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FACTORS AFFECTING THE OUTCOME OF  
TREATMENT OF PULMONARY TUBERCULOSIS  
IN SUB-OPTIMAL CONDITIONS:

An 18-month Follow-up of 224 Patients

By

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# Silicosis in the Gold Mining Industry in Rhodesia

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## GEOLOGICAL ASPECTS

For all practical purposes the occurrence of gold in Rhodesia is confined to hydrothermal vein and shear zone deposits found exclusively in the so-called gold belts. These are sinuous belts of "basement schists" of Archaean age together with the immediately surrounding and engulfing granites. The deposits themselves have variable dimensions. The few larger ones measure a mile or more in strike and extend thousands of feet in depth. The auriferous reefs are composed of vein quartz or siliceous replacements of the country rocks, so that the material mined is frequently almost 100 per cent. free silica as quartz.

Mining of these deposits in shafts, drives, other tunnels and stopes leads to seriously high concentrates of free silica dust in confined spaces underground. Primary crushing and milling processes are normally carried out on surface with comparatively little dust hazard.

## DUST SUPPRESSION IN MINING

Dust formation underground is reduced by means of wet drilling and controlled by use of water sprays and exhaust fans. With wet milling there is little surface hazard. In rare instances of dry milling a negative pressure ensures a dust-free atmosphere in the mill building.

Three hundred particles per c.cm. is the yardstick for permissible dustiness. In South Africa it is 200 particles or less.

The earliest evidence of what Pendergrass (1958) calls simple silicosis are the small multiple shadows 2 to 6 mm. in diameter. These are more or less uniform in density and do not disappear in an X-ray on slight rotation. They usually vary much in size, shape being sometimes round and often turns oval; others again are irregular. The nodules may have a uniform density and occasionally they may be quite dense, similar to that produced by calcium. The nodules are usually to be found in both lungs, being distributed along the vascular channels and the bronchial tree. Whilst they are mostly bilateral, occasionally they are seen in one lobe only.

Pendergrass has recorded that the nodules may increase in size or may become conglomerated (1 to 5 mm. in diameter) when several or more of the nodules coalesce and the nodulation in fact is replaced by massive shadows. Again, he records that the nodulations may either completely or almost completely disappear on X-rays over the years. Pendergrass includes under the classification of simple silicosis the conglomerated lesions which are 1 to 5 mm. in diameter. Such a lesion is less thick and dense than in infective silicosis and its outline is irregular, with its longest diameter in the vertical position. Further in the stage of simple silicosis, emphysema may appear and in advanced cases on occasions cor pulmonale may appear. The hilar glands at this stage may be enlarged, but this is not easy to demonstrate until the next stage in what he refers to as infective silicosis.

If there is much emphysema the domes of the diaphragm may be depressed or the domes of the diaphragm may be peaked from adhesions which have formed.

It is by no means easy to decide when infection (or what Pendergrass terms silicosis with infection) has developed. Should cavitation develop in the lesions, tuberculous disease may well have set in. In others, with infection, the lesions soften and break down. Another suggestive sign of infection is mottling and a soft appearance of the nodules, but it is almost impossible at times to predict whether the infection is due to the tubercle bacillus or other organisms. Another suggestive sign of infection is extensive calcification in the hilar glands. The shadows may become massive (massive fibrosis) once infection sets in and vary in size from, say, 5 mm. to as much as 20 cm. Their shape varies from being round, oval or wedge-shaped, rare in a pneumoconiotic and even rarer in emphysema.

In the majority of cases the infection is by the tubercle bacillus, but other infections by organisms such as the staphylococcus fungi and histoplasmosis may occur from time to time. The lymph nodes may become densely calcified in the infective stage. The calcification may be diffusely or irregularly deposited in such a way as to give an eggshell appearance. It is usually assumed if calcification is found that the individual has developed a tuberculous or histoplasmosis infection.

#### THE MATERIAL

Eighty-seven Africans who had worked only in gold mining were available for analysis, and of them 39 had uncomplicated silicosis and 48 were accepted as being pulmonary tuberculosis (Figs. 1, 2, 3 and 4).

It would seem that workers remain in gold mining longer than in asbestos or coal groups before symptoms are complained of.

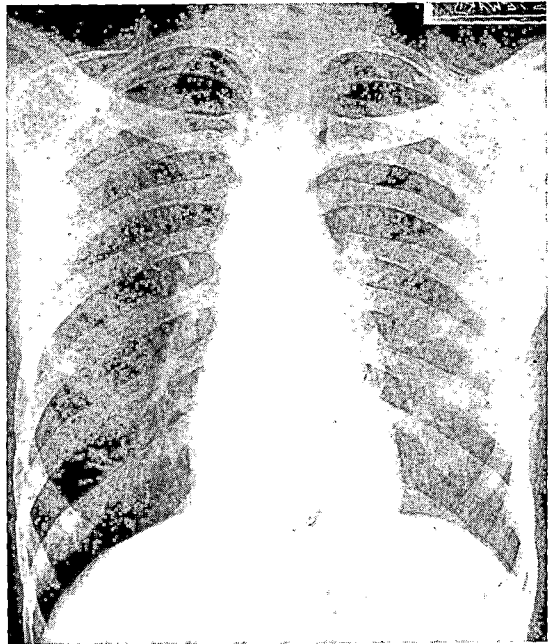


Fig. 1—First stage silicosis (384 months' service).

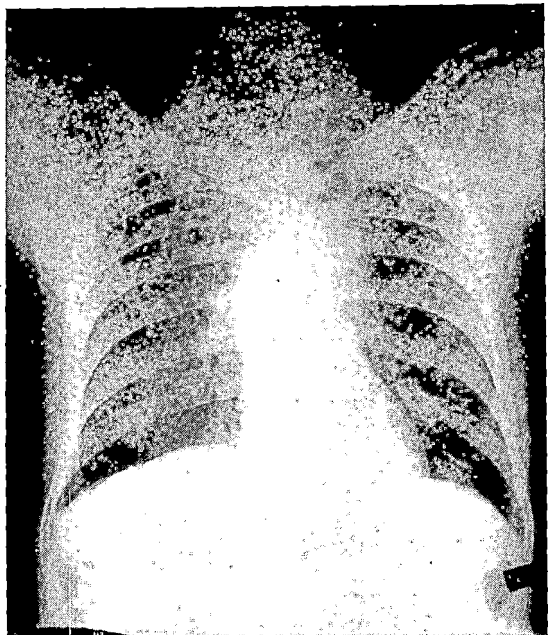


Fig. 2—Second stage silicosis (90 months' service).

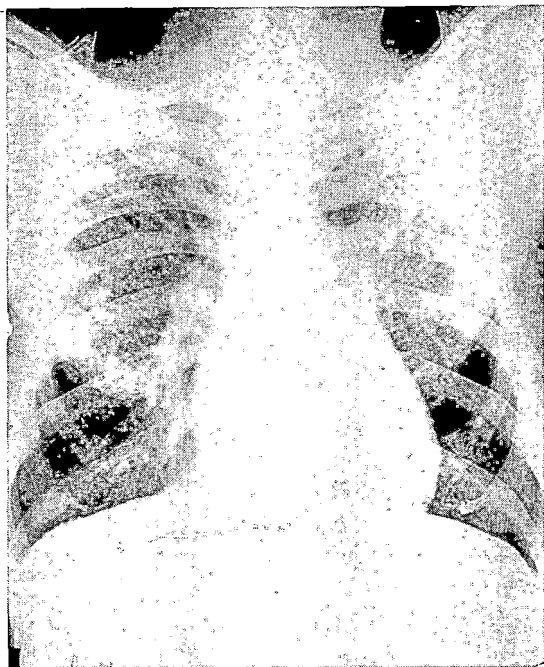


Fig. 3—Silicosis, third stage (298 months' service).

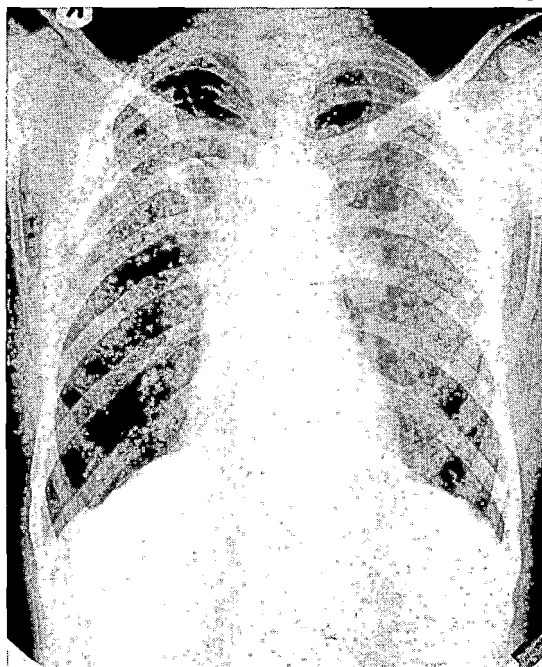


Fig. 4—Third stage silicosis (274 months' service).

Thus tuberculosis in the gold miner would appear to develop in the first 200 to 300 months of service, whereas in pure silicosis the disease is recognised later, mostly after 301 months of service.

**X-RAY SIGNS**

There were more abnormalities seen in the chests of these gold miners than in those who were employed in asbestos, coal or chrome mines. The signs of silicosis were more marked and the nodules seemed harder and more sharply defined, but there were others with increased reticulation with soft and small nodulations, thus simulating

that found in coal, chrome and asbestos miners. There were 17 out of 27 cases who had definite evidence of tuberculosis with little or nothing to suggest accompanying silicosis, and an additional 31 who had both tuberculosis and silicosis. The workers who had tuberculosis alone tended to present in the earlier years of employment (under 300 months), while the silicosis presented later (beyond 200 months); a smaller number of cases where stage I or doubtful stage II (13) in comparison with the number of stage III cases were seen (9).

D. J. C. Gilson, Head of the Pneumoconiosis

*Table I*  
MONTHS OF SERVICE WHEN SILICOSIS IS FIRST RECOGNISED

Months	2	4	13	13	6	1
Months of service .....	1-100	101-200	201-300	301-400	401-500	500 +

*Table II*  
MONTHS OF SERVICE WHEN TUBERCULOSIS FIRST DETECTED

Number	6	14	17	9	2	
Months of service .....	1-100	101-200	201-300	301-400	401-500	500 +

Research Unit of the Medical Research Council of Great Britain, paid a visit to the Salisbury Pneumoconiosis Bureau and kindly studied 22 consecutive cases of the present 87 miners declared by us to have the disease. Out of the 22 cases, 12 were found by us to have silicosis. He agreed with 11, but one he would have regarded the changes as being within normal limits. Seven of the 11 cases best describe nodulation [1958 I.C.O. Classification 1/2 M (1 case), 2/1 M (3 cases), 2/3 M (1 case), 2/2 N (1 case), 3/3 P (1 case)]. In the remaining four cases the striking feature linear markings were abnormally increased [0/1 t (1 case), 2/3 t (1 case), 3/2 (1 case), 3/3 t (1 case)]. Calcification of the hilar gland was found in five cases and in one there was an irregular cardiac border.

The distribution pattern of the silicotic lesions of the lung was one which was expected. In 39 cases with silicosis from gold mining, the distribution shown in Table III was seen. It was a somewhat generalised type of involvement frequently seen in the middle thirds of the lung, but less often the upper or lower zones were affected.

Table III

DISTRIBUTION OF LESIONS IN 24 CONSECUTIVE CASES OF UNCOMPLICATED SILICOSIS, THE MAIN SITE OF THE LESION BEING THE MIDZONE OF EACH LUNG

	Right	Left
Upper zone	12	14
Middle zone	21	20
Lower zone	16	9

In cases that had evidence of tuberculosis in addition, the distribution is shown in Table IV.

Table IV

THE DISTRIBUTION OF THE MAIN DENSITY OF LESIONS IN THE LUNGS OF 24 CONSECUTIVE CASES OF TUBERCULOSIS WHO HAD WORKED AT LEAST FIVE YEARS IN THE GOLD MINING INDUSTRY

	Right	Left
Upper zone	19	16
Middle zone	21	22
Lower zone	9	10

There was a tendency towards increased involvement of the upper lobes when tuberculosis was also present.

The X-rays of five Europeans who had worked

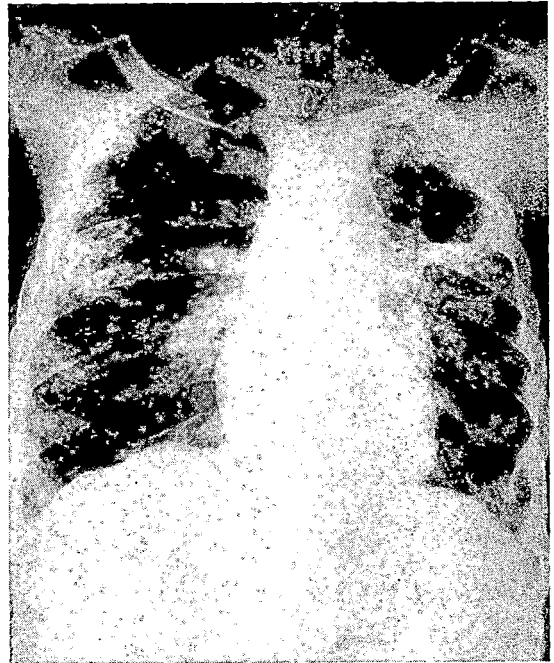


Fig. 5—Silico-tuberculosis (390 months' service).

only in gold mines in Rhodesia were available. Two had typical stage II silicosis, two were equivocal stage I and the other was negative. The general appearance of the involved chest showed no difference from that seen in the African except that four out of five had considerable emphysema.

The clinical features of the 39 cases of uncomplicated silicosis showed that cough, shortness of breath and loss of weight were the main complaints. The chief physical findings varied from diminished breath sounds and expansion to rhonchi and rales.

Table V

THE SYMPTOMS LISTED BY DIFFERENT MEDICAL OFFICERS IN 39 SUBJECTS WITH SILICOSIS

Symptom	Number
Cough	25
Loss of weight	14
Pain in chest	6
Haemoptysis	2
Shortness of breath	19

In none of the cases was the sputum positive for the tubercle bacillus. The stage of silicosis in the 39 cases, based on the physical findings as well as the radiological features, was as follows: first stage, 14; second stage, 10; third stage, 15.

The range of expansion of the chest shows that one can expect on pure silicosis a limitation, which in the majority of cases is quite definite.

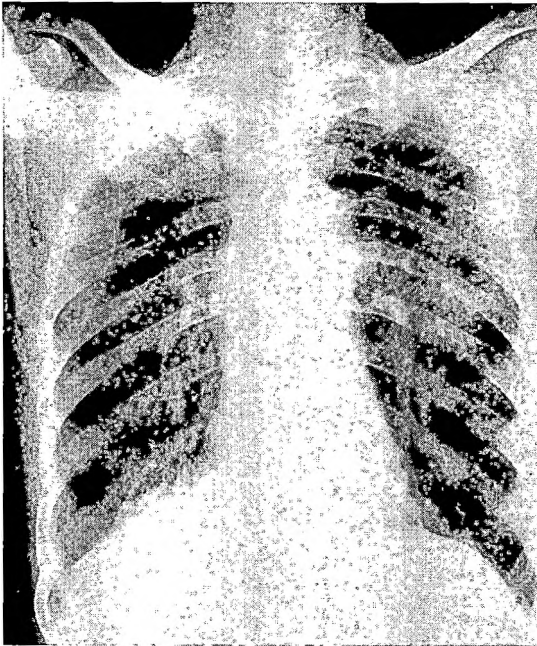


Fig. 6—Tuberculo-silicosis (225 months' service)



Fig. 7—Tuberculo-silicosis (187 months' service).

**Table VI**  
RANGE OF EXPANSION OF CHEST OF 39 AFRICAN MINERS WITH UNCOMPLICATED SILICOSIS

Number	21	13	5	0
Range of expansion	0-1	1.1-2	2.2-3	3+

In the 48 miners who were found to have tuberculosis with or without silicosis, 42 men-

tioned a cough, 28 had loss of weight and 25 were short of breath. Pain in chest was complained of by 13 of the subjects. Of these 48 cases, the sputum contained tubercle bacilli in 24 cases. It was difficult to know when one was dealing with uncomplicated tuberculous disease of the lungs or whether silicosis was also present. If the disease was strictly unilateral or if the mining history was less than one year, one was inclined to favour tuberculosis.

The symptoms mentioned in the 48 cases are summarised in Table VII.

Physical findings were recorded by most medical officers, the chief signs recorded being rales, diminished breath sounds and rhonchi. In this group of cases the limitation of the range of expansion of the chest was more striking than in the case of those who were found to have uncomplicated silicosis.

**Table VII**  
SHOWING SYMPTOMS COMPLAINED OF BY 48 AFRICAN GOLD MINERS WHO WERE CONSIDERED TO HAVE TUBERCULOSIS WITH OR WITHOUT SILICOSIS

Symptoms	Number
Cough	42
Loss of weight	28
Shortness of breath	25
Pain in chest	13
Haemoptysis	4

**Table VIII**  
RANGE OF CHEST EXPANSION OF 48 MINERS FOUND TO HAVE TUBERCULOSIS

Number	27	21	0	0
Expansion in inches	0-1	1.1-2	2.1-3	3+

**SUMMARY**

Silicosis as found in the Rhodesian miner follows a similar pattern and course as is described elsewhere. Most of the cases encountered were in the first and second stages, but the third and the complicated stage with tuberculosis occur not uncommonly. The main clinical features of silicosis are described together with its radiological changes.

**REFERENCE**

PENDERGRASS, E. P. (1958). *Amer. J. Roentgen*, 80, 1.

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