Asbestosis in Rhodesia*

BY

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The purpose of this study was to investigate the
effects of the inhalation of asbestos on employees
(mostly African) in the Rhodesian mining in­
dustry. Every effort was made to ensure that
each worker investigated had been exposed to
only this dust and had not worked in any other
type of mine.

Asbestos is mined in the Shabani-Mashaba
region in the southern part of Rhodesia. The
variety occurring in this country is the fibrous
modification of chrysotile, chemically a hydrated
magnesium silicate. This fibrous nature coupled
with heat resistance determines its value as an
asbestos. The long fibre, blue asbestos, crocidolite,
and the shorter fibre, amosite, mined in South
Africa are not known to occur in Rhodesia. These
two belong to the amphibole group of minerals
and differ in chemical composition from chryso­
tile. Crocidolite is a sodium/iron silicate and
amosite is a magnesium/iron silicate.

On the surface, chrysotile asbestos is quarried,
but underground mining is carried out by stand­
ard methods. The use of water and adequate
ventilation renders the hazard of lung disease
almost negligible. In quarries wagon drills are
employed to drill a line of long holes in benches
10 feet high and over. These holes are blasted
electrically with no person present, and so the
resulting dust cloud is harmlessly dispersed to the
atmosphere. While drilling is in progress, dust
generated is removed by an apparatus which
sucks it from the drill hole and discharges it down
wind at a safe distance from the drilling crew.

As soon as dust forms in the mills, special
exhaust systems aspirate it throughout the plant.
Many of the machines also operate under nega­
tive air pressure to prevent the escape of dust to
the atmosphere. The exhaust dust is led to bag
filters which collect it and do not allow it to
escape to the atmosphere. Water is added to the
collected dust to form a “slurry” which is con­
voyed to a dump by conveyer belts. On the dump
it forms a hard cake impervious to wind action.
As the capital outlay of filtration is so great, the
exhaust dust in smaller mills is discharged from
high chimneys and so dispersed to the atmosphere.

The standard of permissible dustiness in Rho­
desia must be no more than 300 particles per
cubic centimetre. No particle is to be longer than
five microns and no fibre beyond 40 microns.
The majority of particles are fibrous, varying
from five microns in length to 40 microns; the
non-fibrous portions are generally below five
microns, but if over they would not be counted.

The dust hazard underground is negligible and
in quarries the methods of dust suppression are
most effective. On the other hand, the dust
hazard in milling originates from crushing, grind­
ing and the transfer of material from one carriage
belt to another, and consequently the hazard in
this branch of the industry is much greater.

Asbestosis has been divided into three phases.
In the first the asbestos body or fibre is deposited
in the bronchiolar or bronchial wall. In the next
phase there is a peribronchiolar or peribronchial
oedema, and in the third, interstitial fibrosis
(Fig. 1). The asbestos body inhaled varies from
one to five microns in length and is said to
become coated with a ferritin-containing gela­
tinous material which possibly protects the
pulmonary tissues. The lesions which ensue may
be caused by mechanical irritation, but it is also
thought that liberation of silicic acid formed by
the deposition of the asbestos fibre is ultimately
responsible for the fibrous tissue laid down
(Freundlich and Greening, 1967). An increased
incidence of tuberculosis has also been said to
follow exposure to inhalation of asbestos fibre,
but the evidence is conflicting (Webster, 1964).

As asbestos consists essentially of an interstitial
fibrosis in the lung, the most functional change
is a lowered diffusing capacity, together with a
diminished ventilatory one, hyperventilation
(often accompanied by desaturation) on exertion
without evidence of air flow obstruction, unless
complicated by asthma or emphysema. Further,
these functional changes may be present inde­
pendent of the physical signs and radiological

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ASBESTOS IN RHODESIA

Fig. 1—First stage asbestosis. Increased reticulation, especially right base.

Fig. 2—Second stage asbestosis. Marked fibrosis. Right lower zone, pleural reaction in left side with shaggy heart appearance.

Fig. 3—Second stage with lesions mostly in middle zones. (In employ 192 months.)

changes (Williams and Hugh-Jones, 1960) (Figs. 2 and 3).

Without doubt asbestosis occurs in the Rhodesian industry. We have good radiological evidence of this disease and it has also been found at autopsy in men who have served only in these mines. However, we cannot give a figure for the incidence of the disease since the bulk of the employees have worked in other mines, both in and outside Rhodesia, and we are not aware of the exact number of miners who have been engaged only in this industry. The average number of Europeans employed in asbestos mines from 1963 to 1967 was 712 in contrast to 7,624 Africans. In this period 235 men were certified as having the following diseases: tuberculosis alone, 76; tuberculosis with pneumoconiosis, 41; pneumoconiosis alone, 118. But this figure provided us with no idea as to the frequency of the disease in those who had worked only in Rhodesian asbestos mines. Accordingly we had to take a fresh look at their places of employment to find out how many had been exposed only in asbestos mines in this country. In the period 1963-67 the Pneumoconiosis Bureau was concerned with 97 cases thought to have disease
which could only be attributed to employment in these mines. We scrutinised these cases again and our new assessment excluded seven as being within normal limits and two as doubtful. The results are given in Table I.

**Table I**

<table>
<thead>
<tr>
<th>CASES DISCOVERED IN ASBESTOS MINES ONLY, FIVE YEAR PERIOD 1963-1967</th>
<th>96 AFRICANS; 1 EUROPEAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos</td>
<td>96 (total 39)</td>
</tr>
<tr>
<td>Tuberculosis or tuberculosis/asbestosis</td>
<td>48</td>
</tr>
<tr>
<td>Carcinoma of the lung</td>
<td>1</td>
</tr>
<tr>
<td>Doubtful</td>
<td>2</td>
</tr>
<tr>
<td>Probably no abnormality</td>
<td>7</td>
</tr>
</tbody>
</table>

One European out of 712 contracted asbestosis and 38 Africans out of 7,624. The subjects with asbestosis were examined by various medical officers at the different mines and therefore it is not possible to claim any uniformity in procedure. Nevertheless, the paucity of these findings may add more to their value. The symptoms mentioned by the patients in order of frequency are shown in Table II.

**Table II**

<table>
<thead>
<tr>
<th>Symptoms in Uncomplicated Asbestosis</th>
<th>No. of subjects (total 39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cough</td>
<td>25</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>24</td>
</tr>
<tr>
<td>Pain in chest</td>
<td>19</td>
</tr>
<tr>
<td>Haemoptysis</td>
<td>7</td>
</tr>
<tr>
<td>Loss of weight</td>
<td>4</td>
</tr>
<tr>
<td>Sputum positive for tuberculosis</td>
<td>0</td>
</tr>
</tbody>
</table>

The relative frequency of cough and shortness of breath on exertion does not call for special comment, but pains in the chest seem to be fairly common, being mentioned by 19 out of 39 subjects. This may be the result of pleural reaction and fibrous tissue formation which is apparently not an uncommon feature of the disease. Perhaps worthy of mention are the seven patients who complained of the presence of blood in the sputum. As tuberculosis was absent in these cases, could not haemoptysis occur at times in a damaged lung with bronchiolar changes?
five cases of lung cancer among a total European population of the region of about 4,000. One was a miner from the Shabanie Asbestos Mine, one a small worker (gold) from Belingwe, two worked at Bannockburn station and the last case, a woman visitor, who had come to spend her last few days with her daughter. As this European hospital serves Shabani, Belingwe, Mashaba and Bannockburn, it is difficult to give a precise population figure, but Dr. Walker estimates it at about 4,000. The African population on the Shabanie Mine is about 4,000. The two European cases in the period 1960-65 (inclusive) were a miner from Mashaba and another from Shabani. During each of these periods three Africans developed carcinoma of the lung.

Table VI

<table>
<thead>
<tr>
<th>Year</th>
<th>European</th>
<th>African</th>
</tr>
</thead>
<tbody>
<tr>
<td>1955-59</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>1960-65</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

In our present series there was one probable case who had a carcinoma of the bronchus.

At the Mashaba Mine, Dr. A. G. Bradley reports in a personal communication that between June, 1961, and July, 1968, there were two cases of primary carcinoma of the lung noted in employees. One was an African found at Gaths Mine at autopsy to have had this lesion. The second case, a European, was found to have this disease in 1968. The Gaths Mine employs 1,650 Africans and 190 Europeans.

Again, at the Pangani Asbestos Mine in Filsabusi, which has been in operation since 1963, no case of lung cancer has been reported. There are about 44 Europeans and 428 Africans in employment.

Thus in this study, while we are unable to show a relationship between the two diseases, we suspect that exposure to chrysotile may have some causal relation to the development of lung malignancy.

X-ray appearances

Characteristic of the X-ray appearances of asbestosis is the ground glass motting of the lung fields, especially in their lower sections, pleural thickening and a shaggy border of the heart. Some authorities report that calcified pleural plaques are frequently seen in asbestosis (Figs. 4, 5 and 6). For instance, Freundlich and Greening (1967) state that they occur in 21.4
per cent, and a shaggy heart in 19.6 per cent. of cases. Other fairly frequent findings include Kerley's B line in about 18 per cent. of workers, but this is not always associated with pleural or parenchymal asbestosis.

Williams and Hugh-Jones (1960) report that in the majority of cases a higher degree of mottling is found in the lower zones than in the mid zones. There is little difference between the two sides. Although a shaggy border to the heart and a pleural reaction are regarded as common in asbestosis, these workers report them to be far less frequent than is commonly found.

Hurwitz (1961) provides us with an excellent account of the radiological features of asbestosis in South Africa. Like other observers in America and elsewhere, he emphasises pleural changes in the form of uni- or bilateral parietal thickening to a varying degree. However, he brings to light a more specific pleural lesion in the form of calcification in the typical pneumoconiotic plaques. These calcified plaques may be minimal or extensive, linear or distributed in irregular patterns. More often they are bilateral and more or less symmetrical, tending to occur mainly along the parietal pleurae, especially in the middle and lower zones. But he mentions that it is worth

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Fig. 6—Asbestosis with pleural calcification left side. (In employ 280 months.)

Fig. 7—Asbestosis. Severe pleural reaction on left side.

Fig. 8—Note the extensive fibrotic mass in each lung, proved histologically to be due to asbestosis.
noting that extensive areas of calcification may be observed along the anterior aspect. Further, both the diaphragmatic and mediastinal pleura are commonly involved. The plaques are different in appearance and character from silicotic ones, which, though not frequent, are located mainly in the upper zones towards the periphery of the lungs. Hurwitz also emphasises that in pure asbestosis associated "eggshell" lymph node calcification is singularly absent in contradistinction to that found in silicosis (Figs. 7 and 8).

The variability of the X-ray changes and the difficulty in trying to classify them into various stages has been stressed by others (Williams and Hugh-Jones, 1960). Our X-ray findings were not quite the same as described by others. We did not see the frequent pleural thickening or pleural calcification that has been described in South Africa (Selikoff, 1965, and Sluis-Cremer, 1965). There were four cases somewhat similar in appearance to those described by Selikoff. One had a marked left-sided pleural reaction. A few others had calcification, but in association with obvious old tuberculous disease, and the oostophrenic angles were not frequently impaired (right 9, left 14 in 96 patients). One case had a typical diaphragmatic adhesion. Emphysema was noticed in the films of seven of the 39 cases with pure asbestosis.

The "shaggy appearance" of the heart is emphasised by others (Pendergrass, 1958, and Webster, 1965). Only two rather equivocal examples of this were seen. No finding suggestive of cor pulmonale was encountered. In only five cases the heart shadow appeared abnormal, looking like old hypertensive or valvular disease.

Nodules and infiltrates were seen quite frequently, but often in association with obvious tuberculous nodes, and in some cases seemed to be due solely to tuberculosis. There was little tendency for the nodules to coalesce, and when cavities were detected they seemed obviously of tuberculous origin rather than due to colliquative necrosis of large silicotic masses.

The association with tuberculosis was frequent and in some cases the entire appearance of the lung seemed best explained by tuberculosis alone (Figs. 9 and 10). Acid-fast bacilli were found in 29 out of 93 cases, in which the sputum was examined. Cavities were demonstrated in 22 cases and from the X-ray appearance alone the diagnosis of tuberculosis was made in 47 cases. The incidence of tuberculosis among asbestos miners does not seem to be greater than in non-mining male Africans (Wester, personal communication).

Significantly increased reticulation was noted in 39 cases, sometimes without and sometimes

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**Fig. 9**—Tuberculosis in an asbestos miner. (In employ 215 months.)

**Fig. 10**—Tuberculosis in an asbestos miner.
In the seven cases of asbestosis in which the lesions were apparently confined to one lung, six were on the left side and one on the right. When asbestosis was accompanied by tuberculosis the pattern changed to that shown in Table VIII.

Pendergrass (1958) reports a diminution in the superior-inferior distance of the chest in asbestosis. This finding was not noted in our cases.

SUMMARY

(1) Our more frequent radiological findings were the presence of nodules, increased markings and a ground glass appearance in the lung fields. None of these seemed at all specific for asbestosis.

(2) Pleural involvement with or without calcification was not seen as frequently as we expected.

(3) The "shaggy heart" appearance is probably uncommon.

(4) No case of pleural mesothelioma was noted, nor was cancer of the lung of significance, as there was only one possible case in our series based on radiological evidence.

REFERENCES

WESTWATER, M. L. Personal communication.

The Regions of Involvement

We also studied radiologically the distribution of the lesions of asbestosis in the lungs and compared these results with those found in miners considered to have tuberculosis who had worked at least five years in the asbestos industry.

Table VII

<table>
<thead>
<tr>
<th>Table VII</th>
<th>Radiological Distribution of Lesions Found in 24 Miners With Uncomplicated Asbestosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
</tr>
<tr>
<td>Upper zone</td>
<td>4</td>
</tr>
<tr>
<td>Middle zone</td>
<td>15</td>
</tr>
<tr>
<td>Lower zone</td>
<td>18</td>
</tr>
</tbody>
</table>

Table VIII

<table>
<thead>
<tr>
<th>Table VIII</th>
<th>Radiological Distribution of Lesions Found in 24 Miners Considered to Have Tuberculosis With Five Years or Over of Service in Asbestos Mines</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
</tr>
<tr>
<td>Upper zone</td>
<td>18</td>
</tr>
<tr>
<td>Middle zone</td>
<td>10</td>
</tr>
<tr>
<td>Lower zone</td>
<td>3</td>
</tr>
</tbody>
</table>

When one compares these two tables it will be observed that with pure asbestosis the lesions are found mostly in the middle and lower zones, whilst in tuberculosis they are mainly in the upper zones. Nevertheless, in many of the cases of pure asbestosis the lesions were fairly evenly distributed throughout the lungs.