SOCIAL AND ECONOMIC BENEFITS OF PREVENTION MEASURES AT EW FLUORSPAR MINE

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ABSTRACT

Since 1962, synthetic dust-lowered measures have brought the significant social and economic benefits to the EW fluorspar mine: (1) The maximum dust concentration (from 1118 mg/m^3 to 18.1 mg/m^3) and mean dust concentration (from 366 mg/m^3 to 1.3 mg/m^3) have been reduced by 98.40% and 99.69% respectively. (2) Accumulative incidence rate, morbidity and mortality have been decreased from 24.8%, 85.4% and 5.9% to 0.8%, 0.08% and 0% respectively. The incubation period of the disease was prolonged from 4.3 years to 11.9 years. There has been no patient with silicosis among the miners who have been employed since 1966. (3) If the synthetic measures had not been adopted, there should have been 1709 patients with silicosis and 184 of them should have died of the disease. The measures have actually saved 103.3223 million yuan for the compensation of the loss of the output value, pension etc. After deducting the ventilation and the dustproof, their salaries and other costs used for the patients who have actually suffered from silicosis, 100.7723 million yuan of the economical benefit was gotten. (4) It is an invaluable social benefit that the good health condition of the miners has brought happiness to their families.

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STUDY ON PROTEIN FACTOR IN ALVEOLAR MACROPHAGE OF EXPERIMENTAL SILICOSIS

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The immunological theory of silicosis suggested by Vigliani et al opened a new way for studies on the pathogenesis of silicosis.[2] Previous researches on biochemical, pathological, and immunological changes in silicosis showed that immunological factors were involved in the producing and developing process of silicosis,[3] and that alveolar macrophage (AM) phagocytosis and destruction were important in the pathogenesis of silicosis. In this paper, the research results of a protein factor (PF) in AM of experimental silicosis were reported. It may be of practical significance for early diagnosis and further understanding of the pathogenesis of silicosis.

Conventional methods were used for animal models coping, dust particle preparation, dust instillation, observational indices and pathological, biochemical, immunological examinations.[4,5,6]

1. *Detection of serum protein factor (SPF) and the relationship between this SPF and the lesion in silicosis.* The anti-silicotic-rat lung rabbit serum (ASLS) and double agar diffusion method were used in the tests. Totally 243 serum samples from 53 silicotic rats and 28 normal rats were examined. The results showed that a SPF existed in the serum of silicotic rats, and between this serum and anti-serum a precipitation line was observed. The positive rate of SPF in silicotic rats was up to 82.8%, while the results were all negative for normal rats.

Different kinds of dust particles were injected into rat lungs. By checking the serum reaction in animals, it could be found that the positive rate of SPF in silicitic rats was closely related to the pathogenetic effect of dust. Higher positive rate was observed for more pathogenetic dust, and vice versa. (see Table I)

SPF positive rate increased with the periods after intratracheal injection of dust. Seven days after injection, SPF was negative; on the fifteenth day the positive rate increased up to 7.7%, and it was as high as 61.5%, 72.7%, 83.0%, and 100%, respectively after 30, 60, 180 and 210 days.

In order to study the dependence of SPF positive rate of silicotic rats on the silicosis lesion, 109 rats were divided into five groups according to wet weight of the lungs. Serum reactions, pathological changes and the amount of lung collagen were compared, and the results showed that SPF positive rate was in consistence with the extent of lesion. (see Table II)

It was also found that SPF positive rate decreased in some degree with the alleviation in silicotic lesion after therapy with PVNO and other drugs in our experiments. (see Table III)

For understanding the SPF level of rats intratracheally injected with quartz dust, 98 serum samples from 22 dusted

Table I

Relationship between SPF Positive Rate and Dust Property

dust	animal numbers	positive numbers	positive rate(%)	mean wet weight of rat lungs (g)
SiO_2	47	34	82.98	6.3
CaF	4	1	25.00	2.8
SiO_2+Na_2F	10	2	20.00	4.7
SiO_2+$Al(OH)_3$	11	4	36.36	4.9

Table II
Relationship between SPF Positive Rate and Silicotic Lesion

Wet weight of rat lungs(g)	animal numbers	positive rate (%)	pathological grade(IV-V%)	content of collegen in whole lung (mg)
3	4	0.0	0.0	63.6
3–4	35	14.3	43.3	130.2
5–6	52	67.3	59.9	184.2
7–8	15	93.3	63.6	247.9
9	5	100.0	70.0	306.3

Table III
Relationship between SPF Positive Rate and Curative Effect of Drugs

groups	animal numbers	positive rate(%) before treatment	positive rate(%) after treatment	wet weight of rat lung (g)	pathological grade
PVNO prevented	5	-	0.0	2.9	0.0
PVNO treated	20	95.0	0.0	4.3	38.7
anti-silica 14	13	76.9	50.0	5.3	70.7
SiO_2(control)	15	92.8	77.7	6.3	73.0

rats were examined from 45 to 180 days after chest, peritoneal, subcutaneous, intraveneous injection, and SPF were all found negative, while SPF positive rate after intratracheal injection was as high as 72.7% to 83.9%.

2. *Relationship between SPF and AM—Study on the source of SPF.* It is of practical importance to study on the source of SPF for finding a simple, reliable method to diagnose the early silicosis and to define a curative effect index. Hence, we prepared an anti-silicotic-rat AM rabbit serum (ASMS) and investigated its reaction with SPF.

   Through light microscope observations of silicosis pathology and tests about PVNO treatment, it was found that the SPF positive rate was closely related to the destruction of dusted AM.

   Cytotoxicity test showed that ASLS, ASMS had significant cytotoxic effects on the AM of dusted rats when complements existed in vitro. About 75 to 99 percent of AM was coloured by trypan blue.

   Agglutination reaction showed that ASLS, ASMS had higher agglutination effect on AM of dusted rats and the agglutination title were 1 640 and 1 1280, respectively.

   During agar diffusion precipitation processes, when ASLS and ASMS reacted with the same reactant (serum or lung homogeneity of dusted rats) it was found that two precipitation lines presented pattern of fusion. Precipitation lines formed by the same anti-serum and different reactants fused with each other.

3. *Dynamics of AM numbers in the developing of experimental silicosis.* Using Myrvik's method, AM of rats was collected via bronchus alveolar lavage.[1] By counting the cell numbers, AM numbers of dusted and normal rats were compared and the results showed that the former was much more than the latter. Mean AM numbers of the dusted and normal rats were 169.2 and 38.1 $\times 10^6$ respectively.

   The number of AM at different time after exposure to quartz dust was observed. The results indicated that AM numbers increased with the time. Mean AM numbers were counted to be 57.8, 163.9, 102.9, 175.1, and 347.4 ×

10^6 in 15, 30, 60, 90 and 130 days after exposure of dust. Whereas at each time AM numbers markedly differed from that in normal rats (38.1×10^6).

Wet weight of the lung, lesion extent and lesion hardness were usually used as indices for the degree of silicotic pathological changes. If the silicotic rats were grouped according to wet weight, it could be observed that the increase in AM numbers was in accordance with the increase in wet weight. For instance, AM numbers was 58.6×10^6 for wet weight less than 4 g, the numbers increased to 171.2×10^6 for wet weight of 4–5 g, and it was 239.9×10^6 when the latter was more than 5 g.

If the rats were grouped by AM numbers, it would be found that there was correspondence between AM numbers and extent or hardness of lesion. (Table IV)

DISCUSSION

The serum of experimental silicotic rats may react with ASLS, thus forming a clear precipitation line on the agar base. This indicated that a certain SPF existed in both silicotic rat serum and silicotic rat lung. In the serum of normal rats, due to the lack of the SPF or the small quantity, if there was such PF, it was not detected. SPF positive rate was proportional to the pathogenetic effect of dust, time prolongation after exposure of dust and the extent of silicotic lesion, so this rate might reflect the seriousness of experimental silicotic lesion. SPF positive rate would decrease due to the utilization of effective drugs. In general, the method is characterized by easy operation and can be applied to dynamic observations to rats, and is appropriate to be used as an index of curative effect for experimental silicosis.

Researches on the morphological changes of AM on the tissue section and on the effect of PVNO treatment demonstrated that there was correspondence between SPF positive rate and AM lesion. As the time after exposure to dust increased, AM was gradually destroyed, meantime the lesion progress with the presence of quartz dust. During the process PF was released and accumulated, its content into blood from lung increased. For this reason SPF positive rate grew.

Control experiments using ASLS and ASMS showed that both anti-serums were cytotoxic to the AM of silicotic rats and caused the AM to agglutinate in vitro. During the agar diffusion tests, the precipitation lines formed between ASLS or ASMS and silicotic rat serum, AM or lung homogenecity fused with each other. The silicotic rat SPF detected by both anti-serums were located in α-globulin position and the precipitation curves tended to fuse. Based on the above mentioned results, we could draw the conclusion that silicotic rat SPF and the destruction of dusted AM were closely related.

The consistent increase of AM reflected the continuous death of macrophages. It is assumed that the following methods can be used for prevention and treatment of silicosis: inhibiting the source of local AM for decrease of phagocytosis; restraining the phagocytotic ability of local AM for reduction of the number of destroyed macrophages: stabilizing the lysosome membrane for protecting AM from quartz dust.

CONCLUSIONS

1. In the serum of silicotic rats a PF was found, the positive rate which is proportional to lesion seriousness, lung fibrogenic extent and the extent of AM destruction. It is also inhibited by some effective drugs.
2. The PF in the serum of silicotic rats was located in α-globulin position and originated from dusted AM.
3. The number of AM in dusted rats was much more than that in normal rats. It increased with time after exposure of dust and was directly proportional to the silicotic lesion.
4. Experimental results showed that AM destruction played an important role in the developing of experimental silicosis. It is believed that silicotic lesion may be detected and evaluated by ASMS, thus a new way to study the early diagnosis, presentation and treatment of experimental silicosis will be provided.

Table IV

Relationship between AM Numbers and Silicotic Lesion

AM numbers ($\times 10^6$cells)	animal numbers	numbers lung of leaves	lesion extent(%) 0	+	++	+++	lesion hardness(%) 0	+	++	+++
100	7	70	30.1	57.1	11.4	1.4	330.0	41.4	24.3	4.3
100–200	6	60	10.0	38.3	36.7	15.0	10.0	41.6	21.7	26.7
200	7	70	2.9	45.7	22.9	28.5	2.8	47.1	45.6	4.5

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RESPIRABLE DUST WEIGHT CONCENTRATION AND QUARTZ CONCENTRATION IN RESPIRABLE DUST WEIGHT CONCENTRATION IN TAEBACK AND KANGNEUNG COLLIERIES

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ABSTRACT

In order to evaluate the working environment of underground coal mines, the respirable dust and the concentration of quartz in respirable dust were measured at the area of Taeback and Kangneung collieries. The quartz concentration was measured by Fourier transform infrared spectrophotometry. The results were compared according to the area and work site (drilling, coal face).

The distribution of data of respirable dust and quartz concentration in respirable dust were well fitted to the log-normal distribution. The geometric mean values of respirable dust were 1.34 mg/m^3 (SD, 2.81) on drilling site and 2.55 mg/m^3 (SD, 2.61) on coal face at Taeback collieries. At Kangneung collieries, they were 2.44 mg/m^3 (SD, 3.63) on drilling site and 4.24 mg/m^3 (SD, 2.37) on coal face. The geometric mean values of quartz concentration in respirable dust were 4.24% (SD, 2.59) on drilling and 1.39% (SD, 2.22) on coal face at Taeback collieries. At Kangneung collieries, they were 2.55% (SD, 3.08) on drilling and 1.24% (SD, 2.33) on coal face. There was no significant difference in the mean value of respirable dust between two areas. But the mean concentration of quartz in respirable dust showed significant difference between work site ($p<0.05$) but no difference between area ($p>0.05$).

INTRODUCTION

In Korea, raw prevalence rate of occupational disease was 2.2% in 1986. Among them, about 57.3% was pneumoconiosis. Eighty-eight percent of penumoconiosis was coal worker's pneumoconiosis.[7] So the environmental management of coal mine is important. Coal vein is narrow, so application of mechanical mining is difficult. Zahorski reported differences of prevalence and incidence rate of C.W.P. according to areas, and similar report was reported by Gilson about prevalence rate.[12,4] Seaton reported that small concentration of quartz in coal dust is important for pathogenesis of coal workers pneumoconiosis.[11]

Now there are a few systemically analyzed data about quartz concentration in respirable dust of coal mines in Korea. We planned to evaluate the work environment of coal mines located at Kangneung and Taeback by measurement of respirable dust weight concentration and quartz concentration in respirable dust.

METHOD AND MATERIALS

We selected 70 sampling points at collieries in the Taeback area and 35 sampling points at collieries in the Kangneung area. For the measurement of respirable dust weight concentration, we got 52 samples from Taeback area and 33 samples from Kangneung area. For the measurement of quartz concentration in respirable dust weight concentration, we got 65 samples from Taeback area and 35 samples from Kangneung area. Casella personal air sampler (England) and MSA Fixt-Flo (Model 1, U.S.A.) were used for sampling of respirable dust. For the analysis of quartz concentration in respirable dust weight concentration, Fourier transform infrared spectrophotometer (Analet Instrument FX-6160, U.S.A.) was used. We got the standard respirable quartz from NBS (National Bureau of Standards, standard reference material number, 1878, particle size <5 μm).

The mean air flow rate of personal dust sampler was 1.80 l/min (SD, 0.13;1.5-2.0). Sampling was conducted at coal face and drilling site. The zone of sampling point was respirable zone of worker. Fixed site sampling method was used. Three samplers were used at the same time. Sampling was conducted during one shift and the available mean sampling time was 214 (SD, 42; 60-354) minutes. Membrane filter was dried at desiccator for 24 hours and the weight was measured for 5 times. Accuracy of measurement was 0.24%. The pretreatment of sample was conducted by muffle furnace for ashing at 650°C for 2 hours.

For analysis of quartz, we made 7 mm pellet with 80 mg of KBr by the manual of FT-IR of Analet Co. For the compensation of sample loss, correction factor (C.F.) was used as

below.

$$C.F. = \frac{C3}{C1 + C2}$$

C1: the initial weight of KBr (80 mg)
C2: the weight of standard sample or treated sample
C3: the weight of pellet

Standard calibration curve was calculated with the standard respirable quartz (NBS, standard reference material number, 1878, particle size<5 μm) at the wave length of 799 cm^{-1} (Figure 1).[3] The measurable range of quartz was 9.7-196 μg with the sensitivity of 90-112%.[2]

Percent concentration of quartz was calculated

$$\text{as Quartz (\%)} = \frac{S2}{S1 \times 1000} \times 100$$

S1: the weight of corrected sample (mg)
S2: the weight of quartz in sample (μg)

The distribution of respirable dust weight concentration and the quartz concentration in respirable dust weight concentration were tested for normality by chi-square test.

RESULTS

Respirable dust concentration was measured by the time weighted average concentration (mg/m^3, TWA) with unit of 0.01 mg. The mean concentrations were calculated by arithmetic and geometric means (Table I). Among all of the respirable dust weight concentrations, 40% of samples were less than 2 mg/m^3. The distribution showed skewness to right (Figure 2). When we converted the data into logarithm, histogram showed normal distribution ($p>0.1$) (Figure 3). So we used the geometric mean value for t-test. There was no geographical difference between Taeback and Kangneung. But there was significant difference between the drilling and coal face in Taeback (Table II). Quartz concentration was calculated as percent concentration in respirable dust.

Table III shows the quartz concentration in Taeback and Kangneung area. The histogram showed skewness to right

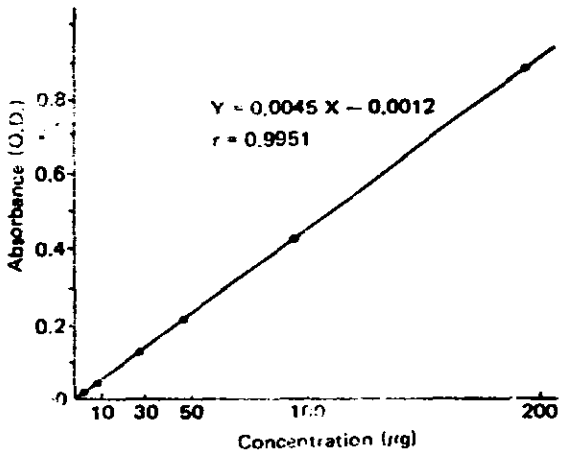

Figure 1. Standard calibration curve for quartz determination by Fourier transform infrared spectrophotometry.

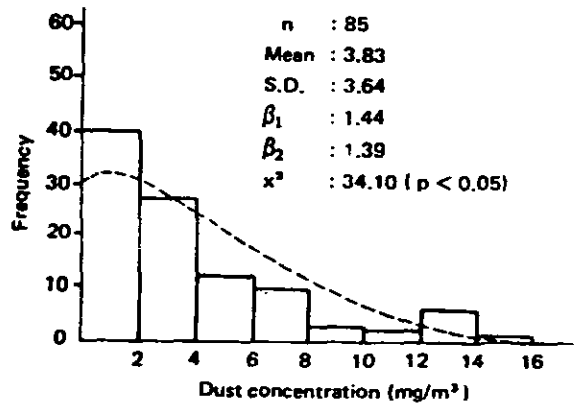

Figure 2. Histogram and expected distribution curve of respirable dust concentrations in Taeback and Kangneung areas.

Table I

Respirable Dust Weight Concentration in Taeback and Kangneung Areas

Area	Site	Cases	Respirable dust concentration (mg/m3)					
			Arithmetic		Geometric			
			Mean	S.D.	Mean	S.D.	Min.	Max.
Taeback	Drilling	23	2.00	1.56	1.34	2.81	0.12	5.55
	Coal face	29	3.74	3.14	2.55	2.61	0.30	11.49
Kangneung	Drilling	16	4.55	4.51	2.44	3.63	0.25	12.88
	Coal face	17	5.77	4.53	4.24	2.37	0.50	14.76

S.D.: Standard Deviation, Min: Minimum, Max.: Maximum

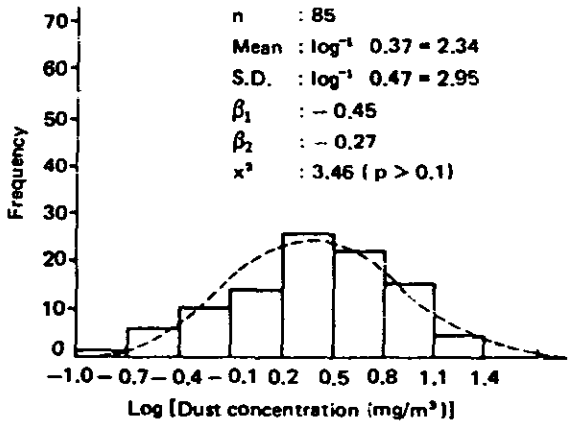

Figure 3. Histogram and expected distribution curve of logarithms of respirable dust concentrations in Taeback and Kangneung areas.

(Figure 4). So, it was converted into logarithmic data (Figure 5) and the logarithmic distribution showed normal distribution ($p>0.1$). There was no geographical difference of quartz concentration but there was difference between drilling and coal face in both areas ($p<0.05$) (Table IV).

DISCUSSION

The TLV of coal dust is 2 mg/m^3 in the case of less than 5% of quartz concentration.[1] Table I and Figure 1 reveal that many samples are over the TLV of ACGIH. Zahorski reported that the more narrower of coal seam, the more prevalence rate of coal workers' pneumoconiosis.[12] Saric reported that the dust is more produced from more crumbly coal.[10] The coal seam of South Korea is thin, crumbly anthracite.[8] So, we think that the higher concentration of respirable dust concentrations are partly due to the character of coal seam in comparison with other countries.[6,5]

The distribution of respirable coal dust and quartz concen-

Table II

Comparison between Drilling and Coal Face at Taeback and Kangneung Collieries by Logarithms of Respirable Dust Weight Concentration

		Area		t-value
		Taeback	Kangneung	
Site	Drilling	0.13 ± 0.45	0.39 ± 0.56	-1.61
	Coal face	0.41 ± 0.42	0.63 ± 0.38	-1.80
t-value		-2.32*	-1.45	

* $p < 0.05$

Table III

Quartz Concentration in Respirable Dust Weight Concentration

Area	Site	Cases	Quartz concentration (%)					
			Arithmetic		Geometric		Min.	Max.
			Mean	S.D.	Mean	S.D.		
Taeback	Drilling	31	6.18	5.52	4.24	2.59	0.58	24.12
	Coal face	34	1.89	1.54	1.39	2.22	0.40	5.85
Kangneung	Drilling	18	3.54	2.12	2.55	3.08	0.06	7.14
	Coal face	17	2.05	3.37	1.24	2.33	0.46	14.72

S.D.: Standard Deviation, Min: Minimum, Max.: Maximum

tration in respirable coal dust (Figure 3, Figure 5) revealed log normal distribution as Lazarus had reported.[9]

Goldstein reported different respirable dust and quartz concentration in respirable dust weight concentration according to different quality of coal.[6] Saric also reported that even if the quality was the same, quartz concentration was different according to colliery.[10] He reported that even in the same colliery, there was much variation in quartz concentration. The quality of coal and geologic epoch of Taeback and Kangneung are the same. So, we think that there is no significant regional difference of respirable coal dust and quartz concentration. But we think that the difference of quartz concentration between drilling and coal face is due to rock drilling (Table IV).

SUMMARY

We evaluated the two collieries of Taeback and Kangneung. Respirable dust weight concentrations were measured. Quartz concentration in respirable dust weight concentrations were analyzed by Fourier transform infrared spectrophotometer.

The data of respirable dust and quartz concentration distributed as log normal. In Taeback colliery, geometric mean respirable dust weight concentrations were 1.34 (SD, 2.81; range, 0.12-5.55) mg/m^3 at drilling, 2.55 (SD, 2.61; range, 0.30-11.49) mg/m^3 at coal face.

In Kangneung colliery, they were 2.44 (SD, 3.63; range, 0.25-12.88) mg/m^3 at drilling, 4.24 (SD, 2.37; range, 0.50-14.76) mg/m^3 at coal face. As a quartz concentration in

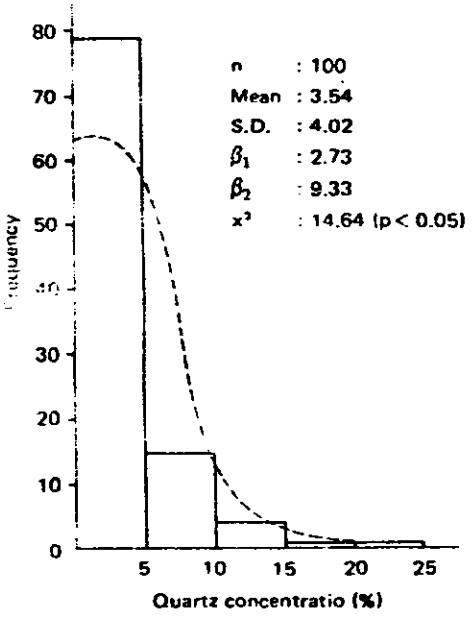

Figure 4. Histogram and expected distribution curve of percent quartz in respirable dust concentrations in Taeback and Kangneung areas.

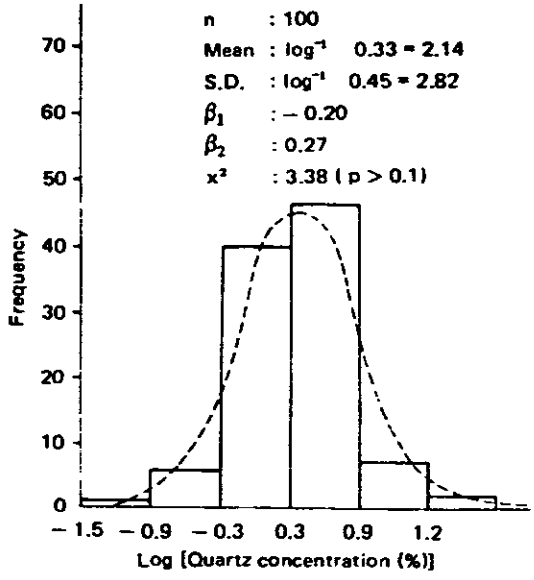

Figure 5. Histogram and expected distribution curve of logarithms of percent quartz in respirable dust in Taeback and Kangneung areas.

Table IV

Comparison between Drilling and Coal Face at Taeback and Kangneung Areas by Logarithms of Quartz Concentration in Respirable Dust

		Area		t-value
		Taeback	Kangneung	
Site	Drilling	0.63 ± 0.41	0.41 ± 0.49	1.69
	Coal face	0.14 ± 0.35	0.09 ± 0.37	0.48
t-value		5.11*	2.13*	

* p< 0.05

respirable dust weight concentration, geometric mean value of Taeback colliery were 4.24 (SD, 2.59; range 0.58-24.12)% at drilling, 1.39 (SD, 2.22; range, 0.40-5.85)% at coal face.

In Kangneung colliery, they were 2.55 (SD, 3.08; range, 0.06-7.14)% at drilling, 1.24 (SD, 2.33; range 0.46-14.72)% at coal face.

There was no statistically significant difference between two collieries of respirable dust weight concentration and quartz concentration. But there was statistically significant difference in quartz concentration between drilling and coal face at both collieries ($p<0.05$).

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COALWORKER'S PNEUMOCONIOSIS AND RESPIRATORY FUNCTION IN CHILEAN MINERS

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INTRODUCTION

Coal mining began in Chile in 1882. The coalfields are located in the central part of the country, under the sea, having the collieries an extension of 5 to 25 kilometers from the shore. Their total workforce has been between 5,000 to 10,000 miners that extracts bituminous coal by means of the "long wall" mining method.

In 1979 an Occupational Health Program was established, and this study was developed with the goal of showing the results of the first three years of medical assessment of underground miners. The main objectives were to know the prevalence of Coalworkers Pneumoconiosis (CWP), the respiratory manifestations related to the exposure to coal mine dust, and the probable cause of the respiratory complaints in these coalminers.

MATERIAL AND METHODS

Between 1979 and 1983 a population of 3,754 underground coal miners, actives and retired, were examined at the Occupational Health Department. The mean age of these miners was 45.4 ± 9.4 years, with an average mining working life of 20.6 ± 11 years. The mean weight was 69.4 ± 11.7 kg and their height 163.5 ± 12.4 cm. Most of the retired workmen were referred as claimants for occupational disease benefits, representing a selective group.

The medical assessments include a chest X-ray study consisting in full size postero-anterior radiographs, that were read by a single reader and classified according to ILO/UC International Classification of Radiographs of Pneumoconiosis.[8] Pulmonary function tests were offered to 1,905 coalminers, the physiological techniques used were those described in previous publications.[2,18] The spirographic data obtained from the tracings included the forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and the mean forced expiratory flow 25% to 75% of FVC ($FEF_{25-75\%}$). The ratio $FEV_1/FVC \times 100$ (FEV%) was also calculated; if its value was lower than 70%, the subject was considered to suffer a bronchial obstruction to airflow. All volumes were expressed in BTPS. The estimated normal values were obtained from Kory, R.C.[9]

In 294 coalminers the lung volume was studied. The subdivisions considered were the residual volume (RV), functional residual capacity (FRC) and total pulmonary capacity (TPC), measured by means of the closed circuit helium dilution method.[7] Normal values were taken from those published by Bates, D.V.[1]

An adapted questionnaire of chronic bronchitis and smoking habits was applied to the coalminers with spirometry function tests.[13] The smokers were classified according to Brinkman, G.L.[3]

RESULTS

The results of the chest X-ray reading are presented in Table I.

In the 1,905 coalminers tested there were 20.8% with bronchial obstruction, 1% with a restrictive ventilatory insufficiency and 41.6% with chronic bronchitis. Only 3.6% of those with bronchial obstruction showed an abnormal FEV_1 (less than 80% of the estimated normal). In these miners 29% were smokers and only 1.7% of them were heavy smokers. These low figures prevent the effects of smoking in our results.

Figure 1 shows the prevalence of bronchial obstruction in the non-smoking coalminers, with and without CWP, distributed by age.

The mean values of FVC, FEV_1 and FEV%, expressed in percent of the expected normals, were not altered in these miners and the different CWP categories didn't show any effect over them. The $FEF_{25-75\%}$ and the RV/TPC proportion showed, on the other hand, a progressive deterioration in relation to the increased severity of CWP. The differences observed between categories 0/0 and 2/2 were statistically significant. The low number of cases in category 3/3 prevent its statistical comparison.

Table I

Resultados de Radiografias de Torax de Mineros Activos y Retirados
Mineria del Carbon (1979–1983)

I.S.T.	0/0	0/1	1/0	1/1	1/2	2/1	2/2	2/3	3/3	A-B-C	TOTAL
ENACAR	2872	343	161	191	84	11	61	15	8	8	3754
			N = 436 (11,6 %)			N = 531 (14,1%)					

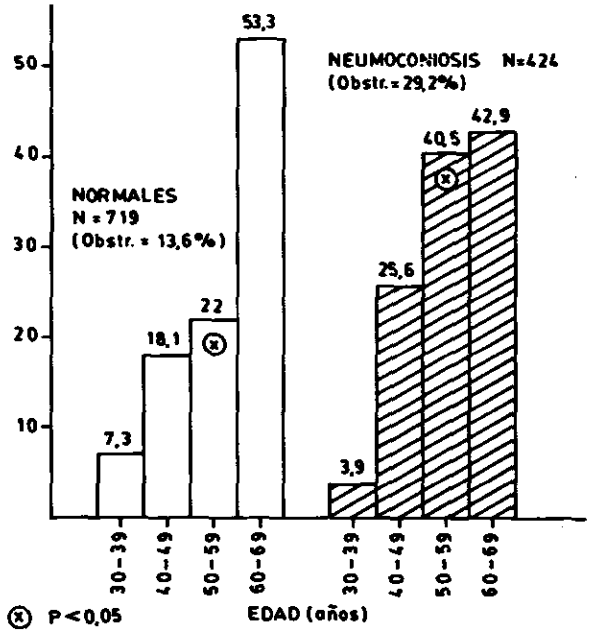

Figure 1. Proporcion de casos obstructivos en mineros sin y con neumoconiosis que no fuman.

Table II illustrates the mean values of FRC, RV, and TPC, expressed as the percentage of observed values to predicted normal in relation to CWP categories.

In Table III the effect of bronchial obstruction on the lung volumes can be observed.

DISCUSSION

The prevalence of CWP found in this study (14.1%) was influenced by the selected group of retired miners seeking for compensation, by the fact that they were older and that, at the time of the examination, they already had a presumed diagnosis of CWP. For this reason it is most probable that the prevalence in our active miners is lower.

PMF was until now an unknown entity in our coalminers. The observed prevalence (0.22%) in this sample was very similar to what has been published elsewhere,[16,12] and points out the similarities of the lung reactions to coal dust.

Bronchial obstruction was more prevalent (20.8%) than what has been found in non-smoking not exposed workers (7.8%) ($P<0.001$).[2] The prevalence in the non-smoking coalminers with CWP (29.5%, was higher than what was found in those without CWP (15.6%); but when compared by

Table II

Volumenes Pulmonares Obtenidos por el Metodo de Dilucion de Helio por Categoria Radiologica

CATEGORIA RADIOLOGICA	N	$\bar{X}$ C.F.R. % obs / est.	$\bar{X}$ V.R. % obs / est.	$\bar{X}$ C.P.T. % obs / est.
0/0	104	98,0 ±21,3	117,5 ±30	112,4 ±13
0/1	37	94,6 ±20,8	111,2 ±28	111,4 ±14
1/1	123	97,1 ±20	117,3 ±30	112,9 ±13
2/2	25	109,7 ±30	145,5 ±62	118,7 ±22
3/3	5	105,4 ±16	126,2 ±11	118,0 ±9

Table III

Volumen Residual (yr) y Capacidad Pulmonar Total (CPT) en % de lo Observado/Estimado Normal Segun Categoria Radiologica y Funcion Ventilatoria

CATEGORIA RADIOLOGICA	NO OBSTRUCTIVOS			OBSTRUCTIVOS		
	N	CPT %	VR %	N	CPT %	VR %
0/0	83	112,2 ± 13	110,9 ± 25	21	114,9 ± 13	133,7 ± 34
0/1	31	110,9 ± 13	105,5 ± 19	6	114,2 ± 20	140,2 ± 47
1/1	78	109,6 ± 12	106,8 ± 22	45	118,0 ± 13	131,4 ± 34
2/2	17	113,5 ± 17	127,5 ± 28	8	129,8 ± 28	187,5 ± 92
3/3	2	110,5	126,0	3	123,0	126,3

age groups only those between 50 to 59 years continue to show a significant difference. This low involvement of the larger airways in CWP is in agreement to what has been published.[20,14,19,5]

Coincident with other studies, these coalminers had increased RV, TPC, and RV/TPC when compared to the estimated normal values in the general population.[17,15] CWP was demonstrated to have a significant effect in the increased RV when comparing categories 2/2 with 0/0 coalminers. Morgan, W.K.C.,[14] Lapp, N.L.,[10] and Churg, J.L.[4] has suggested that the anatomical changes attached to the localization of the coal macule at the respiratory bronchioles can explain these abnormalities. It is almost certain that the increased small airways resistance in these cases play a major role in the increased RV;[15] and the significant deterioration of the $FEF_{25-75\%}$ in relation to the severity of CWP observed in this study is also in keeping with these suggestions.[5,11]

The absence of an important involvement of bronchial airflows and the proved late emergence of emphysema in CWP, makes it unlikely as an important factor in the etiology or the ventilatory abnormalities in these miners.[6]

The influence of bronchial obstruction on the results of RV was evident, but it was also clear that the non obstructed coalminers continue to show the same lung volumes abnormalities described with lower values. As in the study of Morgan, W.K.C.,[15] it was noteworthy that bronchial obstruction didn't show the same trend in relation to CWP categories as that observed with RV. Again we are inclined to the view that the increased resistance in the peripheral airways is probably the most important factor in these results.

The low prevalence of abnormal values of FEV_1 in these workers is according to what has been described as a functional parameter unrelated to simple CWP,[20] and it points out the scant influence of this disease in the respiratory impairment seen in a proportion of these miners. The main offender has always been related with complicated CWP or other severe lung disease.

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STUDIES ON PREVENTIVE EFFECT OF ALUMINUM CITRATE ON SILICOSIS

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ABSTRACT

On the basis of experiments, the Al-cit showed its effectiveness in presenting biological effects of silica. A total of 917 cases selected from both engineering corps of railway and coal mines with stage 0 or 0+ by radiographs were studied. All cases were divided into Al-cit group and control group workers with continuing dust exposures. The treatment group workers were injected with Al-cit at a dose of 120 mg Al/person/year and the control group workers received a consolatant or nothing during the time of 1980 to 1985. The radiographic changes were demonstrated that Al-cit showed clear-cut effects in both retardation of the dust-induced fibrosis and reduction of the morbidity of silicosis.

Silicosis is always an occupational disease in many developing countries today. Controlling the concentration of dust in the air at workplaces and keeping it in accordance with MAC were main important measures. But it is not easy to achieve MAC in all workplaces. Particularly for a lot of township industries in China, it will be very difficult. Al-cit showed a good effectiveness in preventing biological effects of silica in our other experimental studies.

This paper compared the efficacy of intramuscularly injected Al-cit group and control group in relieving symptoms, in changes of laboratory examinable indices, and in retarding the progression of established radiological changes.

VOLUNTEERS ACCEPTED AND METHOD

It was decided that all volunteers from both engineering corps of railway and coalmines to be included in the trial must (a) have radiological picture of 0 or 0+ stage according to the Chinese roentgenodiagnostic criteria of pneumoconiosis associated with a history of exposure to silica or coalmine dusts over a period of at least 5 years; (b) show no evidence of cardiovascular disease; (c) be deemed likely to attend regularly for treatment over a number of years and be willing to submit faithfully to all necessary tests of assessment.

All volunteers (1048 male workers) were divided into Al-cit group and control group with continuing dust exposures (Table I showed the dust conditions). The treatment group workers were intramuscularly injected with Al-cit 120 mg Al/person/year and control group workers received Vit B_1 (IM) or nothing during the period of 1980 to 1985.

RESULTS

131 accepted volunteers dropped out in the investigation period. Those dropped out because they changed to other workplaces, retired, did not cooperate or did not receive enough Al-cit, more than 180 mg Al in treatment. At the end of 5 years, 519 group Al-cit and 398 group control persons completed the investigation. The lapses rate, age, years of exposure to dust and distribution of type of job did not show any significance between the two groups (Tables II, III, IV).

All accepted took a radiographic examination once every other year during the period of investigation. The roentgenograms were read and diagnosed by a fixed group of experienced readers according to the Chinese roentgenodiagnostic criteria of pneumoconiosis. Table V shows the progression rate from 0 and 0+ stage group with 1.6%, 10.3% during the period of investigation in the Al-cit group and 12.0%, 26.0% in the control group, i.e., the percentage of retardation of progression of radiograph of silicosis by Al-cit attained 86.6% in 0 stage group and 60.4% 0+ group. Al-cit showed clear-cut effects in both retarding the dust-induced fibrosis and reduction of the morbidity of silicosis. The change in symptoms was assessed by a group of clinical doctors independently, 262 cases in Al-cit group and 180 cases in control group were questioned about their symptoms at intervals during the treatment. Table VI shows the symptoms at incidence of cough, thoradynia, sputum, tympanites in the Al-cit group were decreased more than the control group. 116 cases in the control group received a consolatant vit B_1.

Indices of laboratory examination: such as ceruloplasmine, Lysozyme, Ca++,GPT in serum and blood and urine rule examination, except those of percent of albumin A in Al-cit group showed increased and globalris gamma decreased by electrophasesis examined, did not show any significant changes between both the Al-cit group and control group.

Table I
Condition of Dust in the Air of Workplace

mice or corp	concentration mg/m^3	free SiO_2 %	distribution 5u %
A	7.4(4.7-26.1)	12.3(2.8-37.1)	94.8(91.7-96.6)
B&C			
rock	12.6(4.0- 23.0)	21.1	84.5
semicoal	26.6(18.0- 80.0)	11.6	80.3
fullcoal	89.4(40.0-800.0)	8.9	86.4

Table II
Number of Accepted Volunteers to Drop Out at Different Times of the Investigation

group	started	1982 2 year lapses	1982 2 year invest	1985 5 year lapses	1985 5 year invest	total lapses
Al-cit	588	33	555	36	519	69/588(11.7%)
control	460	28	432	34	398	62/460(13.5%)

Table III
Distribution of Workers' Age and Years of Exposure to Dust

group	n	age(yr)	dust exposure(yr)
Al-cit	519	42.45±0.29	15.46±0.22
control	398	42.80±0.38	15.69±0.33

Table IV
Distribution of Type of Job Between the Two Groups

group		type of job				total
		driller	trans-porter	many sided worker	others	
Alcit	n	235	100	155	26	519
	%	45.3	19.8	29.9	5.0	100.0
control	n	171	104	99	24	398
	%	43.0	26.1	24.9	6.0	100.0

Table V
The Radiographic Changes with Al-cit to Prevent Silicosis

	group	total	after treatment		progression rate %	P
			no prog	prog		
before treatment 0	Al-cit	306	301	5	1.6	0.01
	control	225	198	27	12.6	
0+	Al-cit	213	191	22	10.3	0.01
	control	173	128	45	26.0	

progression: 0 into 0+ or I; 0+ into I or II

DISCUSSION

Since the 1930s, a lot of experimental studies and clinical investigations have been reported in literature, which suggest that the therapeutic inhalation of metallic aluminium dust is beneficial to silicosis. But from the mid 1940s to the early 1950s, there is the important additional feature that inhaled aluminium dust may itself be capable of causing diffuse interstitial fibrosis. Over ten years ago, the efficacy of aluminium chlorohydroxyalltoate inhalations in reducing fibrosis of rats which suffered quartz dust was reported by Policard (1966) and Bouffant (1967, 1977). Unfortunately, we have not found the practical report about it. As we know insoluble aluminium (as metallic Al) dust inhalation might be retained and demonstrated to cause fibrosis in lung. According to the experimental study, Al-cit intramuscularly injected on rats which suffered silica dust, the Al contents in lungs increased more than that in livers and kidneys (Table VII). It may be very useful to prevent silicosis with Al-cit, but intramuscular injection is not an ideal method to give the medicine for every recipient. So to find a more ideal method would be necessary to study in the future.

The results of this study showed that retarding progression rate of radiographic of silicosis by Al-cit attained 86.6% in 0 group and 60.4% in 0+ group for the investigation period of 5 years. The retarding rate of both treated groups showed

Table VI
Symptom Level of Al-cit Group and Control Group

variable	Al-cit group (n 262)		Control group (n 180)	
	1980	1985	1980	1985
cough (%)	20.2	6.9	13.9	11.2
thoracodynia(%)	21.8	10.8	13.3	11.2
sputum	18.9	5.0	13.9	10.0
tympanites	11.8	7.6	10.6	17.8
electrophasesis				
albumin(%)	68.7	70.1		
globulins(%)	15.6	15.1		

Table VII
Al Content in Lung, Liver, and Kidney of Rats Compared Between Injected and Not Injected Al-cit

organ	normal		suffered quartz dust	
	control	injected Al-cit	control	injected Al-cit
lung				
ug/g	10.36±0.71	12.40±0.31	5.29±0.38	17.13±1.12
ug/total	23.01±1.72	28.73±1.12	37.05±2.68	98.41±6.76
liver				
ug/g	5.50±0.40	21.0±0.96	4.77±0.40	5.08±0.22
ug/total	83.78±5.60	326.59±4.96	59.23±5.76	66.10±3.50
kidney				
ug/g	7.82±0.38	32.60±1.35	4.88±0.25	6.83±0.55
ug/g total	79.70±1.13	85.70±5.30	11.37±1.20	16.64±1.32

a significance in comparison with each control group.

In this investigation we did not notice any toxicity or side effects from the use of Al-cit.

How to prevent or retard the fibrogenesis of inhalated silicon dust is an important problem. On the basis of our result, the Al-cit complex may be a practical method to cope with it.

SUMMARY

A controlled trial of Al-cit intramuscular injections in the prevention of ERC and coalmine workers silicosis with continuing dust exposures was conducted over 5 years. Retarding progression rate of radiographic by Al-cit attained 86.6% in 0 group and 60.4% in 0+ group. Al-cit does not show any toxicity and side effects from this study condition. This investigation shows that the Al-cit may be a practical method to prevent the fibrogenesis of silicon dust in body.

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RETROSPECTIVE MORTALITY STUDY OF ASBESTOS WORKERS IN LAIYUAN

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A retrospective cohort study was conducted at a chrysotile mine in Laiyuan, Hebei province 1972 and 1981. Mortality rates among 1227 men who had worked at the mine for at least one year before 1972, were compared with those among 2754 local residents of Laiyuan commune who apparently had never been exposed to asbestos. Between 1972 and 1981, there were 67 deaths in the asbestos workers and 247 deaths in the commune residents. Standardized rates of mortality from all cases, malignant tumors and lung cancer were 924.3, 433.6, 344.4 per 100,000 persons in the miners and 836.8, 62.9, 14.3 per 100,000 in the commune residents. The rates of mortality from malignant tumors and lung cancer differed significantly between the two groups (p 0.001).Three cases of mesothelioma were observed in asbestos workers, the mortality rate, 24.9 per 100,000 persons. The lung cancer mortality rate among asbestos workers tended to be higher in 1977-1981 than 1972-1976.

In order to survey the incidence of tumor of asbestos miners and work out the prevention measures of the asbestos hazard, we made retrospective cohort study about the asbestos miners in Laiyuan, Hebei province.

GENERAL INTRODUCTION

The asbestos mine of Laiyuan is located at central-west part of Heibei province; east of Taihang mountain. Its main product is chrysotile. The country rocks are dolomite serpentine, marble and little quartz rock. There were no other industrial pollution sources within 10 kilometers of the asbestos mine. The food was supplied mainly by the Laiyuan city, which is 30 kilometers away from the asbestos mine.

The asbestos in Laiyuan has been exploited for 60 years; after 1949 it was changed into state-run. The output and number of workers began to increase in the late 1950s. This mine was gallery exploited by handwork in the early time. The asbestos selecting rooms of mechanization were put into operation in the latter half of 1954; the dust in the air of working condition was very high, as follows: 1168-1453 mg/m^3 gallery drilling, 356.8 mg/m^3 dressing. To follow the development of production, the mechanic ore dressing and dust eliminating apparatus was used and then, the dust concentration began to decline. However, the dust concentration in the major dust-producing workplaces still go beyond mg/m^3 (which is the national hygienic standard). The dust concentrations over the years are: mining 26.8 $\pm$ 4.4 mg/m^3 varied 0.5-80 mg/m^3; dressing 29.7 $\pm$ 4.2 mg/m^3 varied 0.5-80 mg/m^3. The dust AED 5 μm is 80%, free SiO_2 in the original asbestos is 1.5%, the subsiding dust in dressing is 3.6-6.2%.

There are 1500 asbestos miners in the asbestos mine. Many older workers who were employed before 1949, when the mine was established had been exposed to high concentrations of dust. Up to now, the grand total of the asbestosis was 154 and a number of malignant tumors occurred among the asbestos miners.

THE OBJECT OF SURVEY, CONTENT AND METHOD

We investigated the male asbestos miners who registered on January 1st, 1972 and were exposed to asbestos at least one year. We wanted to know their incidence and mortality rate (MR) of malignant tumor, from January 1st, 1972 to December 31st, 1981.

In order to choose the case population, we selected such people in Laiyuan commune to take the control group, their living conditions and medical services are the nearly the same as the asbestos miners. They are never exposed to asbestos and other carcinogens. They registered on January 1st, 1972, and are older than 15 years.

The trained interviewers collected the register of object respectively for the asbestos mine. The register would be collected from labor card and health management card and be examined; for the commune the register would be collected from residence card of the police office. After that, each register would be checked according to questionnaire. The dead was traced for cause from hospital death certification. The smokers were questioned by the survey staffs. Information about the dead was supplied by the relatives or the insiders. The dust concentrations of working environment were supplied by occupational health and safety department of the asbestos mine or local anti-epidemic station in Bao Ding or other unit; the materials of the two groups were standardized for the sake of easy comparison.

RESULTS

The response rate of asbestos miners group and the commune residents group are as follows: 99.9%, 99.3%, the malignant tumors were diagnosed by the county hospital, asbestos mine hospital and other advanced hospital, the lung cancers were diagnosed above grade II (shown in Table I).

1. The death toll of asbestos miners was 67.24 deaths from malignant tumor in which 9 people died from lung cancer (3 mesothelioma). On the other hand the death toll of the commune residents was 246.16 deaths from malignant tumors in which 3 people died from lung cancer. After standardization, the death rate (mentioned above) of asbestos mines are significantly higher than those of the commune residents (Table II). The ratio of standard MR of lung cancer in asbestos mines was 24.

   In the cohort study of asbestos miners, there were 154 cases of asbestosis, among which 14 died (7 died from malignant tumors and 6 died of lung cancer). The rate of asbestosis with lung cancer complications is 3.9%. Lung cancer percentage in the death cause of asbestosis is 42.9%.

2. The distribution of two groups of death cause is different. On one hand, in the asbestos mine, the former six death causes were 96% of the total death cause. Its order is as follows: malignant tumor, respiratory disease, stroke, coronary heart disease and other cardiac disease, brain vessel disease. On the other hand the former six death causes were 83% of the total death cause in the commune, its order is as follows: other heart disease (mainly cor pulmonale), respiratory disease, brain vessels disease, stroke, malignant tumor infectious disease. It is clear that the malignant tumor is the first death cause and 32% of the total death cause in the mine. It is very striking.

3. Lung cancer was 41% of all deaths caused by malignant tumor of asbestos miners, stomach cancer and liver cancer come second. Stomach cancer and esophagus cancer occupy the first death cause, together they are 63% of malignant tumor for commune residents. We should pay much attention that MR of lung cancer of asbestos mine is very high. In addition, there are three cases of mesothelioma which occurred rarely in general population, however, the MR of the mine is so high as to reach 24.91 per 100,000. The trend of MR of malignant tumor from the former five years (1972-1976) and later five years (1977-1981) were 125.4, 152.9 per 100,000 in the miners and 81.8, 24.3 per 100,000 in the commune residents. The prevalence rate of lung cancer is 27.9 in the former five years and 82.3 in the later five

Table I

The Diagnosis Grade of Two Groups

group	tumor category	grade of diagnosis*				total
		I	II	III	IV	
asbestos miners	lung cancer	3(33.3)#	6(66.7)	---	---	9(100.0)
	the others	7(46.7)	8(55.3)	---	---	15(100.0)
commune	lung cancer	---	3(100.0)	---	---	3(100.0)
	the others	---	11(84.6)	2(15.4)	---	13(100.0)

* national census of tumor in 1973-75.
\# out of the brackets are cases, in the brackets are percentage.

Table II

Comparison of the SMR Between Asbestos Mine and Commune

	all cases	all malignant tumor	lung cancer
asbestos mine	926.3	433.6	344.4
commune	836.8	62.9	14.3
p	0.001	0.001	0.001

years for the asbestos miners, and 13.6 and 6.0 in the commune residents. The trend of MR of all malignant tumor and lung cancer is increasing. This is in accordance with long latency period of lung cancer in the asbestos miners.

DISCUSSION

The reliability and comparison between the exposure group and control group is the key problem of the survey. The response rate of the survey is over 99%, interviewers were all professional and well trained before the survey, the survey was conducted according to the uniform plan. The death cause was confirmed in the clinical service, in which the deceased was diagnosed and confirmed by case report or doctors who were responsible for the dead.

The diagnosis level of malignant tumor between the two groups was similar. All were diagnosed above the county level hospital. 2 cases of malignant tumor in commune residents were diagnosed grade III (12.5% of all malignant tumor); the others were diagnosed grade I-II. In order to achieve the reliability of original material, we checked all the problems of the survey, so we think the material is reliable.

As to the comparability between the control group and exposure group, we think it is comparable, reason: 1) The geography condition and diagnosis level of the two groups are similar. 2) For the commune residents, MR of all death cause, all malignant tumor and lung cancer are similar to those of retrospective cohort study on death cause of Bao Ding area and in Xin Cheng County in 1974-1976, those are nearly Laiyuan. 3) The age constitution of the two groups population is a bit different. This is related to the special age constitution of asbestos miners; this problem can be solved by standardization. After standardization, we find that the indices of the asbestos miners which include, MR of all death causes, all malignant tumor and lung cancer are higher than that of the commune residents. Its difference is significant. It implies that there are special factors which make the MR of lung cancer of asbestos miners higher than that of the commune residents.

We should analyze the reason why the SMR of malignant tumor is higher than that of the commune residents. Beside the difference of the lung cancer between the two groups, the SMR of stomach cancer of asbestos miners is higher than that of commune residents. The SMR of lung cancer will increase in such conditions: industry population and smoking. There are no industrial sources of high incidence of lung cancer near the local district. On the contrary, the commune residents whose living and natural conditions are similar to the asbestos mine, have lower prevalence of lung cancer than the asbestos miners. The survey on the death cause in 1979 to 1981 showed the rude MR of lung cancer in Bao Ding city was 8.17 per 100,000, the country side of Xing Cheng 8.22 per 100,000, the commune residents 9.63. These are lower than that of the asbestos mine. It implies that the industry pollution or the local reasons which make the high incidence of the lung cancer of the asbestos mine do not exist.

The material of the recent years proved that lung cancer is closely associated with smoking, but this survey indicates that the MR of lung cancer has no significant relationship with smoking in miners (p 0.1) and with smoking in commune residents (p 0.9).

The survey also indicates that smoking is not the main cause which makes the higher MR of lung cancer of the asbestos miners, but people who smoke and are exposed to asbestos have much higher MR of lung cancer than those who smoke without exposure to asbestos at the same time (p 0.01).

The relationship between the death from lung cancer and type of job or year of asbestos exposure is shown in the following:

Exposure (years)	5	5–	15–	25
Incidence of lung cancer (%)	0	0.35	0.61	2.42

The relationship of the incidence of lung cancer and the year of asbestos exposure dust is as follows:

(y=0.1035x - 0.9433 x: year y:incidence (%) r=0.918 p 0.01).

The relationship between the incidence of lung cancer and type of job is as follows: miller 1.44%; management of production 1.33%.

The materials show that the incidence of lung cancer is associated with purity of asbestos and exposed time. This is the same as the general report, that the incidence of lung cancer of asbestos processing is higher than that of asbestos mining.

We can come to the conclusion that the high MR of lung cancer is mainly associated with asbestos. The shortest time of cancer onset is 24 years, the longest time is thirty-two and four months. The mean value is 28.18 years (28.18 ± 0.83). The cancer worsened quickly after diagnosis, the time from diagnosis to death is about six months (6.33 ± 2.08). There is no discovery of the lung cancer among the miners whose exposure to asbestos is less than 5 years. In this survey three cases of mesothelioma were found. The cause of death from malignant tumor in the general population is about 1-3 per 100,000, but in the asbestos mine of Laiyuan it is as high as 4479 per 100,000.

SUMMARY

1. The retrospective cohort study was conducted at chrysotile mine and comparison was made with commune residents in Laiyuan during 1972–1981. The SMR from all cases, malignant tumor, and lung cancer were 924.3, 433.6, 344.4 per 100,000 persons in the miners and 836.8, 62.9, 14.3 per 100,000 in the commune residents. The SMR of malignant tumor and lung cancer differed significantly between the two groups (p 0.001).

2. The MR of the lung cancer of the asbestos mine is closely associated with dust of asbestos. Smoking and exposure asbestos can make the MR of lung cancer increase. Abstinence of smoking and no smoking should be advocated among the asbestos exposed workers.

3. The trend of the MR of lung cancer in the asbestos mine in Laiyuan is ascending. All this predicts that the peak of the lung cancer of this asbestos mine is coming, so it is important to take steps to prevent it.

SMOKING AND RADIOLOGIC OPACITIES IN U.S. NAVY ASBESTOS WORKERS

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ABSTRACT

The United States Navy's Asbestos Medical Surveillance Program monitors current civilian and military employees who have histories of asbestos exposure. The prevalence of radiologic opacities $\geq$ ILO category 1/1 was 3.9% for 32,233 smokers versus 0.48% for 13,414 for non-smokers, giving an age-adjusted risk ratio of 2.29. The prevalence difference between smokers and non-smokers persisted in all age groups, and was greatest in the more than 11,000 surveyed workers older than 50 (risk ratio 2.58). These data lend support to a persistent role for smoking in the development of radiologic opacities, and further suggest that the potentiation increases with age through the period of employment.

No Paper provided.

THE DISTURBANCE OF BREATHING MECHANICS IN RATS AFTER INTRATRACHEAL INSTILLATION OF RESPIRABLE COAL MINE DUSTS

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ABSTRACT

The effect of airborne coal mine dust intratracheally instilled on the breathing mechanics of rats was tested with a body plethysmograph. Six months after instillation of airborne coal mine dust high in minerals, a greater loss of specific conductance resulted than with instillation of a mineral poor dust. The finer fraction of the mineral rich dust reduced the specific conductance more considerably than the coarser fraction of the same dust.

No Paper provided.

THE PHYSICAL CHARACTERISTIC OF DUSTS APPLICATED INTRATRACHEALLY IN RATS IN THEIR DISPERSED AND SUSPENDED STATE

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ABSTRACT

Theoretical formulae are clearly presented necessary to characterize tested dust applicated by intratracheal instillation or by intraperitoneal injection. It is a question of the characteristic physical dimensions, that must be determined in dispersed states of dusts directly: e.g., the density, the specific adsorption total surface per mass and volume or indirectly as the surface structure number, the hypothetical minimal surface per mass and volume or the number and volume distribution. Artificial dust mixtures applicated in animal experiments were characterized in detail in a dispersed state by the estimation of the minimum mass, the homogenity and inversion rate as well as the difference in the density and the specific adsorption surface. The ascertained changes in density and surface indicate the existence of chemosorption between the dust particles of mixtures as well as their different stabilities and surface activity. New crystals were formed by the mixture of single dusts; i.e., new substances, that could not be reckoned on and in mixtures reacted differently than if applied separately. The physical state of applied dust suspensions in animal experiments were characterized by two different methods of quantification. The first group has separate independent values such as surface tension, permeability coefficient and pH values; the separate independent values of the second group were the specific conductivity, the total molecule and total molecule ion numbers as well as the density. The adequate ascertainment of the values of the dust samples in a dispersed state explains the relationship between these values and the biological action of the dust samples to be demonstrated.

No Paper provided.

SILICOSIS AMONG STONE MORTAR WORKERS IN NORTHERN THAILAND, 1986

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BACKGROUND

The high rate of premature death (death at age of 30–40 years old) was found in a group of villages in Payao Province, Thailand. These villages had been named as the village of widows. The main occupation in these villages is the production of stone mortar and pestles. This doubtful situation led to at least three field investigations to find the cause of premature death in such villages. There were no definite reports of silicosis among these mortar workers in the villages, except a lot of tuberculosis cases could be reviewed from the routine tuberculosis registration at the local health authority. From working conditions with stone containing a high percentage of quartz and increasing prevalence of tuberculosis among these mortar workers, we carried out a cross-sectional epidemiology study of silicosis and a risk factor study on silicosis to confirm the silicosis cases existing in the village, explain silicosis distribution among the stone mortar workers and to identify risk factors on silicosis.

The effects of silicosis, the chronic fibrosis of the lungs produced by prolonged and extensive exposure to free crystalline silica, have been recognized for centuries. Pulmonary disease produced by dust is mentioned by Agricola in his Treatise on Mining and is described in stonecutters by Van Diemerbroeck Ramazzini.[1] Clinical evidences of previous exposure to free silica in old mines, abandoned quarries, and ancient flint tools and weapons were demonstrated.[2] Silicosis is caused by the inhalation and retention of dust containing silica in occupations such as mining, tunnelling, quarrying, stone dressing, sandblasting, fettling, boiler scaling, and in pottery, ceramics and brick manufacture.[3] Symptoms of silicosis cases are increasing dyspnea, non productive cough and chest pain, progressing to compensatory emphysema and cor pulmonaly.[4] There was a report of silicosis among miners with the prevalence of 19.48% (5,366/27,553) together with pulmonary tuberculosis of 13.83% (742/5,366).

In Thailand, there were no epidemiological reports of silicosis prevalence among particular occupations, but we did have the first case report of silicosis who was a worker in a wulfraum mine.[6]

METHODS

A cross-sectional morbidity study of stone mortar workers in three villages at the Northern Part of Thailand was carried out in January 1986. Detailed occupational, smoking, and respiratory histories were obtained on questionnaires by trained interviewers. Physical examinations, pulmonary function tests and chest radiographs were also performed. A case-control study was also conducted by randomly selecting non-case workers in the same plant at ratio case: control of 1:3.

For physical examinations, the respiratory signs concerned were basal crepitation which dry end-inspiratory crackles were heard and did not clear with cough, chest expansion, cyanosis, and clubbing fingers. The pulmonary function tests were obtained using the spirometer. Test results derived included forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC). Three efforts were obtained. The maximal FEV_1, and FVC were selected. The FEV_1 and FVC maneuvers were considered reproducible if the 2 best values for each agreed within 5% of the larger value or 100 ml, whichever was greater. Predicted values based on age, sex and height for FVC, FEV_1 and FEV_1/FVC were obtained from the prediction equation of Crapo and coworkers.[7] The predicted values was corrected with 0.85 for non-caucasian people.

For chest radiography, posteroanterior and lateral chest radiographs of 16*17 inches films at a standard distance of 72 inches at 11 kvp. Interpretation was carried out by a radiologist and an occupational health physician by using the ILO-1980 international classification of radiographers of the pneumoconiosis.[8] The case definition of silicosis used was a mortar worker with chest radiograph of fibro-nodular profusion at 1/1 and above.

For statistical analysis, the prevalence rate of silicosis was calculated by age specific groups, job, duration of work, worksite, smoking habit and cloth using instead of approved masks. In case-control study, Chi-square and Student's t-tests were used to calculate the significance of factors between cases and control.

RESULTS

Fifty six cases met the silicosis case definition from 266 stone mortar workers which provided the prevalence rate of 21.1%. Mean age among cases was 40.7 years with median and mode of 35 and 38 years respectively. The age range was 15–59 years. The highest prevalence rate of 43.3% (13/30) was among the workers of 50–59 years age groups, together with 32.1% and 30.8% among the 40–49 and 30–49 years age groups respectively. The specific prevalence rate by duration of work was highest among the workers aged between 21-25 years with the rate of 66.6% (6/9). The sex specific prevalence rates were 29.1% (46/158) among male and 9.3% (10/108) among female. The prevalence rate by job was 28.7% (39/136) among the workers making stone mortars which was higher than the ones making stone pestles. To work inside building had the higher rate of 31.5% (23/73) than to work outside the building of the rate 17.1% (33/193). The workers who used clothes covering their noses and mouths during work had 24% (36/150) of silicosis prevalence rate, and the ones who did not use the clothes had silicosis prevalence rate of 17.2% (12/116). The smokers had 18.8% (39/208) of silicosis prevalence rate and non-smokers had 29.3% (17/58). Clinical symptoms were 75% chest pain, 71% dyspnea, 53% chest tightness, and 50% weight loss. The cases had abnormal physical examinations of 55% cyanosis, 53% clubbing fingers, 53% decrease chest expansion less than 3 centimeters, 50% decrease breath sound. All cases had abnormal ventilatory defect, with 92.8% (52/56) of restrictive ventilatory defect.

Chest radiographs were with shapes and sizes of p and q with the most profusion of 2/3 (28.6% by Table I). There were 7 cases from 56 cases that had large opacities, and 57% (4/7) was 'B' type. There were some other abnormalities consistent with pneumoconiosis including tuberculosis at 25% (13/52), cavity at 15.4%, definite emphysema at 13.6%, ill-defined diaphragm at 9.6%, enlargement of hilar or mediastinal lymphnodes at 9.6%, calcification in small pneumoconiotic opacities at 7.7%, abnormality of cardiac size or shape at 5.8%, pleural thickening in interlobar fissure or mediastineum 3.8%, eggshell calcification of hilar or mediastinal lymphnodes at 3.8%, bullae at 1.9%, ill defined heart outline at 1.9% and honeycomb lung at 1.9% (Table II).

In case control study, there was no significant difference between 56 cases and 168 randomly selected control in terms of smoking habit and using clothes instead of approved masks. The men were ill more than female significantly ($p < 0.05$, or = 3.5). The cases were older than the controls significantly ($p < 0.05$, OR = 2.8). The ones who worked with longer period had more likelihood to be case, more than the ones who worked with shorter period significantly ($p < 0.05$, OR = 2). The workers who polished mortars had the chance to develop silicosis 8 times higher than the ones who did not polish the mortar ($p < 0.05$, OR = 8).

DISCUSSIONS AND RECOMMENDATIONS

To prevent workers from exposure to silica is among the highest priorities in protecting the health of the workers. As silicosis is not reversible. If one gets the disease, one will be affected for the rest of one's life. Thus, this epidemiological study aimed ultimately to such prevention. As one definition of epidemiology is the study of distribution and determinants of the disease. The classical process consists of examining a series of variables to ascertain causation including age, sex, socioeconomic status and other. It is known that silica causes silicosis, but there were several major difficulties involved in attempting to do this, which were difficulties in the accurate determination of exposed dose, difficulties in the accurate determination of the health effects and difficulties in dealing with competing variables such as cigarette smoking and host susceptibility.[9] This study of health effects from silica was

Table I

Small Opacities of Parenchymal Abnormalities by Profusion among Silicosis Patients in Northern Thailand, 1986

Profusion	Number	Percentage
1/1	6	10.7
1/2	4	7.1
2/1	12	21.4
2/2	8	14.3
2/3	16	28.6
3/2	9	16.1
3/3	1	1.8
3/4	0	0.0
All types	56	100.0

Table II

Other Abnormalities Consistent with Pneumoconiosis among Silicosis Patients in Northern Thailand, 1986

Type	Descriptions	Number	percentage
bu =	bulla(e)	1	1.9
cn =	calcification in small pneumoconiotic opacities	4	7.7
co =	abnormality of cardiac size or shape	3	5.8
cv =	cavity	8	15.4
em =	definite emphysema	7	13.5
es =	eggshell calcification of hilar or mediastinal lymph nodes	2	3.8
hi =	enlargment of hilar or mediastinal lymph nodes	5	9.6
ho =	honeycomb lung	1	1.9
id =	ill-defined diaphragm	5	9.6
ih =	ill-defined heart outline	1	1.9
pi =	pleural thickening in interlobar fissure or mediastinum	2	3.8
tb =	tuberculosis	13	25.0
All Abnormalities		52	100.0

performed even though there were many constraints mentioned above, because we wanted to provide useful findings used in prevention and control of silicosis. From the study, it seems that the ones who were exposed with mortar polishing need to be protected from free silica more than others. To work inside the building is more dangerous than to work outside. To wear clothes instead of approved masks is not useful and may be harmful, thus the workers should wear approved masks.

Since there were 25% of tuberculosis among silicosis workers or silicotuberculosis in this study in the high tuberculosis prevalence country, when it is compared to the study among miners,[5] we recommended all pulmonary tuberculosis to be referred for further management in the chest hospital or special clinic concerned with silicosis.

Cases of definite silicosis (ILO-1980), classification of "p 1/1" and above aged below 35 years and who are symptomatic should preferably not continue in work with silica exposure. All definite silicosis cases must be followed up annually to exclude complications (e.g. pulmonary tuberculosis, chronic bronchitis and cardiac failure).

For reduction of stone dust at worksite, we recommended wet process in appropriate way.

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SILICOSIS AMONG WORKERS IN REFRACTORY BRICK FACTORY, THAILAND

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BACKGROUND

Silicosis is a pulmonary fibrotic lung disease caused by inhalation of high concentrations of very fine free silica dust particles. The main industries and occupations at risk are mining, quarrying, manufactures of ceramics, sand blasting, and brick manufacturing.[1]

A case of more than ten years of diagnosis as pulmonary tuberculosis from refractory brick factory, had no improvement of tuberculosis treatment, went to the National Chest Disease Hospital and received transbronchial biopsy revealed silica particles in the tissue under polarized light microscope. His job was to weigh the ground raw material used in production of refractory brick. This case was reported to the Division of Occupational Health. To study the magnitude of silicosis among the workers in that factory was neccessary to be performed to identify the risk factors on silicosis developing, thus the epidemiological study of silicosis was conducted through this factory.

Despite the fact that silicosis has been a common, occupationally related disease for many years, only a few studies have been directed toward its epidemiologic aspects.[2] The study by Renes et al.involving iron foundries found 9% of silicosis prevalence rate among 2,000 workers and 25.8% of prevalence rate among those who had worked for 20 or more years.

Among workers in the brick plants, one of the studies was in an Ontario brick plant in which it was claimed that there were no cases of silicosis.[3] A study done earlier by Keatinge and Potter revealed similar results among workers in British brick work.[4] The study in a Pennsylvania brick works came up with different results.[5] The material used to make brick was significantly different from that in Ontario; it contained more quartz and less aluminum. The prevalence rate of silicosis was very high in this population. Silicosis was found at all levels of exposure, except below 2 mppcf. It was found to be more prevalent in workers involved with burned brick than "green" brick.The silica content of both was high.

The refractory brick plant in this study is the one established in Thailand, started operating in 1953. It served initially to produce fireclay refractory bricks for cement kiln linings, heating furnace walls runner bricks for steel ingot casting. There were two tunnel kilns and highly equipped machinery.

This factory produced fireclay brick, refractory castables, plastic refractory, mortars ramming mixes, gunning mixes, and insulating firebrick.

The process used in this refractory brick production was crude crushing, impact crushing, ball milling, clay grinding, size screening, vibrating milling, weighing by car, mixing, process of tamping or pressing or ramming or hand moulding, burning and packing.

Silica contents in the products were 31.2–58.7% in fireclay brick, 7.3–46.2% in high alumina brick, 51.9% in fireclay base castable, 59.6% in heat setting mortar, 46.5 in air setting mortar, 9.0–14.9% in plastic refractory, and 51.8–68.2% in the insulating firebrick.

Thus, this refractory brick plant used the material of rather high content of silica when it was compared to other brickworks. This study had the golden aim in prevention and control of such a disease.

METHODS

A cross-sectional descriptive study was designed and self-administered to collect the essential data concerning age, sex, race, job, duration of work, smoking habit, mask wearing and respiratory history, from all of the workers in the refractory brick plants. Physical examinations, pulmonary function tests and chest radiographs were also performed. A case-control study was also conducted by randomly selecting non-case workers in the same plant at ratio case : control of 1:3.

For physical examinations, the respiratory signs concerned were basal crepitation which dry end-inspiratory crackles were heard and did not clear with cough, chest expansion, cyanosis, and clubbing fingers. The pulmonary functoin tests were obtained using the spirometer. Test results derived included forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC). Three efforts were obtained. The maximal FEV_1, and FVC were selected. The FEV_1 and FVC maneuvers were considered reproducible if the 2 best values for each agreed within 5% of the larger value or 100 ml, whichever was greater. Predicted values based on age, sex and height for FVC, FEV_1 and FEV_1/FVC were obtained from the prediction equation of Crapo and coworkers.[6] The predicted values were corrected with 0.85 for non-caucasian people.

For chest radiography, posteroanterior chest radiographs of 16*17 inches films at a standard distance of 72 inches at 11 kvp. Interpretation was carried out by a radiologist and an occupational health physician by using the ILO-1980 international classification of radiographs of the pneumoconiosis.[8] The case definition of silicosis used was a mortar worker with chest radiograph of fibro-nodular profusion at 1/1 and above.

For statistical analysis, the prevalence rate of silicosis was calculated by age specific groups, job, duration of work, worksite, smoking habit and cloth using instead of approved masks. In case-control study, Chi-square and Student's t-tests were used to calculate the significance of factors between cases and controls.

RESULTS

There were eighteen cases of silicosis that met the definition from 190 workers in the plant. The whole plant prevalence rate was 9.5% (18/190). Mean age of cases and mean duration of work were 49.6 (range = 42–56) and 23.9 (10–32) years. Female prevalence rate was 27.8% (5/18), while male rate was 7.6% (13/172). When prevalence rate was classified by position, it is found that prevalence rate among workers was 9.8% (17/173) and rate among foremen was 5.9% (1/17). The prevalence by section was highest among workers in production section 'B' of 13.3% (2/15) followed by 11.5% (13/113) in production section 'A', 6.1% (2/33) in maintenance section, and 4.5% (1/22) in quality control and technical section. When it was considered by job description, the highest prevalence rate was 15.7% (8/51) among those who prepared raw material, followed by the prevalence rate of 12.8% (5/39) in "green" brick production job and 10% in repairing brick model job description.

Seven cases or 38.8% (7/18) had clinical symptoms included weakness, dyspnea, low fever and chest pain. Eleven percent (2/18) of cases had abnormal physical signs of cyanosis and clubbing fingers. The pulmonary function test among cases was abnormal at proportion of 44.4% (8/18) which 75% (6/8) was restrictive ventilatory defect.

Two of cases were silicotuberculosis. The chest radiographs revealed mostly p and q of shapes and sizes with the parenchymal profusion of 2/2 at 38.9% (7/18).

In the case-control study, the case had worked for 25 years or more at 20.8 times of controls and this was significantly different ($p<0.05$, OR = 20.8). This was not adjusted for age. The cases and controls were not significantly different in terms of smoking habits ($p<0.05$, OR = 0.8).

DISCUSSIONS AND RECOMMENDATIONS

Even two from three studies concerned the occurrence of silicosis among brick workers did not show any cases of silicosis.[3,4] This study confirmed the existing prevalence of silicosis among brick workers of 9.4% which was rather high. Since the development of silicosis depended upon the material used in the process, thus this study, different from other two, identified silicosis cases among refractory brick along with rather high silica content. As the highest prevalence rate was found among workers preparing raw materials to produce bricks, so the main concentration in providing prevention and control measures should be set for this group of workers first if there is limited budget. The primary prevention for those workers who did not develop the disease should be urgently set up by using engineering control, especially the local hood ventilation.

For two cases of silicotuberculosis were referred for further management in the chest disease hospital.

Cases of definite silicosis (ILO-1980), classification of "p 1/1" and above aged below 50 years and who are symptomatic should preferably not continue in work with silica exposure. All definite silicosis cases must be folowed up annually to exclude complications.

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