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ASBESTOSIS WITH PLEURAL CALCIFICATION AMONG INSULATION WORKERS

By J. FROST, J. GEORG and P. FLEMMING MØLLER

Pulmonary disease due to the inhalation of asbestos dust has been known for the last fifty years. The first case was described by Murray (1906). In Scandinavia, cases were reported from Norway and Finland by Wolff (1940), Schrumpf (1941), Wegelius (1946) and Noro (1946).

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After consultation with the Union officials, we began examinations in 1953 by selecting workers who had been in the trade for twenty years or more. The Copenhagen Union of Insulation Workers had about a hundred members during the thirties. These men often change from one firm to another and are employed on all kinds of insulation work. Before 1930 or so, lagging material chiefly consisted of kieselguhr and magnesia, mostly mixed with asbestos, or of asbestos ropes, or, in the case of boilers, mattresses filled with asbestos flock.

Since about 1935 the use of rock-wool and glass-wool has gradually come to the fore in the insulation of hot-water pipes, etc. A special process for the insulation of ships' walls, *i.e.*, spraying with powdered asbestos, has been used to a certain extent.

The Union urged all the workers who had been in the trade for more than twenty years to submit themselves for examination: 31 attended; 3 did not. The occupational history was recorded, and a detailed clinical examination was carried out with X-ray of the chest (frontal, lateral and oblique positions).

The average age of the subjects was 52 years, ranging from 41 to 70; the period of exposure averaged 27 years, ranging from 20 to 45 years. Six of them complained of shortness of breath, which they considered abnormal for their age. All of them were working full time.

RESULTS

Roentgenographic examinations revealed abnormalities in 22 cases. 9 cases showed definite signs of pulmonary asbestosis, varying in degree — usually a fine mottling or nodulation. In no less than 19 cases abnormalities of the pleura were found. These changes ranged from obliterated sinuses and pleural adhesions to extensive thickening of the pleura with calcification.

The pleural abnormalities were bilateral in 12 cases; unilateral in 7. Calcification of the pleura was bilateral in 8 cases; unilateral in 3.

Parenchymatous lesions of the lungs alone were found in 3 cases, and in 6 cases combined with pleural lesions, 3 of which were calcifications.

In a few cases the abnormalities of the pleura were so widespread that no definite diagnosis could be made regarding the conditions of the lungs.

COMMENTS

It was a surprise to find 22 subjects with abnormalities of the chest out of a total of 31 examined. Only one of these stated that he had

suffered from any lung disease, *i.e.*, pleurisy with effusion 13 years previously.

While it is generally observed that asbestosis of the lungs is accompanied by pleural thickening and adhesions, we have only been able to find one reference to pleural calcification in this connection. (Jacob & Bohlig, 1955).

Calcification of the pleura is a rather rare finding in radiological examinations of the chest. The incidence among unselected cases is estimated by Patch & Perry (1952) to be less than 0.2 per cent. Floyd & Hepburn (1939) found 28 in 15,000 examinations, and Kristiansen (1944) 15 in 10,000. In selected groups, con-



Fig. 1.

Insulation worker, age 70 years, exposure 45 years.
Bilateral pleural calcification.

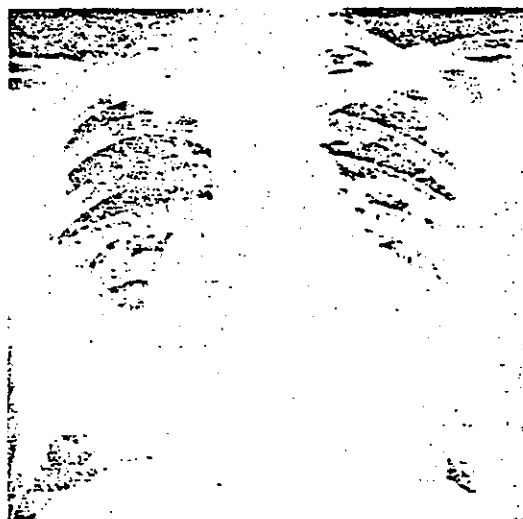


Fig. 2.

Insulation worker, age 57 years, exposure 38 years.
Extensive pleural calcification over lower two-thirds
of the lungs.

taining many ex-servicemen, Ulrich (1930) found 16 out of 5,700 (etiology: bullet wounds, 5 cases; pleurisy, 5 cases; tuberculosis, 1 case; pneumonia, 1 case; unknown, 4 cases), and Behrendt (1930) found 12 out of 966 subjects (etiology: bullet wounds, 5 cases; tuberculosis, 7 cases). Head (1934) considers tuberculous pleuritis and hemothorax the only causes definitely known to produce calcification of the pleura.

Patch & Perry point out that calcification is usually unilateral, but bilateral in the so-called idiopathic cases (approximately 20 per cent of all cases).

A special investigation of workers exposed to dust was carried out by Smith (1952). She found 35 cases of pleural calcification out of 8,779 subjects examined. Only four groups showed a definitely higher incidence of calcification than that among the average population, viz., workers exposed to the dust in making bakelite insulators, (1.5 per cent), calcimine (1.7 per cent), mica (1.6 per cent) and tremolite talc (6.3 per cent). Tremolite talc is a calcium magnesium silicate, which structurally resembles asbestos. It is known to cause pneumoconiosis. Calcimine is composed of whiting, clay, talc, silica, mica and asbestos. Four cases of pneumoconiosis were found in this group. Mica is a complex silicate of potassium, aluminium, magnesium, calcium and fluorine. Bakelite was mixed with talc and mica. No case of pneumoconiosis was found among the workers exposed to mica or bakelite. No pleural calcification was found among 261 asbestos workers. Smith suggests that it is the combined exposure to calcium and magnesium, together with a dust producing pleural irritation, which provokes the calcifications.

None of the workers examined by us have been working with asbestos alone; all of them have been exposed to kieselguhr, magnesium, rockwool and glass-wool too. The last three substances do not cause pneumoconiosis. Exposure to kieselguhr is known to involve a risk, as several cases of pneumoconiosis seemingly caused by this substance have been reported. According to Luton, Champeix, Ravet & Vallaud (1956) it is primarily a question of the alpha-quartz content. Exposure to the amorphous form of kieselguhr involves considerably less risk than does exposure to the flux-calcinated substance, nearly all of the silica of which may be in the form of alpha-quartz. The kieselguhr used in this country is not known to be flux-calcinated, and sample-analysis has not revealed the presence of alpha-quartz.

In our cases the workers have been exposed to asbestos, which is known to produce pneumoconiosis with pleural affection, and to kieselguhr, magnesia, rock-wool and glass-wool. Our findings

thus give some support to Smith's contention that the incidence of pleural calcification may be connected with exposure to mixed dust; but it should be emphasized that our subjects have not been exposed to calcium.

While smaller pleural thickenings and adhesions are a rather common finding in chest X-rays of persons not known to have had any lung disease previously or to have been exposed to dust at their jobs, the findings of pronounced bilateral pleural changes in the present series definitely point towards an occupational origin. The diagnosis of asbestosis may be made with confidence when these pleural changes are found together with parenchymatous lesions of the lungs. The occurrence of similar pleural changes without any definite changes of the lung proper may also, with reasonable certainty, be accepted as evidence of asbestosis in subjects known to have worked with insulating material of the sort used by the workers examined here.

SUMMARY

31 workers engaged for 20 years or more in different kinds of insulation works were examined for occupational lung disease. They had been exposed to dust containing asbestos, kieselguhr, magnesia, glass-wool and rock-wool. 9 were found to have definite signs of pulmonary asbestosis. 19 showed abnormalities of the pleura, 12 of these being bilateral. In 11 cases calcification of the pleura was found, being bilateral in 3 of them.

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Keppel Street, W.C.1

It might be reasonable to suppose in some cases that t was proportional to D , irrespective of particle size, in which case the volume is

$$\frac{4}{3}\pi D^3 \text{ END}^3$$

making $\alpha = \frac{1}{3} \cdot \frac{t}{D}$.

For spherical particles $\frac{t}{D}$ is $2/3$; the value for any other shape is smaller and the data for siliceous minerals given in the paper correspond to $\frac{t}{D} = \frac{1}{3}$.

In the fifth chapter the relationship of the Stokes and projected area diameters is discussed. The separation of a fraction by settlement defines the upper and lower Stokes diameters of the particles therein. Microscope sizing of the same fraction reveals a greater range of projected area diameters which extend only slightly below the lower limit of the Stokes range, but considerably above the higher limit. In order to relate the two concepts of particle size the volume/surface diameter is deduced for each. This quantity is defined as

$$D_v = \text{END}^3 / \text{END}^2$$

Being concerned with cubes and squares of D it is little influenced by the finer particles in the range and reasonable agreement is obtained between optical and electron microscope evaluation for dusts containing particles exceeding 0.1 micron in size.

D_v is found from the Stokes size limits by assuming the exponential size distribution, referred to above, and taking the ratio of integrals which are equivalent to the summations in the microscope formula.

This supposes that the volume of a particle is proportional to the cube of its Stokes diameter and the surface area to the square. On this occasion there is no analogue of Cauchy's theorem to vindicate even the latter assumption. The rate of fall of a particle is proportional to the ratio of its volume to the diameter of a sphere having the same fluid resistance at the same rate of fall. This latter diameter can be evaluated for an ellipsoid and is a complicated function of the length of the 3 axes. It is certain that no justification exists for the simple assumptions made in this paper.

The outcome, for 46 size graded functions covering Stokes diameter ranges of 4:1, and mostly less, is that the ratio of the count volume surface diameter to the Stokes diameter is 1.54 ± 0.31 . [The scatter of the count diameters themselves was much less than this, which confirms that the assumptions discussed above are unjustified and that the volume/surface diameter does not convey the information which its name implies.]

A similar criticism must also be levelled at the last chapter in which the estimation of specific surface from size distribution is discussed.] C. N. Davies

FROST, J., GEORG, J. & MÖLLER, P. F. Asbestosis with Pleural Calcification among Insulation Workers. *Danish Med. Bull.* 1956, Nov., v. 3, No. 7, 202-4, 2 figs. [18 refs.]

In Denmark only a few persons manipulate insulation products, which include asbestos, kieselguhr,

magnesia, glass-wool and rock-wool. The first two have been regarded as fibrogenic to the lungs when their dust is inhaled. In order to ascertain any occupational risk in the work 31 workers with more than 20 years' exposure were carefully examined clinically and by X-ray. The average age of the subjects was 52 years, and the average period of exposure was 27 years. Abnormalities were found in 22. A total of 9 exhibited fine mottling with nodules indicative of pulmonary asbestosis. In 19 patients pleural changes were seen, which were due to adhesions and extensive thickening with calcification. The abnormalities of the pleura were so widespread in some instances as to obliterate other pathological changes. Pulmonary abnormalities in 22 out of 31 persons was a surprising proportion. The calcification is unusual and may be ascribed to combined exposure to calcium and magnesium, in the presence of fibrogenic asbestos dust. Sample analysis of the kieselguhr in use did not reveal the presence of alpha-quartz. The finding of pronounced bilateral pleural changes in the present series definitely points to an occupational origin. E. L. Collin

ERNHARDT, W. Nichtsilicotische Staubschäden der Lunge. [Non-Silicotic Dust Hazards of the Lung.] *J.d.g. Hyg. u. ihre Grenzgebiete.* Berlin, 1956, Mar.-Apr.-May-June, v. 2, No. 2/3, 226-30.

The following dust diseases are briefly reviewed: pneumonia caused by manganese dioxide and slag, beryllium and cadmium. A long list is given of dusts which cause bronchitis and asthma and which may often involve an allergic reaction, as for instance paprika, flax and sugar-cane dust. Byssinosis is said to be often due to infection by *Aerobacter* [*Clostridium cloacae*]. Dusts producing interstitial fibrosis are aluminium and radium. The latter may also cause bronchial carcinoma. Other carcinogenic dusts are asbestos, chromates and, according to Japanese workers, dusts from generators in the iron industry and components of the tar fraction with boiling point above 300°C. G. Nagelschmidt

CARLÍN, C. E. & FERRÁNDIZ, J. J. Algunas consideraciones sobre saturnismo entre los trabajadores de una fundición. [Reflections on plumbism among the Workers at a Foundry] *Rev. Med. Exp.* Lima, 1956, July, v. 10, No. 1, 43-52. [12 refs.] English summary.

The article is based on an examination of 133 persons employed in all branches of a foundry where metal containing lead was smelted. For each a full medical and occupational history was taken. Clinical, radiological and laboratory examinations were made. There was definite evidence of lead poisoning in 133 employees. In 247 others there was evidence of absorption of lead but no symptom of poisoning. In each of these groups there were 3 who had worked in the foundry for only 30 days. The majority of those with lead poisoning were in the age group 35-45.

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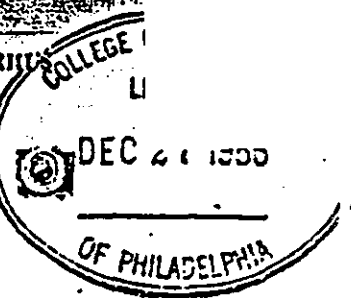
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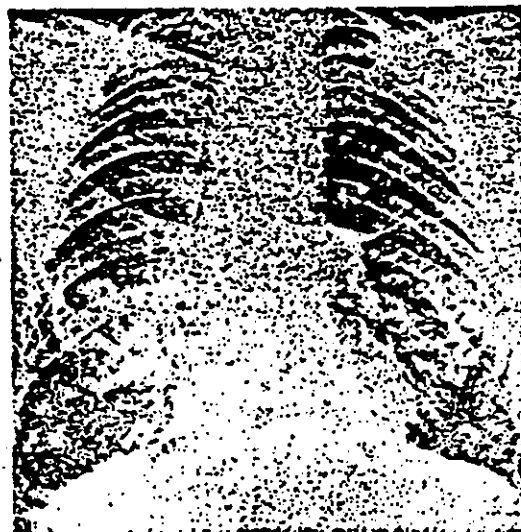


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Bilateral pleural calcification.



Fig. 2.

Insulation worker, age 57 years, exposure 38 years.
Extensive pleural calcification over lower two-thirds of the lungs.

taining many ex-servicemen. Ulrich (1930) found 16 out of 5,700 (etiology: bullet wounds, 5 cases; pleurisy, 5 cases; tuberculosis, 1 case; pneumonia, 1 case; unknown, 4 cases), and Behrendt (1930) found 12 out of 966 subjects (etiology: bullet wounds, 5 cases; tuberculosis, 7 cases). Head (1934) considers tuberculous pleuritis and hemothorax the only causes definitely known to produce calcification of the pleura. Patch & Perry point out that calcification is usually unilateral, but bilateral in the so-called idiopathic cases (approximately 20 per cent of all cases).

A special investigation of workers exposed to dust was carried out by Smith (1952). She found 35 cases of pleural calcification out of 8,779 subjects examined. Only four groups showed a definitely higher incidence of calcification than that among the average population, viz., workers exposed to the dust in making bakelite insulators, (1.5 per cent), calcimine (1.7 per cent), mica (1.6 per cent) and tremolite talc (0.3 per cent). Tremolite talc is a calcium magnesium silicate, which structurally resembles asbestos. It is known to cause pneumoconiosis. Calcimine is composed of whiting, clay, talc, silica, mica and asbestos. Four cases of pneumoconiosis were found in this group. Mica is a complex silicate of potassium, aluminium, magnesium, calcium and fluorine. Bakelite was mixed with talc and mica. No case of pneumoconiosis was found among the workers exposed to mica or bakelite. No pleural calcification was found among 261 asbestos workers. Smith suggests that it is the combined exposure to calcium and magnesium, together with a dust producing pleural irritation, which provokes the calcifications.

None of the workers examined by us have been working with asbestos alone; all of them have been exposed to kieselguhr, magnesium, rockwool and glass-wool too. The last three substances do not cause pneumoconiosis. Exposure to kieselguhr is known to involve a risk, as several cases of pneumoconiosis seemingly caused by this substance have been reported. According to Lutton, Champetiz, Ravet & Vallaud (1956) it is primarily a question of the alpha-quartz content. Exposure to the amorphous form of kieselguhr involves considerably less risk than does exposure to the flux-calcinated substance, nearly all of the silica of which may be in the form of alpha-quartz. The kieselguhr used in this country is not known to be flux-calcinated, and sample-analysis has not revealed the presence of alpha-quartz.

In our cases the workers have been exposed to asbestos, which is known to produce pneumoconiosis with pleural affection, and to kieselguhr, magnesia, rock-wool and glass-wool. Our findings

thus give some support to Smith's contention that the incidence of pleural calcification may be connected with exposure to mixed dust; but it should be emphasized that our subjects have not been exposed to calcium.

While smaller pleural thickenings and adhesions are a rather common finding in chest x-rays of persons not known to have had any lung disease previously or to have been exposed to dust at their jobs, the findings of pronounced bilateral pleural changes in the present series definitely point towards an occupational origin. The diagnosis of asbestosis may be made with confidence when these pleural changes are found together with parenchymatous lesions of the lungs. The occurrence of similar pleural changes without any definite changes of the lung proper may also, with reasonable certainty, be accepted as evidence of asbestosis in subjects known to have worked with insulating material of the sort used by the workers examined here.

SUMMARY

31 workers engaged for 20 years or more in different kinds of insulation works were examined for occupational lung disease. They had been exposed to dust containing asbestos, kieselguhr, magnesia, glass-wool and rock-wool. 9 were found to have definite signs of pulmonary asbestosis. 19 showed abnormalities of the pleura, 12 of these being bilateral. In 11 cases calcification of the pleura was found, being bilateral in 8 of them.

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INDUSTRIAL MEDICINE

1156. Asbestosis with Pleural Calcification among Isolation Workers

1156. Frost, J. G. and P. F. Møller. *Danish Medical Bulletin* [Dan. med. Bull.] 3, 202-204, Nov., 1956. 2 figs., 17 refs.

Experience in many countries has established that workmen employed in the lagging of pipes and boilers may contract pneumoconiosis in the course of their employment. Lagging materials vary in composition; common ingredients are kieselguhr, magnesia, and asbestos, and in more recent years rock wool and glass wool. About 100 lagger are employed in the shipyards and factories in and around Copenhagen. The authors examined 31 of these workmen who had been engaged for 20 years or more in the processes, and 9 were found to have definite signs of asbestosis. In addition, 19 showed abnormalities of the pleura, and in 11 of these there was calcification of the pleura, which was bilateral in 8 cases.

[The main purpose of the authors of this paper was to record the condition of "calcification" of the pleura in asbestos workers, they having found only one previous reference to such a case (Jacob and Bollig, *Fortschr. Röntgenstr.*, 1955, 83, 515). Since being shown this series of radiographs in Copenhagen in 1954, the abstractor has seen a series of similar radiographs from asbestos workers in the mines in South Africa. The dense, well-defined shadows are very striking, but as yet there is no necropsy evidence which confirms the deposition of calcium salts in the plaques. Since dense pleural sclerosis can simulate calcification such evidence of the morbid anatomy and pathology of the condition is needed.]

A. Meiklejohn

1157. Cardiovascular Changes in Lead Workers. (Le alterazioni cardiovascolari nei lavoratori del piombo)

M. CERRETI, F. GOURATO, and G. SCANSETTI. *Minerva medica* [Minerva med. (Torino)] 2, 1910-1918, Dec. 8, 1956. 6 figs., 37 refs.

The cardiovascular function of 73 persons employed for periods of 4 months to 54 years in work involving exposure to lead was investigated by routine clinical and electrocardiographic (ECG) examination at the Institute of Industrial Medicine of the University of Turin and the findings correlated with the results of laboratory tests which included a full blood examination and the estimation of porphyrins in the urine and blood and in some cases of urinary and blood lead content.

The workers were divided into three groups: (1) those showing signs of lead absorption but no toxic symptoms; (2) those suffering from or having just recovered from an acute attack of colic; and (3) those with a long history of exposure to lead, and with a past history of toxic symptoms. In Group 1 there were neither clinical nor ECG changes; in Group 2 the blood pressure was raised during the attack of colic, with either bradycardia or a tendency to tachycardia, and there was some evidence of vagal hypertonia; in Group 3 hypertension, with a

diastolic pressure above 90 mm. Hg. was frequent, the ECG usually showed disturbance of rhythm, and there was one case of simple auriculo-ventricular block.

It is concluded that cardiovascular changes are significantly frequent in both acute and chronic lead poisoning. In the initial stages these changes are functional (arteriolar spasm) and therefore reversible; they are represented clinically by arterial hypertension, transitory at first, but leading eventually to changes in the renal, cerebral, and coronary circulation, of which coronary spasm in young persons is especially noteworthy. In the advanced stages of lead intoxication the arteriosclerotic changes become organic and irreversible. Of the cases here reported, 38.5% showed a constant hypertension, due in some to arteriosclerosis, in others to nephrosclerosis. Cardiac complications in the form of coronary disturbance or left ventricular insufficiency or both occurred in 21.2%. One case only of obliterating endarteritis (Buerger's disease) was observed.

Ethel Browning

1158. The Bone Marrow in Occupational Lead Poisoning. (Il midollo osseo nell'intossicazione professionale da piombo)

V. PRATO and L. FIORINA. *Minerva medica* [Minerva med. (Torino)] 2, 1937-1945, Dec. 8, 1956. 2 figs., 38 refs.

At the Institute of Industrial Medicine of the University of Turin stained films of the sternal bone marrow of 24 patients with lead poisoning were examined. The subjects were divided into three groups according to their clinical symptoms and length of exposure: (1) those who were not regarded as having reached the fully developed phase of poisoning, had had only short exposure, had suffered from fluctuating abdominal pain, and had no anaemia (7 patients); (2) those who had had acute episodic attacks (11 patients, all except 2 being anaemic); and (3) those with a history of long exposure and past episodes of intoxication (6 patients, of whom only one was anaemic, though all showed increased peripheral reticulocytosis).

In the great majority the erythroblastic activity of the bone marrow was more marked than the leucoblastic, the ratio being inverted in Group 2. The curve of erythrocytic maturation was characteristic of a stimulative effect, with a higher level of polychromatic than of orthochromatic erythroblasts. Karyokinesis was increased in Groups 1 and 2, and polyploidism (increase in the number of chromosomes) in Group 2, but not to such an extent as reported by other investigators. Erythroblasts with basophilic granulation were much more numerous in cases with severe anaemia, and in the more acute phases of intoxication.

Granulocytic haematopoiesis was generally unaltered. On the whole, except in Group 1, the reaction to lead intoxication in man appears to be stimulative, in contrast to that in animals, where it has been reported as aplastic. This stimulative effect is regarded as a proliferative reaction to an abnormal destruction of erythrocytes by lead, accompanied by increased rapidity of maturation. With the cessation or decrease of haemolysis, both these phenomena return to the normal, the erythroblastic reaction first.

Ethel Browning