THE INFLUENCE OF MINING IN INCIDENTS OF LUNG SILICOSIS

INTRODUCTION

The earliest association of iron-ore mining with life-threatening disease of silicosis dates to over a century. Before that, it was traditionally believed amongst both laymen and the medical professionals, that haematite iron ore mining was a very *healthy* profession. After the introduction of pneumatic drills is the 19th Century, all the "mishaps" and "evils" that occurred were attributed to their use. Various researchers around the world conducted several studies and inferred that **"iron-ore miners not only show a higher mortality from pulmonary diseases but also shown a maximum death rate from phthisis at a later age period"** (Craw, 1947). Even today, this statement holds true, and much research has been conducted ever since to understand the mechanism of silicosis and its relation with iron-ore miners.

Silicosis is an irreversible and incurable lung disease caused by the inhalation of dust containing crystalline silica particles. Silicosis is one of the most important occupational diseases in the world and exposure to silica generally occurs in mining, construction, works/ quarries, pottery manufacturing and denim sandblasting (Croteau et al., 2004; Ulm et al., 2004; Gungen et al., 2016). Although cement does not contain much silica, substantial amounts of respirable quartz can be generated when concrete building materials containing sand and stone are cut, ground, or drilled. Drilling in confined spaces can cause excessive silica exposure, as reported in hand-dug caissons in Hong Kong (Ng et al., 1987). Workers in the mining industry experience the highest risk of lung cancer due to the magnitude and duration of their silica exposure. Approximately 2 million workers in USA, 2 million workers in Europe, 0.5 million workers in Japan and more than 23 million workers in China are estimated to have been exposed to the causative agent and 4.2% of deaths among industrial workers in China is attributed to silica dust exposure (Leung et al., 2012; Steenland and Ward, 2014; Maciejewska, 2008; Ministry of Health, Labour and Welfare, Japan, 2016; Ministry of Health, China, 2011).

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TYPES OF SILICOSIS

Silicosis is classified into three phases: acute (developing within weeks to a few years), accelerated (developing within 10 years) and chronic (developing more than 10 years after initial exposure). The onset of disease is influenced by both the concentration and duration of exposure. To aid in diagnosis, regular clinical examination accompanied by chest radiography is recommended for people exposed to silica dust on a regular basis. There is little doubt that prolonged inhalation of crystalline silica can cause silicosis. Silica particles of size less than 10µm can reach and persist in the peripheral lung where they are adsorbed by the epithelial cells that result in the generation of Reactive Oxygen Species (ROS). These ROS attack the bronchial/epithelial cells and initiate regeneration process within the body which supports fibriogenesis and carcinogenesis. Epidemiologic studies show that silica exposure is associated with an increased risk of oesophageal, stomach, skin and most importantly lung cancer (Yu et al., 2005; Cocco et al., 1996; Partanen et al., 1994). This process may sometimes be asymptomatic or be accompanied by rapid onset/worsening of symptoms like dyspnea, cough, fever and chest pain. Silicosis also increases susceptibility to other disorders such as tuberculosis, autoimmunity and chronic renal disease. Silicosis deaths in young adults (15-44 years) has not reduced in decades, however, protective measures (dust controls and respirators) have helped in controlling such incidences in developed nations while new outbreaks continue to thrive in developing and under-developed countries.

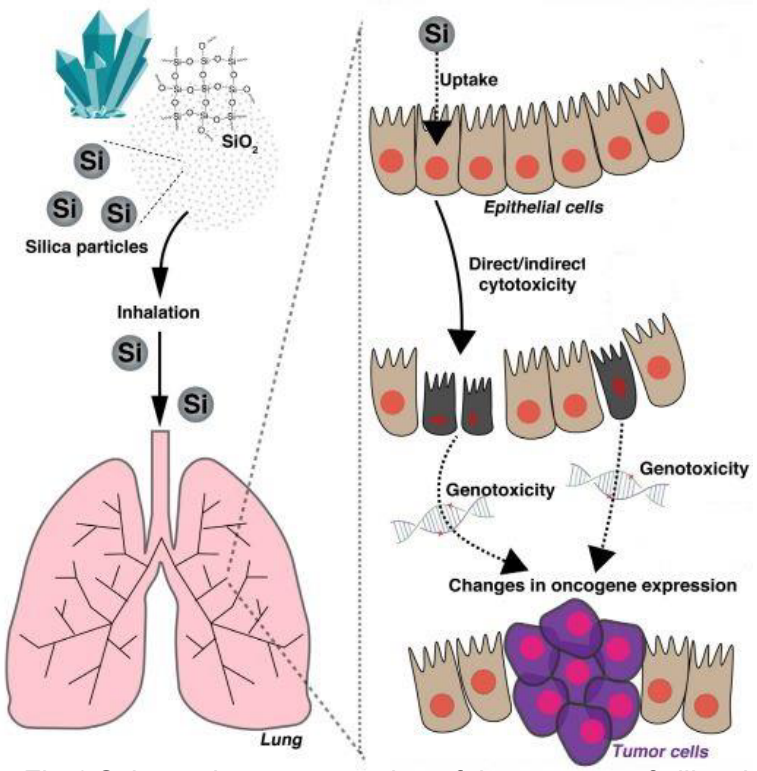

Fig.1 Schematic representation of the process of silicosis after exposure to silica

(Source: Sato, T., Shimosato, T., & Klinman, D. M. (2018). Silicosis and lung cancer: current perspectives. Lung Cancer: Targets and Therapy, 9, 91)

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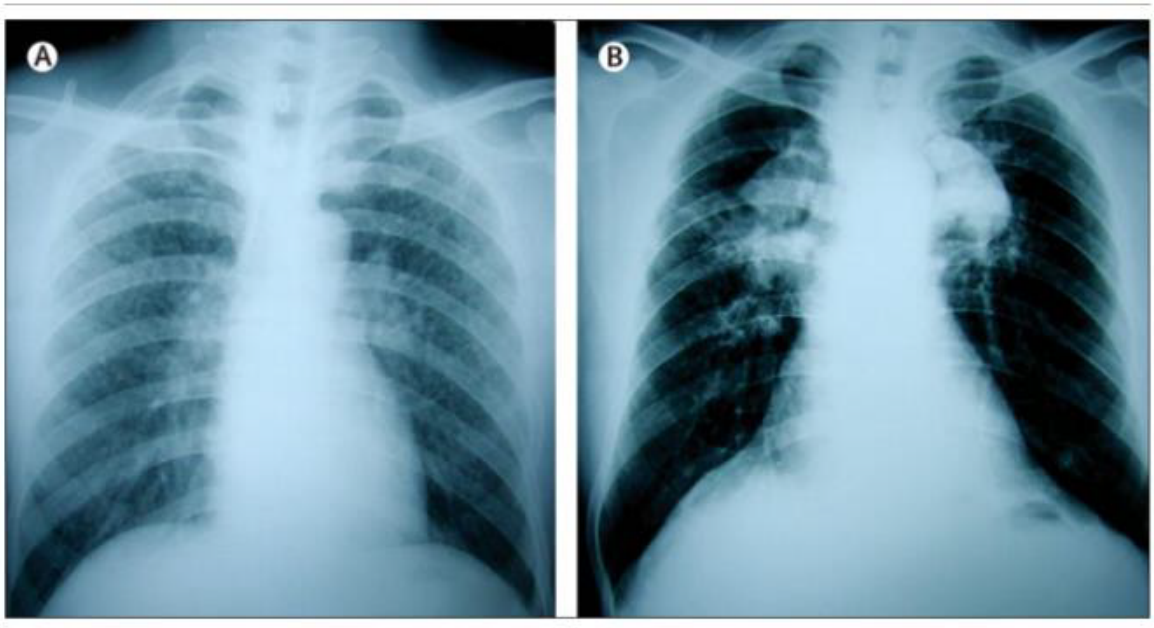

Figure 2. Chest radiographs of a patient with silicosis. Simple nodular silicosis (A) and progressive massive fibrosis (B).
(Source: Leung, C. C., Yu, I. T. S., & Chen, W. (2012). Silicosis. The Lancet, 379(9830), 2008-2018).

Silicosis is a progressive disease characterized by fibrotic changes in the lungs. The sensitivity of chest radiography improves with increasing degree of silicosis.

TREATMENT/PREVENTION

There is no known cure for silicosis. Supportive therapy involving the prevention of infection, use of bronchodilators and oxygen supplementation are the mainstays of treatment (Leung, 2012). Silicosis patients should generally be removed from further exposure. Job accommodation and personal protective measures are essential for individuals remaining in their jobs, even though these measures cannot fully protect those with proven disease from further damage. Smoking cessation, and influenza and pneumococcal vaccines are useful in reduction of complications. Empirical treatment with bronchodilators should be considered for symptomatic patients with airflow obstruction. Cough suppressants and mucolytics could be useful for symptomatic relief (Leung et al., 2012). In the past decade, outbreaks of silicosis have been reported in some small-scale companies or mines in developing countries, mainly caused by poor hazard recognition and few protective measures. The initiative is encouraging

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and supporting countries with silica hazards to establish national action programmes to control silicosis.

Some of the measures as suggested by National Institute of Occupational Safety and Health are described as under:

1. Primary Prevention
   - Silica exposure control at source: Substitution of materials; modification of processes and equipment; wet methods; silica warning sign; work practices
   - Control silica dust emission or transmission: Isolation of the source or workers; enclosed processes; air curtain; water spray; local exhaust ventilation; general ventilation system; enclosed cabs; air supply system.
   - Control silica dust at worker level: Training and education about work practices; personal protection; personal hygiene; personal protective equipment; health promotion.

2. Secondary Prevention
   - Surveillance of working environment: Establish concentration of silica dust; assess health risk for workers exposed to silica dust.
   - Surveillance of worker health: Periodic health examination, such as chest radiography; early detection of the disease; research into biomarkers for early stages of silicosis

3. Tertiary Prevention: Removal from environment; prevention of complications; modification of work processes; rehabilitation

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