise to larger nodular opacities, characteristic of 'progressive massive fibrosis' (PMF). However, Silicosis is also associated with other conditions, such as tuberculosis, bronchopulmonary cancer, and collagen disease, including systemic sclerosis. In most of the mining workers the health effects of breathing in dust containing silica are not understood and those who understand the risks but simply cannot afford to give up work or move elsewhere. Which becomes serious threats to their survival.

Types of silicosis:

The silicosis disease occurs in two clinical forms.

- (i) **Acute silicosis:** known as alveolar silicoproteinosis
- (ii) **Classic silicosis:** recognised as a chronic interstitial reticulonodular disease. It is much more common and it can be classified as simple or common.

Symptoms of Silicosis:

The silica particles build up tissue scar within the lungs. This scarring is irreversible, as more and more lung tissue is damaged, lung function can become severely impaired. The breathlessness led to premature death through heart failure. RCS exposure is also considered a risk factor for developing chronic obstructive pulmonary disease (COPD) – one of India's deadliest NCDs.

The Common symptoms are persistent cough, shortness of breath, chest pain, or, in later stages, the darkening of the skin or a blue tint appearing on areas of the body such as the lips. In cases of acute silicosis where large volumes of silica are inhaled in a short time period breathing can entirely stop due to severely impacted lung function.

Biomarkers for Silicosis:

The biological markers (biomarkers) are cellular, biochemical or molecular alterations that are measurable in biological media such as human tissues, cells or fluids. Biomarkers include tools and technologies that can aid in understanding the prediction, cause, diagnosis, progression, regression or outcome of disease treatment. Alone or in combination, biomarkers can provide an early warning system for risk of future adverse health outcomes. An individual biomarker, once it exceeds a certain threshold, is an indicator of risk of future illness or death due to problems in a particular biological system.

The primary pathologic changes in silicosis are fibrosis in the lungs (1,2). Thus, fibrosis of lungs due to silicosis is accompanied by increases in ceruloplasmin as well as Cu levels in blood serum (3,4).

Neopterin is regarded as an early biomarker of the cellular immune response. The increased serum neopterin level in the silicosis patients compared with the control group, noticed (5,6). Serum Se levels were reduced in silicotic participants (74.0 µg/l and 4.2 mg/l, respectively) compared with control participants. Corresponding serum SeP (116 µg/l and 5.8 mg/l, respectively) levels decreased in a similar way in participants with silicosis. Serum Se and SeP concentration were found to be inadequate in patients with silicosis, and decreased significantly with severity of disease (7,8,9).

Zinc level will be lower according the condition of a patient. If the patient's condition is worsened and the compensating mechanism is destroyed, Zn level will decline. elevated serum-angiotensin converting enzyme (SACE) levels can be attributed to the fibrotic involvement of lung tissue, Heme oxygenase-1 (HO-1), a rate-limiting enzyme in heme catabolism, has antioxidative, antiapoptotic and anti-inflammatory activities (10). Studies indicate that crystalline silica induces the production of reactive oxygen species (ROS), which play a key role in the development of silicosis. Generation of oxidants by crystalline silica particles and by silica-activated cells results in the activation of the following mechanisms:

- (i) Cell and lung injury
- (iii) Mitochondrial dysfunction
- (iv) Increase lipid peroxidation
- (v) Increased expression of inflammatory cytokines

The changes in the concentration of the above biomarkers play a very crucial role in early diagnosis of the disease.

Silicosis problems in Rajasthan:

The stone industry provides employment to the large number of skilled or non-skilled labour in Rajasthan. It has been reported that more than 1.65 million families working at stone quarries and mines for meagre wages. The CAG report states that 7,959 silicosis cases were detected in the state between January 2015 and February 2017, and in the same period, 449 people died of the disease in five districts. The report adds that there were 2,548 silicosis-inducing mining units in Rajasthan in 2017.

The Rajasthan State Human Rights Commission toward the end of 2014 prepared a special report on the state's mine workers suffering from silicosis. The report was sent to the Ministry of Labour and Employment with a direction to take action based on its recommendations. This report was forwarded to the state's Department of Mines and Geology (DMG) and the State Pollution Control Board for further action. The board had committed to carrying out periodic air quality checks near clusters of mines and quarries.

The silicosis has the potential to destroy communities due to its very localised effects based on the surrounding industry. In those area where mining is the most common occupation in the village is mining a disproportionate number of deaths due to silicosis has been reported and resulted in the village being known locally as the “village of widows”.

The death rate of silicosis patients is increased in such areas because it misdiagnosed as TB sometimes because of their similar symptoms and treated with medicines meant for TB, which ultimately don't help. What's even more incredible is that at the time of diagnosis at government hospitals, workers are not asked about their occupation history, which results in a delay from the doctors' board to certify silicosis as many still don't know it's a certified disease,". Another reason of high death is that in hospital's enough oxygen tanks are not available to silicosis patients at the last stage of when they need it the most.

Prevention and treatment:

The simplest prevention strategy is to simply avoid silica dust but it is difficult for the mining workers where this is the only earning source for them, therefore job rotation should be considered.

The Proper safety equipment, including masks fitted with respirators can also make the condition less likely to develop.

The employers who do not provide the necessary equipment to the workers, the legal oversight into workers conditions in these industries could go a long way in reducing disease cases.

Since there are no means to cure the disease so those who develop symptoms management is the most common means of treatment, including the use of inhaled steroids to reduce the build-up of mucus, and oxygen tanks to assist with breathing. The capacity to work is diminished, resulting in further economic hardship.

Conclusion:

The long-term exposure of the mining and related industry workers to the crystalline silica destroy lung of the persons and causes serious threats to the survival of the workers. This disease cause destruction of the communities who totally based on the mining industry.

Therefore, proper diagnosis of the silicosis disease has to undertaken and the relief either social or economic must be given to the sufferer. However, preventive measures such as safety equipment, including masks fitted with respirators and employer must be forced to provide protective measures to the mining workers by government agencies and departments. The change in the values of biomarkers (Serum Cu, Neopterin, Serum selenium, Serum Zn, Angiotensin-converting enzyme and Heme oxygenase-1 in blood serum can help us to diagnose and in the prognosis of the disease. Awareness in most of the sandstone workers about causation, sign and symptoms about the silicosis may provide a better way to deal with the deadly disease.

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