

Silicosis, a Continuing Problem

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THE CONTINUANCE of silicosis in the United States reflects the cumulative effect on society of a preventable but still prevalent occupational disease. After more than 35 years of definitive research and almost as many years of application of controls in some measure, hazardous exposures still exist and new cases of silicosis are developing. The major impact of the disease today, however, is manifested as a socioeconomic problem.

To view the present state of the silicosis problem in proper perspective, I should like to mention some of the past developments that have bearing on the situation today.

Early Knowledge of Silicosis

Prior to the 20th century, the only intimation of silicosis in the United States was found occasionally in physicians' reports of lung diseases with a suspected occupational involvement (1). For instance, in 1887 an autopsy report on a stove foundry worker in Poughkeepsie, N. Y., described the cause of death as the condition that we know today as silicosis. Also in that year, a report appeared on 40 workers employed 25 years or more in a cutlery factory. Of the 34 men who had contracted what was referred to as a chronic disease of the air passages, 23 had died within the previous 10 years. A third report, which came out about 1900 in Utah, told of 30 men who had died following 1 to 2 years' exposure to dust from crushing

quartzite ore in a gold assaying mill in Nevada. The description of findings resembled very closely the characteristics of silicosis.

Entering the 20th century, we find a slow, steady awakening of interest in the health problems of dusty trades. The mechanization of certain stone and mining operations and, in particular, the introduction of pneumatic tools which generated substantial amounts of fine dust contributed to the rising incidence of silicosis and its complicating companion disease, tuberculosis. Evidence of excessive mortality from tuberculosis and relationship to dust exposure began to mount, as reflected in the occupational mortality statistics compiled by Dr. F. L. Hoffman of the Prudential Life Insurance Co. in 1907 and 1918 (1).

Concern over the large incidence of tuberculosis in the dusty trades gave rise to the first real investigation of the problem. The study was undertaken in 1913-15 in the lead and zinc mining industry around Joplin, Mo., by the Public Health Service and the Bureau of Mines (2). Of 720 lead and zinc miners examined, 45.7 percent were found to have silicosis and another 14.3 percent, silicosis complicated with tuberculosis.

Between 1920 and 1930, other environmental and clinical investigations of workers in dusty operations followed. Among these, an examination was made in 1920 by local physicians of 427 granite cutters in Barre, Vt. (1). Practically all of the group were found to have silicosis or tuberculosis alone or in combination. During 1924-26, the Public Health Service, in its study of the Vermont granite industry, found that practically all workers exposed to high concentrations of the dust developed the disease and that a large proportion eventually became tuberculous (3).

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A 1928 study by the New York Department of Labor revealed that 57 percent of 208 workers engaged in rock tunneling in New York had silicosis (4). Similar studies and investigations by various groups were carried out in metal grinding, abrasives grinding, porcelain enameling, and in the sandstone and cement industries. In operations where a dust exposure was evident, incidence of silicosis ranged as high as 67 percent. Studies of this type continued into the 1930's, providing ample evidence of the severity of the dust hazard in certain industries and the dire need for dust control measures.

Developments of the 1930's

Despite the steady buildup of incriminating information, not until the 1930's was silicosis generally recognized as a serious occupational health hazard. The awakening was precipitated by a tidal wave of lawsuits in civil courts based both on legitimate and spurious claims of dust disease due to the occupation. Had these claims prevailed, it is alleged, many of the affected industries and insurance companies would have gone bankrupt. In 1933, alone, it was estimated that damage suits of more than \$100 million were outstanding (5). The grounds for lawsuits were negligence of the employers, since at that time only six States, by so interpreting the term "personal injury," could compensate for silicosis under their laws.

Several factors undoubtedly contributed to this wave of lawsuits. For one thing, a sufficient number of years had elapsed to build up a sizable silicotic population. For another, the Nation had been plunged into an economic depression and silicotic workers were seeking some form of financial compensation for their illness. Another probable reason was the impact of the lag in the application of dust control techniques already developed through scientific research. The lawsuits disclosed that the knowledge of these was not widespread. Employers claimed that they had not been fully informed or warned of the special dangers of certain dusts and, therefore, exercised only general care in prevention which they thought was adequate.

Among other widely publicized events of

the 1930's was the Gauley Bridge disaster in West Virginia. Congressional hearings held in 1936 revealed that 476 workers died from silicosis and 1,500 others were suffering from the disease they contracted while digging a rock tunnel for diverting water to a hydroelectric plant during 1932-34 (6). No safeguards of any kind were used to control the exposures to rock dust, which was almost pure silica.

Working and living conditions among lead and zinc miners in the Joplin, Mo., area continued to be publicized by commentators and writers. Among these was Dr. Alice Hamilton with her article *A Mid-American Tragedy* (7), published some 25 years after the first silicosis investigation was made in the Joplin area. In Massachusetts and New York, commissions were appointed to investigate hazardous conditions in foundries, granite sheds, and other dusty industries.

These and other events of the 1930's catapulted silicosis from relative obscurity into widespread notoriety and spurred the taking of long awaited action. For example, nine States passed legislation bringing silicosis under the compensation laws between 1933 and 1939. By 1949, the number of States making some legal provision for compensation of silicosis reached 40. The First Saranac Laboratory Symposium on Silicosis was held in 1934, and the National Conference on Silicosis in 1936.

Only three States, Ohio, New York, and Connecticut, had industrial hygiene programs prior to 1934, but with the help of Social Security funds, 26 State and city governments established industrial hygiene programs from 1936 to 1939. Several insurance companies also instituted activities for the prevention and control of occupational diseases for the employers they insured.

In a less dramatic vein, industry began the task of controlling and eliminating hazardous dust conditions. The high degree of success achieved by these efforts is unquestionable. One instance is exemplified in the recent follow-up study of the Vermont granite industry by the Public Health Service and the Vermont Industrial Hygiene Division. Dust counts were found within recommended limits and no evidence of silicosis was detected among men

X-rayed periodically who were initially exposed after the installation of dust controls from 1937 to 1939 (8).

The transition to dust control, however, was not as universal or as rapid as some like to believe. During the war years, 1941 to 1945, ventilation equipment was scarce and was released on a priority basis, mainly to war production industries. Studies in Georgia, for example, revealed that as late as 1948 some granite sheds and quarries had silica exposures many times in excess of recommended limits (9).

The job of educating the smaller employers in preventive techniques was far from complete. As late as 1953 a death from acute silicosis, confirmed by histological examination, occurred in one of the States. The worker, 24 years old, had had 5 years of exposure in a small plant making cleansing powder which was 100 percent pure "flour of silica." The 18 dust samples collected by industrial hygiene personnel were all above 16 million particles per cubic foot of air, with counts reaching 770 million particles. The owner had no idea of the hazardous nature of his business and had taken no preventive measures. After official investigation, the plant was closed.

Since the war years, many research advancements have been made which in retrospect have been helpful in shedding more light on the epidemiology of dust diseases. The impression of the late 1930's carried into the 1940's, that the dust problem was largely solved, was on the wane by the 1950's. New uses of silica and its byproducts (10), more widespread mechanization of dusty operations, and technological advances gave rise to the suspicion that possibly new types of exposures were occurring.

The present-day concern with silicosis as a continuing problem led in 1956 to a series of Congressional hearings on safety and health in metal mines (11). This is the second time that Congressional hearings have focused primarily on silicosis as an occupational health hazard.

Prevalence of Silicosis in the United States

Despite all the interest, research, and activity since the 1930's, the precise prevalence of dust diseases remains a mystery. In 1933, Lanza and Vane presented a paper entitled "Prevalence of Silicosis in the General Population and Its Effects Upon the Incidence of Tuberculosis" (12). The status of the disease was disclosed in the first four sentences of the paper. "I wish to make it perfectly clear that there is little in this paper to justify its ambitious title. Silicosis is not a reportable disease. It is still commonly not diagnosed. Even in districts where it prevails, it does not appear on death certificates to the extent which one might expect."

On the basis of various investigations, the authors estimated conservatively that 500,000 workers were then exposed to a harmful degree of silica dust in the United States. Various other estimates, including the projected figures of the Public Health Service (13), established a total silica-exposed population of between 1,500,000 and 2,000,000. Cummings, at the Fourth Saranac Laboratory Symposium on Silicosis in 1939, ventured a guess that about 50,000 employed workers at that time might be found with definite evidence of silicosis (14).

On the assumption that these estimates are valid, the outlook for silicosis as a continuing problem is rather foreboding. Taking the 1933 estimate of 500,000 harmfully exposed workers and applying the then prevalent ratio, of 1 out of every 4 exposed as eventually developing the disease, we arrive at a figure of 125,000 potential silicotics. Even Cummings' guess of 50,000 workers with silicosis in 1939 would impose on today's society a burdensome residue of persons who had acquired silicosis earlier.

In 1955, because of numerous requests for statistics and the mounting reinterest in silicosis, the Occupational Health Program of the Public Health Service began a search for prevalence data in the States. I shall refer only briefly to the results of this study, published in 1956 (15).

By putting together the piecemeal information obtained from official agencies, we arrived at a total of 10,362 cases of silicosis on record in 22 States between 1950 and 1954. They included open and settled compensation cases, cases discovered through X-ray examination of workers in dusty trades, reports by physicians, and some death records. Since then we have added to this total, so that we now have some information on 12,763 cases in 26 States, cover-

ing from 2 to 6 years of records between 1950 and 1955.

When we began our inquiries, we were aware of the impracticability of developing conclusive evidence. But, by accumulating data on a sufficiently large number of cases, we hoped to come up with some general answers.

We found that, in addition to the present silicotic population being sizable, it is primarily an elderly one. Only 2.5 percent of the cases are under 35 years of age; 21 percent are between 35 and 49 years; and the remaining three-fourths, 50 years and over. Since most of our data are for compensable cases representing primarily a disabled group, this distribution may be biased. Records of workers with nondisabling silicosis are scarce, as the disease is under-reported, and very few States compensate for partial disability from it. When partial disability is compensable the proportion of cases of persons under 50 years of age tends to be higher. In West Virginia, for example, it was 35 percent and in New Jersey 55 percent. In States compensating for total disability only, such as Montana and New York, 4 and 15 percent respectively of the cases involved workers under 50 years of age.

The mining industries, coal, metal, and non-metal mining and quarrying, were associated with two-thirds of the cases. Of the manufacturing industries, foundries were associated with 16 percent, and pottery, stone, silica-brick, tile, clay, and glass industries with the remaining 18 percent.

The age distribution by industry showed in each group some cases among men under 35 years of age. However, none of the case totals for the under 35-year-old group exceeded 5 to 9 percent of the industry's total cases. The 50- to 64-year-old group accounted for most cases within each industry as well as for all industries combined.

Another revealing fact was the number of new cases among workers entering dusty trades for the first time since 1935. Of 3,455 cases in 10 States for whom reasonably adequate employment histories were obtained, 10 percent allegedly received their entire dust exposure after 1935. The distribution of these cases by industry shows every group produced at least a few, but that the mining industries, foundries,

and nonmetallic mineral industries were responsible for over one-half of the recent cases.

Our data on pulmonary tuberculosis as a complication of silicosis are not satisfactory since not all States record or tabulate the condition. This is especially true for compensation cases, despite the fact that tuberculosis accounts for most of the disability. Proportions of silicosis cases with tuberculosis reported in a few States are: 34 percent of 111 litigated cases in California; 30 percent of 637 open and closed compensation cases in Ohio; 62 percent of 507 hospital clinic cases and deaths in Missouri; 53 percent of 318 clinic cases in Oklahoma; 12 percent of 162 workers X-rayed in North Carolina; and 24 percent of 723 workers X-rayed in Vermont.

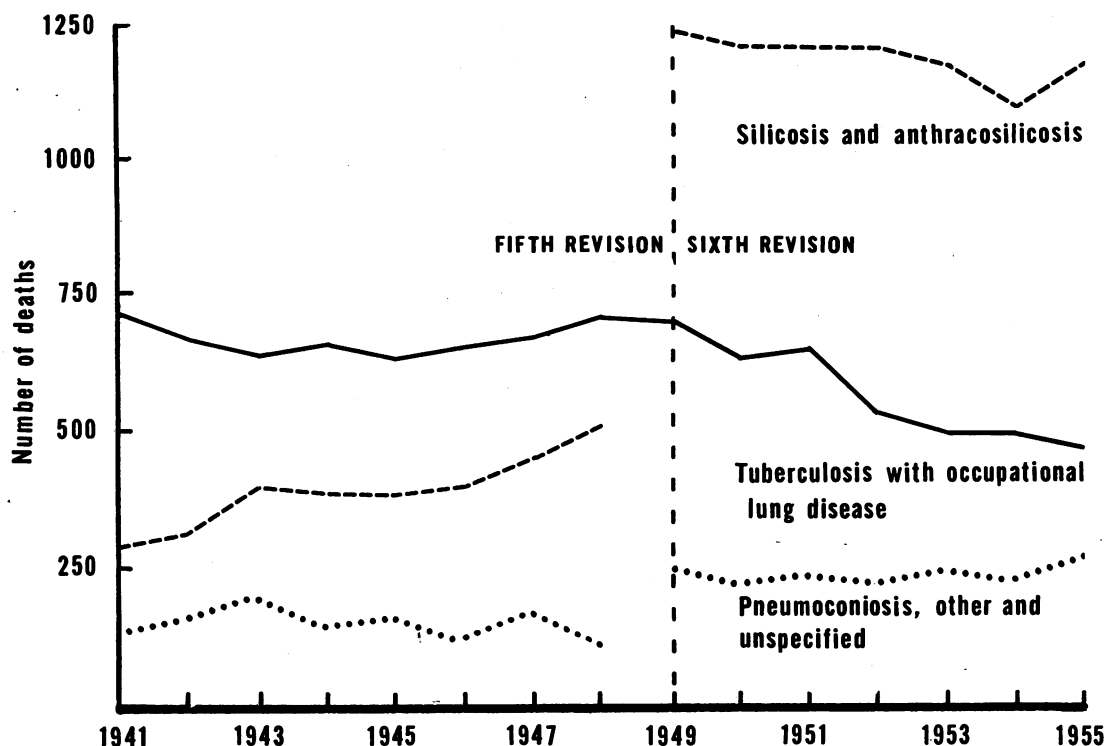
These data give the impression that pulmonary tuberculosis is not as damaging to health of silicotics as it once was, and even with the complication many silicotics live to old age. For example, men with simple and complicated silicosis had the same average age, 56 years, and length of employment, 32 years, according to X-ray examination records of Vermont granite shed workers living during 1950-55. Workers deceased during the same period were, on the average, 6 years older than those in the living group. The only other difference observed was that the persons in the deceased group who also had tuberculosis had worked an average of 4 years less.

This summarizes the few general facts we were able to glean from records on the nature and extent of silicosis in the United States. The current figure of 12,763 cases reflects the extent of our success in collecting statistics on silicosis rather than serving as a measure of prevalence. As such, it is a gross underestimate, owing to the incompleteness of sources of data and lack of statistics for other States with silica hazards.

Mortality Statistics

Further proof of the inadequacy of our so-called prevalence figure lies in mortality statistics of the National Office of Vital Statistics. About 20 percent of the 12,763 cases on record in 26 States during 1950 to 1955 were known to have died. In the entire United States over the same period, 11,650 deaths were recorded as due to occupational pneumoconioses, or an average

Figure 1. Deaths from pneumoconioses in the United States, 1941-55.



of almost 2,000 per year (16). Tuberculosis with mention of occupational disease of the lung accounted for 28 percent of the 11,650 total; silicosis and anthracosilicosis for 60 percent; and unspecified and other pneumoconioses for 12 percent. The 12 percent includes a small number of deaths from asbestosis and anthracosis; however, most are unspecified pneumoconioses and are probably silicosis.

It is not possible to determine to what extent mortality from dust diseases in the United States has increased or decreased over the past years. Figure 1 presents the number of such deaths since 1941. However, prior to 1949, a fixed system of priorities was used in selecting the cause of death to be tabulated. With the sixth revision of the International List of Causes of Death, the cause of death tabulated was, in general, that designated by the certifying physician as the underlying cause of death. This change in coding rules has therefore increased the number of deaths assigned to pneumoconioses since 1949.

The graph suggests, however, that the number of deaths due to tuberculosis with mention of

occupational disease of lungs has been gradually decreasing. The trend for silicosis and anthracosilicosis shows a rise for the first coding period and a level plateau for the second period. It is believed that the calculation of rates, even if the exposed population were known, would not materially affect this picture. If increases in employment in the manufacturing industries and decreases in mining are taken into account, the number of workers in dusty trades probably has not changed appreciably over the 1941-55 period. The steady rate at which the silicotic population is dying off gives us a fairly good idea of the extent of silicosis today and in retrospect.

Deaths from pneumoconioses in Pennsylvania accounted for 40 percent in 1953 and 45 percent in 1954 of all such coded deaths in the United States. For this reason, Pennsylvania death certificates were used to obtain further information. With the aid of the National Office of Vital Statistics, we scanned 137,000 death certificates covering January, February, and March 1953 (a trial period), and the entire year 1954. Information was transcribed on age,

occupation, and causes of death for all certificates giving silicosis, anthracosilicosis, or pneumoconiosis as a primary or contributory cause of death.

In this manner, we obtained a population of 1,519 deaths among silicotics for the 15-month period. Pneumoconiosis as a primary cause of death was assigned officially to 60 percent of this 1,519 total; other causes of death were assigned to 40 percent. Thus, 2 out of every 5 deaths among silicotics were attributed to other causes.

Although uncomplicated silicosis is showing up on death certificates with relatively greater frequency, it is still commonly omitted. For instance, in another State where I had access to the compensation files, silicosis was not mentioned on 42 out of 269 death certificates filed with the claims, although the majority of these cases had received disability benefits for many years prior to death.

The causes of death on the 1,519 death certificates were tabulated to determine what other conditions are associated with these deaths. After several futile attempts at multiple-cause coding, the tabulation shown in the table emerged. It is offered for whatever it may be

Frequency of other conditions mentioned on 1,519 death certificates listing silicosis, anthracosilicosis, or pneumoconiosis as a primary or contributory cause of death, January-March 1953, January-December 1954, Pennsylvania

Condition	Number	Percent
Only silicosis, anthracosilicosis, or pneumoconiosis mentioned.....	218	14. 4
Respiratory tuberculosis.....	143	9. 4
Cancer, respiratory system.....	50	3. 3
Cancer, other sites.....	58	3. 8
Cerebral hemorrhage, thrombosis....	67	4. 4
Heart and other disease of circulatory system.....	861	56. 7
Bronchial asthma.....	67	4. 4
Influenza, pneumonia, bronchitis....	139	9. 2
Ulcer, hernia, cirrhosis of liver, and other disease of digestive system.....	60	3. 9
Nephritis and other disease of genitourinary system.....	57	3. 8
Accidents.....	10	. 7
Cor pulmonale.....	236	15. 5
Emphysema.....	89	5. 9
Pulmonary hemorrhage.....	35	2. 3
Pulmonary edema.....	61	4. 0

worth; I have made no attempt to interpret it.

An age distribution showed that none of the deceased was under 40 years of age at the date of death; 5 percent were between 40 and 49 years old; 39 percent between 50 and 64 years; and 56 percent over 65 years. There were more deaths under 65 years of age among those who also had tuberculosis, 59 percent, than among the others, 43 percent. In our prevalence study we reported that individuals with silicosis are living a relatively full life span.

By occupation, 76 percent of the 1,519 deceased were miners. Coal mining was specified occasionally, but rarely was it described as anthracite or bituminous. Occupations for the remaining were: foundry or steelwork, 6 percent; stonecutting, quarrying, brickmaking or other work associated with silica exposures, 2 percent; painter, electrician, repairman, truck-driver, watchman, restaurant worker, clerk, farmer, or other occupations not associated with silica exposures, 9 percent; and laborer not otherwise specified, retired, or not known, 7 percent.

Compensation Costs

The most forceful evidence we have of silicosis as a continuing problem is what the disease costs society today. The compensation costs of 9,829 cases on record between 1950 and 1955 in 18 States amounted to \$43,693,000. This amount covers benefits paid on open cases up to 1954 or 1955 and awards allowed or paid in death cases. It covers a 6-year period for 4 States, a 5-year period for 9 States, and between 2 to 4 years for 5 States. Medical costs are not consistently included or reported. Making allowances for incompleteness of information and allowing for costs in other States for which data were not available, compensation costs of silicosis cases outstanding since 1950 can be estimated to be at least 10 million dollars per year. In contrast, the budgets of official industrial hygiene agencies for the entire country amount to less than 3 million dollars annually. These agencies are responsible for the control and prevention not only of silicosis but also all other occupational diseases.

In 6 States (Alabama, Montana, New York, Ohio, Pennsylvania, and West Virginia) sili-

cosis costs for varying periods between 1950 and 1955 ranged from \$2,232,000 to \$12,608,000. In the other 12 States (Arkansas, California, Colorado, Idaho, Illinois, Nevada, New Jersey, North Carolina, Utah, Virginia, Wisconsin, and Washington) the spread was from \$78,116 to \$795,431.

Compensation for silicosis is a slow, costly, and complicated business. Requirements for eligibility, determination of liability, assessment of disability, amounts of awards, and methods of processing cases differ tremendously from State to State. In the group of 18 States, the average cost per case ranged from \$1,390 in West Virginia to \$16,180 in New York. Individual payments were as low as \$380 for temporary disability in New Jersey and \$1,000 for stage 1 silicosis in West Virginia and as high as maximum indemnity awards of \$12,000 in Utah, and more than \$20,000 in States with unlimited benefits such as Ohio. When medical benefits are added, costs of some cases exceed \$30,000 each.

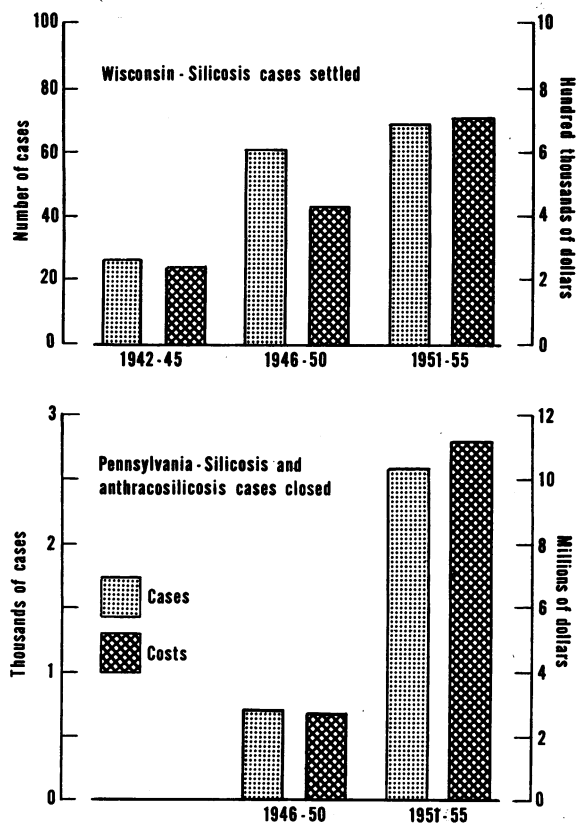
The average cost per case for the 18 States combined is \$4,450. In contrast, the average cost of compensation claims for all work injuries in the United States ranged from a low of \$343 in Alabama to a high of \$1,055 in Montana (17).

Data on compensation costs for earlier years are scarce. Lanza reported that claims for silicosis compensated in 1938 and 1939 average 10 to 12 per year in the industrialized States (14). Up to that time legislation was comparatively new and not widespread. The few States then reporting costs, Wisconsin among them, found that dust diseases accounted for one-third to more than 90 percent of all the occupational disease costs.

The experience of two States, Pennsylvania and Wisconsin, which have published continuous data, shows that costs since 1950 have increased substantially (fig. 2). This is typical of what has probably occurred in many other States. One of the many reasons for the increased claim load is that most of the occupational disease compensation laws were passed after 1940, and since 1950 many have been liberalized.

These figures, impressive as they may be, cover only a fraction of the costs and burdens

Figure 2. Compensation costs in two States.



on today's society of the accrued liability of preventable disease. Countless numbers of true silicotics not legally eligible for compensation are forced to turn elsewhere for help. If restrictions in laws were lifted, the costs would undoubtedly skyrocket to unforeseen proportions.

Conclusions

This, in brief, sums up the evidence we have on silicosis as a continuing problem. The majority of cases on record represent disabled workers and a backlog of early acquired silicosis. The major impact on society is an economic one as reflected in high compensation costs.

The true extent of nondisabling silicosis cannot be determined from official records as yet. There is sufficient evidence, however, to suggest that this group of not yet discovered or disabled silicotics may be important in perpetuating the silicosis problem. There is also evidence of need

for more support for preventive activities by official agencies. Prevention is still cheaper than compensation.

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