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Outbreak Investigation of Silicosis in Saraburi Province, Thailand

Keeratiya Thai-ou*

Bureau of Occupational and Environmental Diseases, Department of Disease Control, Ministry of Public Health, Thailand
*Corresponding author: keeratiya034@gmail.com

Abstract **Background:** The staff of the Office of Disease Prevention and Control 4, Saraburi, Department of Disease Control, Ministry of Public Health, Thailand analyzed the data of 28 cases of diagnosed silicosis (J62.8) whose data were reported to the Health Data Center in Saraburi province, Thailand. Thus, its staff in collaboration with the staff of the Bureau of Occupational and Environmental Diseases, Department of Disease Control, Ministry of Public Health, Thailand formed the outbreak investigation team for this epidemiological outbreak of silicosis in Saraburi province, Thailand and operated from May 15, 2017 to May 17, 2017. **Objective:** 1. To confirm the diagnosis of Silicosis. 2. To find the causes of Silicosis. 3. To advice the health-care issues for Silicosis prevention to all patients diagnosed of Silicosis including high-risk populations of Silicosis **Methodology** 1. Meeting with stakeholders at Saraburi Hospital. This aimed to examine diagnostic Criteria from medical records in Saraburi Hospital and to define the definition of patients and suspected patients with Silicosis as well as organizing an investigation team. 2.Investigated suspected patients with Silicosis by using the clinical criteria which was provided by Saraburi Provincial Public Health Office, the Office of Disease Prevention and Control 4, Saraburi, Saraburi Hospital as well as the Health Promoting Hospitals.3.Meeting of a summarizing the investigation and root cause analysis regarding Silicosis with the Bureau of Occupational and Environmental Diseases, Saraburi Provincial Public Health Office and the Office of Disease Prevention and Control 4, Saraburi at Saraburi Hospital as well as planning for a surveillance system. **Results:** From analysis of 28 cases registered in Health Data Center, Saraburi province, Thailand by the outbreak investigation team, there were one case with no data availability, three cases with non-classification of suspected Silicosis, and 24 cases of suspicion criteria. Out of 24 Silicosis suspected cases, 8 cases were unable to follow up due to their homes being out of the Health Inspection Region 4, one case died of Nocardia species infection, one case of not being occupational cause, and one case of refuse to provide personal health data. Thus, only 13 cases were eligible for study. Of 13 cases, 12 cases were diagnosed of chronic Silicosis whereas one case was not compatible with the diagnostic criteria. **Conclusion:** As a result of the investigation of 13 cases, 12 cases were diagnosed as chronic silicosis. The main cause of silicosis in this study population was receiver, whereas the secondary causes were source and passage.

Keywords: *Silicosis, Cause analysis, Health Data Center*

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1. Introduction

Silicosis is a lung disease caused by inhalation of silicon dioxide, or crystalline silica dust. Silicosis can manifest in both acute and chronic forms, although chronic silicosis is most commonly found. In addition, the sign of Silicosis depends on the amount of silicon dioxide exposed. Silicosis commonly involves the respiratory system and develops clinical signs, such as dyspnea, difficulty breathing, cyanosis, fever, fatigue, and weight loss [1]. The diagnosis of silicosis requires information of history of exposure, symptoms and signs, including chest x-ray reports which requires experts who can read the radiographs using ILO standard [2]. The diagnosis of silicosis Thailand is currently challenging due to inadequate number of such experts, together with the nature of disease with nonspecific signs. Symptomatic treatment is presently applied while the permanent cure is not yet available. Furthermore, complications such as lung infection and respiratory failure can also emerge. Therefore, prevention of the disease is considered vital [3].

Since 2001, Thailand had been implementing Silicosis elimination plan for the country's active monitoring, especially over establishments engaged in rock milling, grinding and grounding [4]. The Ministry of Public Health had developed Silicosis investigation guideline for all of the patients being diagnosed [5].

Data from Bureau of Policy and Strategy, Ministry of Public Health, Thailand showed that there were 241 silicosis patients in 2016, or 0.37% of morbidity, which is increasing from 2015. Data collected during 2013 – 2017 by the Region 4 Health Provider, Thailand showed 0.22%, 0%, 0.25%, and 0.18% of morbidity, respectively. The highest rate of illness caused by silicosis in the region of

the Health Region 4, Thailand was found in Saraburi, followed by Phra Nakhon Si Ayutthaya, Ang Thong, and Nakhon Nayok Provinces, respectively. Additional investigation from an information technology (IT) database had revealed that during 2015 – 2017 there were 99 medical service requests from silicosis patients [6].

Data from the survey of silicosis-risk workplaces in Saraburi Province, Thailand, cross-sectioned in the year 2016, by the Department of Industrial Works showed that there were 419 workplaces in Saraburi. Among this number, establishments engaged in production of concrete products, mixtures of concrete and gypsum products, or plaster products (05801) were most located, followed by establishments engaged in rock milling, grinding and grounding, including production of cement and lime (00301) or plasters, and factories that manufactured glazed ceramic ware, earthenware, pottery ware (05701) and material preparations (05500), accordingly. It was founded that Nong Khae district located most of the workplaces, followed by Chaloem Phra Kiat district, Saraburi, Thailand and Phra Phutthabat district, Saraburi, Thailand, respectively [6].

On April 10th, 2017, Bureau of Occupational and Environmental Diseases, Department of Disease Control, Ministry of Public Health, Thailand was informed by the Office of Disease Prevention and Control 4, Saraburi, who developed the data base in Saraburi area and identified 28 cases of silicosis (J62.8) as coded in Health Data Center (HDC), Saraburi [7]. After the primary revision by the staff of the Saraburi Provincial Public Health Office, Ministry of Public Health, Thailand and the staff of the Office of Disease Prevention and Control 4, Saraburi, Department of Disease Control, Ministry of Public Health, Thailand, there was 1 case without patient record and 3 cases whose records did not match silicosis. Therefore, there were only 24 cases of suspected silicosis remained eligible for the study. Hence, the staff of the Office of Disease Prevention and Control 4, Saraburi, Department of Disease Control, Ministry of Public Health, Thailand contacted the staff of the Bureau of Occupational and Environmental Diseases, Department of Disease Control, Ministry of Public Health, Thailand to collaborate on the investigation of silicosis outbreak in Saraburi during May 15th, 2017 – May 17th, 2017. Objective:

1. To confirm the diagnosis of silicosis
2. To find the causes of silicosis
3. To advice the healthcare issues for silicosis prevention to all patients diagnosed of silicosis, including high-risk populations of silicosis

2. Materials and Methodology

This study was epidemiologically descriptive. Data were analyzed from patient treatment records at Saraburi Hospital, Saraburi, Thailand. There were 28 cases of suspected patients diagnosed with Silicosis under code J62.8 in the HDC database, Saraburi, Thailand during 2013 – 2017.

A meeting among relevant units was set up at Saraburi Hospital, Saraburi, Thailand to collaborate upon the definition of probable and confirmed cases of silicosis, including the planning of field investigation on the cases that matched the definition.

Definition of probable case of silicosis. Meets criteria on item 1 together with at least one from item 2 – 5.

1. A person with at least 2-year-period history of exposure to crystalline silica dust at the workplace.
2. Display symptom of dyspnea and chronic cough without history of other diseases such as lung cancer and pneumonitis or display other deformities from physical examination such as clubbing finger.
3. Chest x-ray result matches ILO classification of pneumoconiosis profusion level 1/1 or above at the upper lung [2].
4. Display abnormality in pulmonary function tests.
5. Display symptom of, or diagnosed of tuberculosis.

Definition of suspect case of silicosis. Meets 2 out of 3 criteria below:

1. At least 2-year-period history of working in the crystalline silica dust exposure risk career.
2. Chest x-ray result shows the abnormality that matches the criteria of International Labor Office (ILO) system of classification of radiographs of pneumoconiosis2000, at profusion level 1/1 or above.
3. Display matching lung pathology with silicosis or having supported epidemiological data together with the history of exposure of crystalline silica dust in the career risk group.

The investigation of general information by questionnaire [8] about the patients' workplaces, types of work, history of illness including symptoms, signs, treatment history, work history, silicosis risk behaviors such as smoking, and the revision of relevant information which were the patient medical records, chest radiology data and other examinations were made. The investigation of medical records had revealed 14 probable cases of silicosis; however, 1 patient had declined to give information, so there were 13 cases of probable silicosis remained to be further investigated.

3. Results

The investigations of silicosis in 13 cases showed 12 probable cases of silicosis, while 1 case was not classified as silicosis due to the minimal exposure to crystalline silica dust, and the symptoms did not match silicosis. In summary, there were only 12 cases who met the diagnosis criteria of confirmed silicosis.

Section 1: Demographic data

The 12 cases who met the diagnostic criteria of confirmed silicosis were 66.67% of male and 33.33% of female with the age median of 56 years old. Most patients completed the highest education from the primary school (91.67%) and the rest completed the lower secondary school (8.33%). The majorities were married (91.67%). The patients' address were scattered among 5 districts from 13 districts of Saraburi Province [9], Thailand where the majority of them lived in Nong Kae district as shown in Table 1.

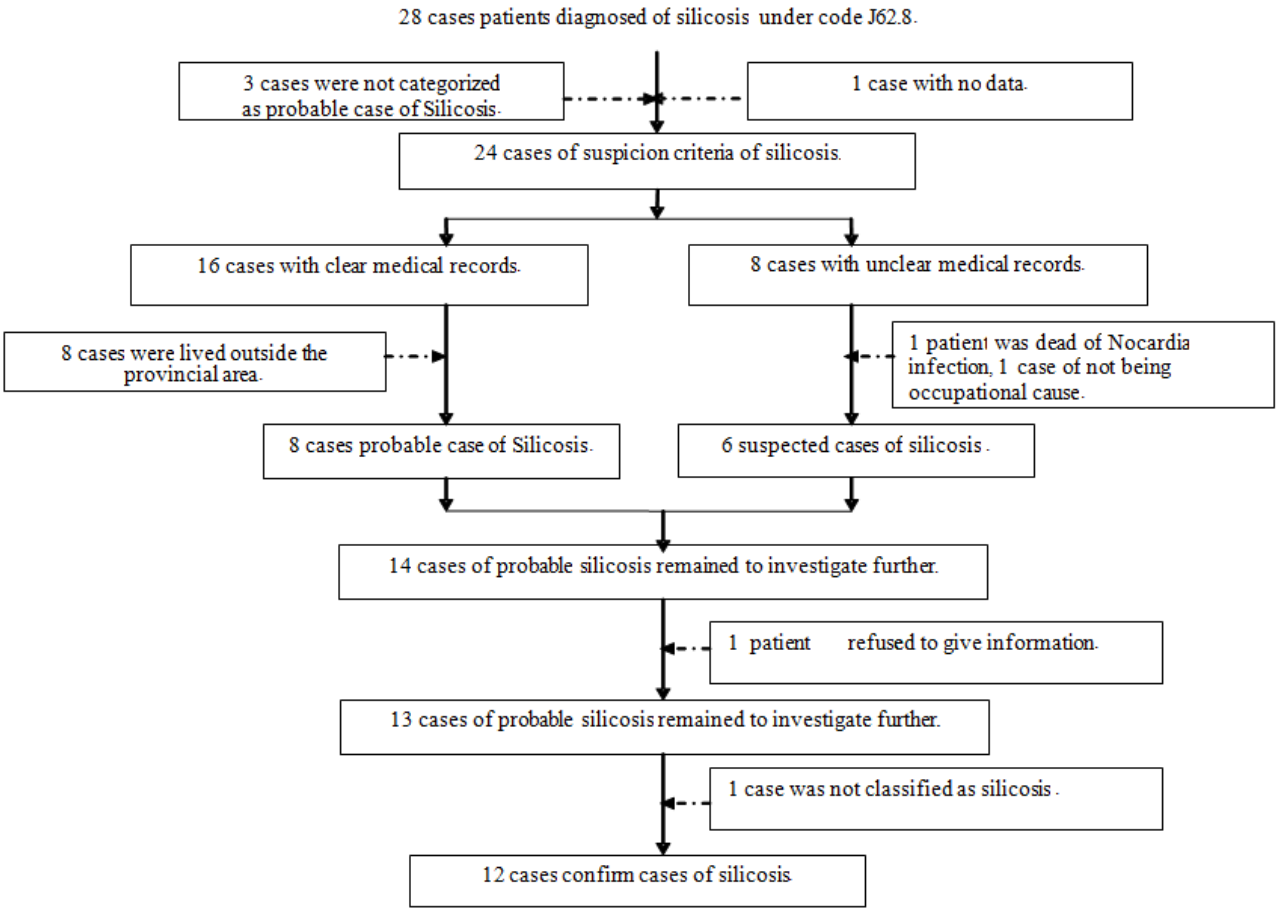

Figure 1. Description of the patients diagnosed of Silicosis code J62.8

Table 1. Percentage, mean, median, minimum and maximum values of population data (n = 12)

Population characteristics	Number (%)
Gender	
Male	8 (66.67)
Female	4 (33.33)
Age (range 46-73**, median** 56)	
41-50 years	2 (16.67)
51- 60 years	5 (41.67)
61-70 years	4 (33.33)
71-80 years	1 (8.33)
Education Level	
Primary School	11 (91.67)
Secondary School	1 (8.33)
Marital status	
Single	1 (8.33)
Married	11 (91.67)
Address by district	
Phra Phutthabat	2 (16.67)
Mueang	2 (16.67)
Kaeng Khoi	1 (8.33)
Sao Hai	1 (8.33)
Nong Kae	6 (50.00)

Section 2: History of health and illness

Most patients never smoked (66.66%) while the rest had either stopped smoking (16.67%), or active smoking (16.67%). Most of the patients had no underlying disorders (58.33%) and the smaller portion had no underlying disorders (41. 67%). The majorities were eligible of using social security benefits (91.67%) and most of the patients received regular annual health check-up (75%) as shown in Table 2.

Table 2. Number and percentage of health and illness records (n = 12)

Health and illness records	Number (%)
Smoking history	
Never smoked	8 (66.66)
Ever smoked	2 (16.67)
Active smoking	2 (16.67)
Medical eligibility	
Social Insurance	11 (91.67)
Co-payment charged	1 (8.33)
Chronic health conditions	
No	7 (58.33)
Yes	5 (41.67)
Annual health check-up	
No	3 (25.00)
Yes	9 (75.00)

Section 3: Types of work and career

As for the work place with risks of the dust exposure, it was founded that the majority of them worked in sanitary ware factories (58.34), tile factories (25%), stone mill (8.33%), and crafting workplace (8.33%). Most patients started working during 21-30 years of age, while most of them did not work overtime (OT, 58.33%). Most patients worked 6 days a week (58.34%) and 5 days a week (33.33%), and 8.33 percent worked more than 48 hours a week. In addition, most patients did not have an extra-

work during their occupational work experience (83.33%) as shown in Table 3.

Table 3. Percentage, mean of job profile and occupation (n = 12)

Job and career	Number (%)
Places to work and dust exposure	
Sanitary Ware Factory	7 (58.34)
Tile Factory	3 (25.00)
Stone Mill	1 (8.33)
Crafting Workplace	1 (8.33)
Age at work (range 18-40**, median age** 23 **years)**	
< 20 years	2 (16.67)
21-30 years	8 (66.66)
31-40 years	2 (16.67)
The number of hours worked per week	
40 hours (5 days / week)	4 (33.33)
48 hours (6 days / week)	7 (58.34)
>48 hours	1 (8.33)
Part time work	
No	7 (58.33)
Yes	5 (41.67)
Extra-work during the occupation	
No	10 (83.33)
Yes	2 (16.67)

Section 4: Patients' silicosis preventive behaviors at their workplaces.

As for the knowledge of silicosis, it was found that most patients had no knowledge about Silicosis (91.67%) and did not know the benefits of protective gears (75%). Most of the patients occasionally wore protective masks (75%)as shown in Table 4.

Table 4. Number and percentage of knowledge and silicosis self-protection behaviors of patients working (n = 12)

The knowledge and silicosis self-protection behaviors of work	Number (%)
The knowledge of silicosis	
No	11 (91.67)
Yes	1 (8.33)
The knowledge of the benefits of protective equipment	
No	9 (75.00)
Yes	3 (25.00)
The use of masks during dusty work experience.	
Sometimes used	9 (75.00)
Regularly use	2 (16.67)
Do not use	1 (8.33)

Section 5: Workplace environment

Half of the workplaces (50%) were operated with ventilation system. The amounts of dust at most of the working sites were medium level (83.33%) as shown in Table 5.

Table 5. Number and Percentage of Workplace Environment Information (n = 12)

Workplace Environment Information	Number (%)
Ventilation in the workplace	
No	6(50.00)
Yes	6(50.00)
Dust at the work sites	
Medium level	10(83.33)
High level	2(16.67)

The analysis of the cause of silicosis

The analysis of the cause of silicosis can be categorized into 3 aspects, the source, the pathway and the receiver. In- depth analysis of each aspect and cause were made as shown in the below diagram and the Table 6

Table 6. Shows the causes of silicosis

Causes of Silicosis.			cases
Source: Silica	Silica dust exposure	Work process	9
		Lack of adequate ventilation	9
	Exposure time	Excessive work hours per day	2
		Worked for several years	10
Pathway	Protective equipment	Do not use protective equipment	8
		Lack of protective equipment	2
	Ventilation of workplace	No ventilation system	6
		Lack of adequate ventilation	7
Receiver	Lack of knowledge	Ventilation is not effective	11
		Not observed abnormal symptoms	12
		Risk behaviors such as smoking	2

The overview analysis of the cause of silicosis of the 12 cases was concluded that the disease was caused by co-occurrence of all 3 aspects. The primary cause was the receiver, followed by the source along with the pathway, respectively.

4. Discussion

The analysis of 28 patient records reported with silicosis (J68.2) revealed that there was no data for 1 case and had found that 3 cases were not categorized as probable case of Silicosis. The remaining 24 cases were remained as suspected-silicosis patients. Among this number of the suspected cases, there were 16 cases with clear records; however,8 of them lived outside the provincial area which had limitations of the follow- up investigation, one patient was deceased from Nocardia infection, and another patient were exclude from the occupational silicosis by the silicosis-outbreak investigation team. Afterwards, the silicosis-outbreak investigation team had investigated all 14 cases but 1 who refused to give information because of the legal concerns with former employer. This equated the total number of 13 cases to be investigated. The field-investigated-work history and treatment history showed that 12 of the cases were confirmed of occupational silicosis and 1 case didn't meet the diagnostic criteria because of the history of minimal exposure to crystalline silica dust together with the symptoms that did not match silicosis. The investigated data of the 12 confirmed cases of silicosis showed that there were 8 males and 4 females. The oldest patient was 73 years old and the youngest was 46 years old, with average age of 56 years old. Most of the cases used social security privileges in medical treatment during working period which were in accordance with the patients annual-health check-up records and the smoking behavior. Most of the patients never smoked which benefited the disease progression and reduced complications of silicosis [1]. However, most patients

were not knowledgeable about Silicosis and the danger of work that they exposed to crystalline silica dusts, including the knowledge of protective gear usage which resulted in the occasional usage of protective masks during the period of silica dust exposure. Exactly, the long work-hour period or more than 48 hours (or 6 days) a week was exceeded the current regulations of 40 hours per week (not exceeding 8 hours a day for 5 days) [10].

The confirmed silicosis patients mostly lived in Nong Kae district, Saraburi, Thailand. These data matched the outbreak investigation of silicosis-risk workplaces in Saraburi, Thailand in 2016, performed by the Department of Industrial Works, Ministry of Labor, Thailand that recorded Nong Kae district, Saraburi, Thailand as the most located workplaces [6]. The workplaces that most patients worked in were sanitary ware manufactories, followed by tile manufactories and quarry factories. This data matched the one from the investigation of Silicosis risk workplaces in Saraburi, Thailand in 2016, performed by the Department of Industrial Works, Ministry of Labor, Thailand that recorded a total of 419 workplaces in Saraburi Province, Thailand where the most recorded type of workplace was the establishment engaged in production of concrete products, mixtures of concrete and gypsum products, or plaster products [6].

5. Conclusion

The analysis of the causes of silicosis in this outbreak investigation indicated that silicosis was caused by 3 co-existing factors, the source, the pathway and the receiver. The primary cause of the disease was attributed to the receiver who lacked of knowledge. Most patients had no knowledge about silicosis and dangers from the silicosis-dust exposure that resulted in the ignorance of strict usage of protective mask during work hours. The remaining secondary causes were the source, exposure of the silicosis dust from the production, and the pathway which were evidenced by the lack of regulation on protective gear usage and the lack of work-appropriate ventilation monitoring.

6. Limitations

1. Inability to thoroughly investigate the patients' history of illness due to many passing years.
2. The suspected silicosis patients had already moved from the former workplaces and were not kept in touch with former colleagues that made the outbreak investigation of their colleagues who also exposed to the silicosis dust from the same department impossible.
3. Chest radiological report of the probable cases were mainly interpreted by non-certified ILO-standardized-system radiologists.
4. The collection of environmental data was limited due to the workplace shut down. There were about 1-2 workplaces that operated. The staff of the Saraburi hospital, Saraburi, Thailand were already suggested to make contact with suspected silicosis cases and further outbreak investigation; however, the data obtained may not be able to use in analysis of association between their work and silicosis development since the suspected silicosis patients under investigation had been away from the former workplaces for a long time. Their current working conditions may not match the actual condition of their past works.

7. Recommendations

Recommendations for the patients

1. The smoking patients are advised to strictly stop smoking.
2. Avoid contact with crystalline silica dust both at work and outside of work. Always wear protective gears every time that the contact is made.
3. Exercise regularly, at least 3-4 times a week.
4. Regular annual health check-up.
5. In case with abnormal symptom arising, such as increasing shortness of breath or chronic cough, urgently consult with the doctor at the hospital.

Recommendations for the government sector healthcare provider

1. Empower personnel in District Health Promotion Hospital with knowledge of how to continually monitor and home visit patients with silicosis.
2. Train the out-patient nurses and the nurses at the screening department to be aware of silicosis which can be diagnosed together with tuberculosis.
3. Encourage the physician training to read chest radiographs that correspond with ILO standards to reduce CT scan referrals.
4. Acknowledge community leaders such as the mayors, chief executives of the Sub- District Administrative Organization (SAO), sub-district headman, and village headman and hospital personnel in the area to be aware of dangers of occupational diseases.
5. Arrange hygiene education teams to educate workers in silicosis risk prone workplaces to understand the nature and prevention of the disease, including the role of Workmen's Compensation Funds for the silicosis patients.
6. Establish health risk registers for workers in workplaces with the dust exposure.
7. Establish thorough registers for types of workplaces within the area, especially establishment with silicosis risk, including Small and Medium Enterprises (SME) and the informal labors within the area.
8. Collaborate for inspection of the workplaces where patients with silicosis are working to evaluate risks and help screening silicosis-risk colleagues.
9. Develop networks and knowledge for public health volunteer in the villages where numbers of stone crafting workers are currently working to help screening and monitoring residents in the risk area.
10. Develop investigation system for the probable cases of silicosis.

11. Encourage workplaces to participate in the "Disease-free, safety workplace, happy mind and body" program.
12. Monitor and evaluate silicosis watch system in order to analyze the country situation.
13. Encourage academic knowledge and media usage to transfer knowledge of the disease and usage of protective gears.
14. Encourage researches on guidelines for silicosis-risk labor care for formal and informal labors.

Recommendations for workplaces

1. The dust level should be measured including installation of ventilators as required by laws and the maintenance of the ventilators to retain effective functioning.
2. Provide sufficient standard protective gears for the workers.
3. Implement measures to regulate usage of protective gears.
4. Monitor workplace environment as regulated by law.
5. Limit working duration in the department that exposes to the dust.
6. Arrange annual health check-up regularly for the workers and inform them about the examination results.

8. Conclusion

Out of 13 silicosis-outbreak investigated cases, there were 12 cases with chronic silicosis, whereas 1 case did not meet the diagnostic criteria due to the minimal exposure history and the unmatched silicosis symptoms.

The cause analysis of silicosis in the 12 outbreak-investigated cases revealed that silicosis was caused by 3 co-existing causes, the source, the pathway and finally, the receiver. The primary cause was the receiver, followed by the source and the pathway, respectively.

Conflict of Interests

No conflict of interests declared.

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Abbreviations

HDC: Health Data Center,
ILO: International Labor Organization,
IT: Information Technology
OT: Overtime,
SAO: Sub-district Administrative Organization

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