COPY FORM	INITIALS	DATE

BOX NUMBER	SEGMENT NO.	REQUESTING PARTY
Microfilm &		F & M

NOTES

Fed Arts

AFFIDAVIT

STATE OF COLORADO)
) ss.
COUNTY OF JEFFERSON)

I, Margaret J. Baumgardner, being of full age and first duly sworn do hereby state:

1. I am the Research Coordinator for the Claims Resolution Management Corporation ("CRMC"), a wholly owned subsidiary of the Manville Personal Injury Settlement Trust ("Trust"). The CRMC was created in December 1998 and is staffed by former Trust employees. On January 1, 1999, CRMC began providing claims resolution facility services to the Trust.

2. In this position, I manage the Asbestos Claims Research Facility ("Facility"), a document and records repository, located at 4755 East 46th Avenue, Denver, Colorado. The Facility contains the business records including but not limited to correspondence, memoranda, reports, records and data compilations ("records") of Manville Corporation or related entities ("Manville"), generally, as well as Manville records relevant to litigation of asbestos liability. The Trust has managed and operated the Facility from November 28, 1988, the date on which the Manville bankruptcy plan was consummated.

3. My experience and familiarity with the documents at the Facility began in 1983 while working for Manville. In my work as a paralegal for Manville, I assisted in locating, indexing and packing many of the records which became the foundation documents for the Facility. I continued to work for Manville until September 1987. From March 1988 to September 1988, I was hired to supervise and assist in the indexing of the first 20,000 boxes which were turned over to the Trust in November 1988. From September 1988 to January 1989, I assisted in the privilege review of documents to be given to the Trust. From November 1988 to April 1994, I worked for Freeborn & Peters and was put in charge of the Facility, managing all productions and "new" acquisitions. In September 1995, I was hired by the Trust to manage the Facility. In December 1998, I was hired by the CRMC to manage the Facility for the Trust. Accordingly, I am personally familiar with many of the records stored at the Facility, as well as how the records have been gathered.

4. To the best of my present knowledge, information and belief, I certify that these records were made at or near the time by, or from information transmitted by, a person with knowledge, were kept in the course of the regularly conducted business activity of Manville, and it was the regular practice and the business activity of Manville to make the records.

5. Documents from this Facility were copied for Trine & Metcalf. The documents copied have come from microfilm and medical article files at the Facility and are bates labeled MT-001691 through MT-001729, and these documents are true and correct copies of documents found at the Facility.

Margaret J. Baumgardner

Subscribed and sworn to before
me this 8th day of March, 2004.

Notary Public

JENNIFER EMMERICH
NOTARY PUBLIC
STATE OF COLORADO
My Commission Expires 2/6/2006

EXCERPTS FROM VARIOUS MEDICAL JOURNALS

ON

PULMONARY ASBESTOSIS

MEMO REPORT #

March 21, 1930
Market Analysis Section
Sales Promotion Department
Johns-Manville Corporation

FOREWORD

A few scattered articles have appeared in medical journals in recent years concerning occupational disease of asbestos workers noticed of late. A thorough study and diagnosis apparently has not yet been made as the disease has not previously been generally recognized.

Excerpts of articles on this disease were taken from medical journals in the Medical Library at Fifth Avenue and 103rd Street and are presented in this report.

EXCERPTS FROM VARIOUS MEDICAL JOURNALS

ON

PULMONARY ASBESTOSIS

Canadian Medical Association Journal
Feb. 1929 - Page 153

Pedley, Frank G. - Pulmonary Asbestosis

Mortality and mobility records of asbestos workers are not available. Information as to the effect of such work on the worker is extremely limited.

Death of an asbestos worker which occurred in 1900 was reported by Dr. Murray in England to the Department of Industrial Diseases and the evidence suggested that the death was due to an occupational disease.(Start of study)

Asbestos is essentially a magnesium silicate. The Canadian asbestos is said to contain about 41% silica and 2.5% iron oxide.

Clinically, asbestos affects two tissues. First, it may produce small warty growths in the skin - the so-called "asbestos corns". Secondly, it may give rise to a fibrosis of the lungs, somewhat similar to that produced by silica. Investigation of "asbestos corns" indicates that they are granulomatous in nature and have for their core a tiny spicule of asbestos fibre.

It is believed that silica is necessary to the formation of pulmonary fibrosis. At present this cannot be disproved by the occurrence of pulmonary asbestosis, since asbestos itself is a silicate. No analysis has been made of pulmonary tissue for silica in cases of asbestosis.

It might be thought that lesions in this condition was essentially the same as that of ordinary silicosis, if it were not for the fact that certain very characteristic bodies are reported unlike those seen in any other pathological picture. We refer to the so-called "curious bodies". Microscopic sections of lungs of asbestos workers show large elongated bodies varying in length

from 10 to 100 microns. They may have single clubbed ends or may appear as elongated dumb bells, and sometimes single coccal or streptococcal forms are seen. They do not stain with ordinary aniline dyes, but are themselves golden yellow or yellowish brown. Apparently they are composed of a central core, which is probably an asbestos spicule, upon which colloidal aggregates of blood proteins have been absorbed.

Since the reported cases of this disease have occurred largely among spinners and weavers, it is possible that the mining and crushing of asbestos does not present a hazard. The failure to recognize the disease in Canada, however, is no evidence of this, for in other occupations experience has shown that large groups of men suffer serious occupational effects which go unrecognized for years.

.....

Bulletin of Hygiene - London - Dec. 1929
V. 4, #12 Pg 978

Abstract - Gloyne, S. Woodhouse

(Wood, W.B., Pulmonary Asbestosis. Radiographic Appearances in Skiagrams of the Chest of Workers in Asbestos. Tubercle. 1923, V. 10. 65-65; 12 figures on 6 pls.: 12 ref.)

The cardinal symptom of pulmonary asbestosis, like that of other forms of silicosis, is dyspnoea, which progresses until in the advanced stages of the disease, it becomes extreme. The dyspnoea may be accompanied by cyanosis and the complexion of most patients has a slightly leaden hue. Chest expansion may be reduced to one inch or less. Cough is seldom excessive and expectoration is moderate in amount or often absent.

The physical signs are those of a bilateral pulmonary fibrosis chiefly affecting the lung bases. Pulmonary tuberculosis may supervene or modify the clinical picture. When the disease is well established the prognosis appears to be grave.

Post mortem, the diagnostic feature which serves to distinguish the condition from other forms of pneumonoconiosis is the presence in the lungs of golden yellow foreign bodies with

segmented outline and clubbed extremities bearing a superficial resemblance to minute crustacean forms.

.....

British Medical Journal - Sept. 28, 1929
(P. 578)

Cooke, W.E. - M.D.; F.R.C.P.Ed.; [illegible].R.C.P. London.; D.P.H.
Asbestos Dust and the Curious Bodies Found
in Pulmonary Asbestosis

A scientific treatment of the analysis of the bodies found. Just some outstanding extracts taken.

I have mentioned that the greater portion of asbestos dust consists of slender translucent fibres. In sections and extracts of lungs there is a remarkable paucity of these fine spicules. The end-results of digestion show the fine granular dust, and the large black, blue, and brown particles, and what appears to be pieces of quartz. Relatively few fine spicules are found, but curious bodies of all descriptions are present in enormous numbers.

All these facts lead us to imagine the bodies to consist of central nuclei of asbestos spicules upon which colloidal aggregates of blood proteins, plus, possibly, soluble fractions of asbestos, and in the case of chrysotile workers an iron salt, have been absorbed and moulded by currents in the bronchi and alveoli.

Occasionally biotite fragments into fine black spicules, and if our reasoning be correct, some at least of the millions of curious bodies should show a central core of this mineral.

.....

British Medical Journal - Sept. 28, 1929

Haddow, A.C. - M.B.; Ch.B.

Clinical Aspects of Pulmonary Asbestosis

A clinical and scientific study of specific cases of this disease.

Examination of some fifteen asbestos workers.

Significant extracts taken.

Of these four fatal cases, the average at death was 41, and the average years actually spent in the factory were under 20, all in asbestos-mattress making for most of the time. The male patient had worked until two days before death (on a light job) but the other three had been incapacitated for an average of two and one-half years (3yrs., 5 mos.; 2 yrs., 5 mos.; 1 yr., 10 mos.). Only in one of them had tubercle bacilli been found in the sputum.

Advanced Cases

In practice, those workers do not call for much attention until they reach the stage of total incapacity. Until then they are naturally more prone to chest troubles during the winter months and sometimes unfit for weeks at a time.

Clinically

Four women
Average - 35 years of age
" 14 years spent in factory
" 3 children apiece (Children all healthy)
Suffer from shortness of breath
Have cough without expectoration
Lean, although not losing in weight
Pain is variable, and occurs from time to time with localized pleurisy
Nightsweats absent
Has been no haemoptysis
No tubercle bacilli have been found
Heart normal - Pulse rate 90 at rest
Average full range of chest expansion is only one inch in the upper thorax and even less around lower ribs.

Onset of symptoms

It is very difficult to ascertain the date of onset of symptoms, but the patients generally believe it was after five years of work.

Conclusions

The following conclusions have been established.

1. That the inhalation of asbestos dust will in the long run produce a state of fibrosis, the distribution being peripheral and basal, the right base becoming more advanced and the upper lobes tending to develop compensatory emphysema at first the diaphragmatic and gradually the entire pleural surfaces becoming obliterated.

2. That the disease is not as a rule complicated by tuberculosis.

3. That the disease is usually first recognized after more than five years exposure, although systematic examination might reveal it earlier.

4. That the condition is usually found first during an attack of influenza or winter cold, when exacerbations of the disease occur.

5. That even in advanced cases there is a marked abatement during the summer months.

6. That the onset of anorexia signalizes to the worker that work is no longer possible.

7. That the patient may then live for several years and continue to bear children, but become progressively weaker and more emaciated, more hopeless, sleepless, and exhausted, until an attack of broncho-pneumonia or bronchitis brings death at last.

8. Further, that asbestosis bodies can be found in the sputum, if any, in all advanced cases, as well as in most early cases.

9. That they can be demonstrated on lung puncture in advanced cases, but since no patient is likely to permit more than one puncture to be made, a negative finding is inconclusive.

10. That radiography is of great value in diagnosis and in observing progress.

11. That the treatment of these cases, being purely palliative so far, calls for great patience and vigilance over several years, and much relief can be afforded.

12. Finally, that the disclosure of the danger arising from asbestos dust has brought home to the workers the need for observing the measures provided for their protection, and is bound to be salutary, although the mortality statistics will probably be swelled by the wider recognition of this disease.

.....

British Medical Journal - Dec. 3, 1927.
(P. 1024)

Cooke, W.E. - "Pulmonary Asbestosis"
McDonald, Stuart - "Histology of Pulmonary Asbestosis"

Oliver, Sir Thomas -
"Clinical Aspects of Pulmonary
Asbestosis"

The above articles are scientific treatments of this same disease. The material covered is practically the same. In fact, much of the material of the later articles from which the abstracts are based appear to be based on the same experiments. The illustrations of the microscopic photographs are enlightening.

MT-001699

posterior lobe, the reaction was negative. Furthermore, the injection of 0.2 c.c. of the hormone of the anterior lobe of the pituitary body, when injected into the skin of a pregnant woman, produces no reaction, whereas, when injected in the same way in the non-pregnant woman a distinct red circle is produced in a few hours, which persists from twenty-four to thirty-six hours.

The accumulated evidence, therefore, goes to show that the hormone responsible for the Zondek-Ascheim reaction is derived from the anterior lobe of the pituitary body; that the reaction is positive quite early in pregnancy, at a time when such positive evidence is most needed; and that the reliability of the test is very high.

It is regrettable that from its nature the test cannot be made generally available. It requires the assistance of a laboratory where a large stock of young female mice is constantly at hand, and where there are trained observers. The test, as a consequence, is expensive. It may prove, however, that the skin test referred to may overcome the difficulty. Recently, Drs. Otto Pollatschek and R. Porges, of Vienna, have made some valuable observations on this phase of the subject, and report that in their hands the skin test has proved to be reliable, except in one patient who had a hypophyseal tumour. Should these observations be confirmed we shall have at last a simple and reliable method of determining the existence of early pregnancy.

A.G.N.

ASBESTOSIS

ASBESTOS is a mineral of interest to Canadian physicians, particularly to physicians practising in the Province of Quebec, for a very considerable part of the world's supply of asbestos is mined in the Black Lake District between Quebec City and Sherbrooke. If work with asbestos presented a hazard to the worker it would be reasonable to suppose that cases of disease would be reported from time to time, but so far as can be determined no cases of specific disease have been reported among asbestos workers in the Province of Quebec. This does not mean, however, that a hazard does not exist; it merely means that no hazard has been recognized.

Mortality and morbidity records of asbestos workers are not available. In fact, information as to the effect of such work on the worker is extremely limited. The death of an asbestos worker which occurred in 1900 was reported by Dr. Murray in England to the Department on Industrial Diseases, and the evidence suggested that the death was due to an occupational disease. This case was not reported in the medical literature. No further reports appeared until 1924, when Dr. W. E. Cooke, of the Wigan Infirmary, published the history of a case of pulmonary asbestosis. Since then a number of isolated cases have been reported, mostly in the manufacture of asbestos, and mostly in England, but four cases in Southern Rhodesia were reported by R. W. Simson in 1928. The latest publication on the subject is by W. E. Cooke, in the *British Medical Journal* for September 28th, 1929. This article is in the nature of a review.

Asbestos occurs in nature as a fibrous form of serpentine. Its analysis varies somewhat in different parts of the world, but it is essentially a magnesium silicate. There may or may not be iron present, and some forms contain aluminum. The Canadian asbestos is said to contain about 41 per cent of silica and 2.5 per cent of iron oxide.

Clinically, asbestos affects two tissues. First, it may produce small warty growths in the skin,—the so-called "asbestos corns." Secondly, it may give rise to a fibrosis of the lungs, somewhat similar to that produced by silica. Investigation of the "asbestos corns" indicates that they are granulomatous in nature and have for their core a tiny spicule of asbestos fibre. Evidently asbestos is mildly irritating to the body tissues. The manner of the formation of the pulmonary lesion is of great interest to students of pneumoconiosis, for there is a widespread impression that silica is necessary to the formation of pulmonary fibrosis. Nor can it be said at present that this view is definitely disproved by the occurrence of pulmonary asbestosis, since asbestos in itself

is a silicate. To our knowledge no analyses of pulmonary tissue for silica have been made in cases of asbestosis.

It might be thought that the lesion in this condition was essentially the same as that of ordinary silicosis, if it were not for the fact that certain very characteristic bodies are reported unlike those seen in any other pathological picture. We refer to the so-called "curious bodies." Microscopic sections of lungs of asbestos workers show large elongated bodies varying in length from 10 to 100 microns. They may have single clubbed ends or may appear as elongated dumb-bells, and sometimes single coccal or streptococcal forms are seen. These bodies do not stain with the ordinary aniline dyes, but are themselves pale yellow or yellowish brown. The "curious bodies" may be isolated from lung tissue by digesting portions of the lung with trypsin. They may then be teased out, and in this way some idea of their structure may be obtained. Apparently they are composed of a central core, which is probably an asbestos spicule, upon which colloidal aggregates of blood proteins have been adsorbed. These "curious bodies" have been reported in different places in England and South Africa; in fact every published report of pulmonary asbestosis has described them. It is the opinion of Dr. Cooke that the 'curious bodies" are diagnostic of pulmonary asbestosis.

Since the reported cases of this disease have occurred largely among weavers and spinners it is possible that the mining and crushing of asbestos does not present a hazard. The failure to recognize the disease in Canada, however, is no evidence of this, for in other occupations experience has shown that large groups of men may suffer serious occupational effects, which go unrecognized for years. FRANK G. PEDLEY.

Editorial Comments

LE MAL DES CRÈCHES

The problem of the crèche or foundling hospital is how to lessen the relatively high rate of mortality that so often exists among the children cared for in these institutions. The death rate, formerly nothing less than appalling, has been of late much improved through a fuller appreciation of the value of pasteurization of milk and of the decisive part played by vitamins, but it is still too high. The outstanding features of the affection that carries off so many infants, as is well known, are athrepsia and diarrhœa. This affection can hardly be termed a disease, as it is not a single entity and the causes are multiple. Yet many names have been applied to it—le mal des crèches, summer diarrhœa, infantile cholera, milk injury (Czerny), disturbance of equilibrium (Finkelstein), and some others. Actually, what is called by these various names is a symptomatic condition with a varied etiology.

Drs. Longpré and Panneton, in a helpful article that appears in the present issue of the *Journal*, have done good service in emphasizing one important cause at least, namely, infection in the nose, throat, and ear, an infection, moreover, which may be diphtherial and, as such, unsuspected. These authors point out that the problem involved, in many cases at least, is one of infection rather than alimentation. Careful examination, of the nose, throat, and ears, both clinical and bacteriological, should be carried out in all infants that are not thriving, for lesions of these organs may be overlooked or, on account of their relative benignity, may be passed over as of little account.

Drs. Longpré and Panneton give some striking figures as a result of their investigations in a crèche with which they are connected, though they do not claim that their findings are necessarily applicable to other similar institutions. In sixty autopsies conducted on children dying with the "mal des crèches" only two infants were found to have intestinal lesions. The outstanding conditions found were otitis and mastoiditis, which were present in fifty cases. Without eliminating completely frank gastro-enteritis, their experience leads them to think that the signs manifested in the digestive tract in cases of athrepsia are not primary but secondary to a septicæmia, usually due to infection in the ear. Furthermore, the authors have examined, in 151 cases, the secretions from the nose and throat in patients manifesting no local symptoms, and the pus in cases of otitis, and were surprised to obtain *b. diphtheriæ* in 85, or 56.3 per cent. Of course, the discovery of *b. diphtheriæ* in noses and throats that do not manifest the typical signs of diphtheria, or, indeed, any signs at all, is not new, but Drs. Longpré and Panneton have performed a useful service in pointing out an important cause of trouble in hospitals for children, where the diets prescribed are proper, and the care is otherwise beyond reproach.

A.G.N.

PULMONARY ASBESTOSIS.

Radiographic Appearances in Skiagrams of the Chests of Workers in Asbestos.

By W. Burton Wood, M.A., M.D., D.P.H.(Cantab.), M.R.C.P.(Lond.)

Physician to Out-patients, City of London Hospital for Diseases of the Heart and Lungs, Victoria Park, E., Consulting Tuberculosis Officer to the Essex County Council.

> ". . . . my first task shall be to consider such Diseases as arise from the offensive Quality of the matter which tradesmen handle in the Way of their Business. Under this Head I reckon the Diseases which affect Mine-diggers and all Workmen who work upon Minerals."—Ramazzini of Padua. (1746.)

Last year Dr. Leonard Williams, Medical Officer of Health and Tuberculosis Officer of Barking, asked me to see several patients who had been attending a local dispensary. He had noted that though they were suffering from pulmonary fibrosis the condition differed in some respects from that usually associated with chronic phthisis. There was in each case a history of exposure to asbestos dust. In only two instances had tubercle bacilli been demonstrated in the sputum and neither signs nor symptoms were typical of tuberculosis in the fibroid form. Despite the absence of the final proof that only post-mortem examination can supply, a diagnosis of pulmonary asbestosis seemed to be justified in most of the cases. While the present investigation was proceeding two asbestos workers were admitted to the Victoria Park Chest Hospital, while the out-patient department of the same institution supplied four more cases. Fifteen skiagrams of the chests of asbestos workers were thus obtained. It is indeed strange that so little attention has been paid to the ill-effects of silicosis among workers in asbestos, a substance well known in commerce since the days of Hippocrates. I have failed to find any mention of asbestosis in standard works on pulmonary diseases and few references to the condition are to be found in recent medical literature.

Asbestos (ἄσβεστος = unquenchable) has been described by W. E. Cooke [1] as "a physical paradox—a mineralogical vegetable, both fibrous and crystalline, elastic and brittle." It is one of the silicates, but as will be seen later, other minerals enter into its composition. It occurs in veins associated with quartz and similar rocks and is widely distributed. The best known varieties are found in Canada, Italy, Corsica and South Africa, but it is also found in the older rock formations of North Wales and Ireland. The Asbestos Mountains in what was formerly Cape Colony contain a fibrous mineral of rich blue colour and beautiful texture resembling strands of finely spun glass. The veins of asbestos run through slaty rocks mingled with jaspers and quartzites rich in magnetite and brown iron ore [2]. The variety imported from Canada is known as white asbestos and has a silky texture. The fibres are obtained by blasting in open quarries, the fragments of rock being then crushed, screened and pulverised [3]. The crushed product is passed over a vibrating machine and the asbestos is withdrawn by vacuum fans into special chambers. To save the expense of carriage these preliminary stages are usually carried

Tubercle 10: 353-363, May 1929

out before importation. Carding and spinning of asbestos form an important industry in this country. In these processes silica-laden dust is generated in large quantities.

The heat-resisting properties of asbestos, its low thermal conductivity and partial resistance to the action of acids account for its extensive use in modern engineering processes. It is much used for jacketing boilers and steam pipes and in the packing of joints. Fire-proof sheeting and curtains, feltings for roofs and floors, even firemen's clothes have been manufactured, and its employment in industry is likely to expand with further developments of the machine age.

Dr. W. E. Cooke states that the composition of Italian and Canadian asbestos fibres is as follows:—

	Italian fibre	Canadian chrysolite
Silica	40·30 ..	40·87
Magnesia	43·37 ..	41·50
Ferrous oxide	0·67 ..	2·81
Alumina	2·27 ..	0·90
Water..	13·72 ..	13·55

The high percentage of silica will be noted. In the process of manufacture, iron is as far as possible eliminated, but Mr. T. H. Byrom's analysis of asbestos dust from carding rooms shows that this may be heavily impregnated with it:—

Finished article: Iron (as ferrous oxide) ..	0·1 per cent.
Crude raw material..	2·81 ,,
Dust from carding room	18·4 ,,

The effects of inhaled silica dust upon the lungs are well known. A concise account of these is given by R. R. Sayers in the *American Journal of Public Health* [4]. Shorter references to the subject will also be found in the well-known textbooks of Norris and Landis [5], and Powell and Hartley [6]. It is doubtful whether the action of silica is purely mechanical, as precipitated silica has been found to produce a similar effect to that of the crystalline forms.

Three deaths occurred among patients of the present series within the last few months. One autopsy was obtained. This provided material for pathological examinations by Dr. S. Reodhouse Gloyne. The results of this and of an investigation of the sputum of asbestos workers will form the subject of a further communication.

Pathology of Pulmonary Asbestosis.

The macro- and microscopical appearances of the lungs of an asbestos worker have been described by W. E. Cooke and Stuart McDonald [7] [8]. The lungs, and particularly the right lung, were the seat of a massive fibrosis with thickened pleura. A large cavity was present on the right side and numerous small areas of caseation, though tubercle bacilli were not demonstrated. The interstitial fibrosis was such as might be expected as a result of a combination of a pneumoconiotic condition and a chronic tuberculous infection.

An account of the histological appearances is given in Dr. McDonald's paper which is illustrated by a series of excellent photo-micrographs. Particular attention is directed to the appearance of certain foreign bodies lying free in the alveoli or within the large mononuclear cells. Of a yellowish-brown colour with narrow segmented bodies and clubbed

extremities, their resemblance to minute crustacean forms was striking. Dr. McDonald thought they were probably "portions of asbestos fibres in the process of alteration and absorption by hydrolysis either by direct chemical action or by enzymes." On treatment with potassium ferrocyanide and hydrochloric acid the prussian-blue reaction was obtained. In specimens from the lungs of the same patient Dr. Cooke also found particles apparently identical with heavy brittle iron-containing fragments of fibre previously found by him in asbestos dust. He states that the curious bodies referred to above are not found in asbestos itself. Dr. M. J. Stewart [9], however, found enormous numbers of similar golden yellow bodies in the expressed juice from the lungs of a patient who had worked in asbestos. Their presence in catarrhal alveoli and in fibrotic patches in sections from the same lungs was also demonstrated. Dr. Gloyne's sections from the lungs of a patient in the present series (Case 7) showed numerous similar bodies. Careful search failed to reveal any similar forms either in samples of raw asbestos or in the sputum of workers.

Symptoms of Pulmonary Asbestosis.

The cardinal symptom of pulmonary asbestosis, like that of other forms of silicosis, is dyspnœa. The dyspnœa is progressive and in advanced stages of the disease may become extreme. Chest expansion may be reduced to one inch or even less, as in Cases V and VI and also in the case described by H. E. Seiler [10]. The vital capacity of a patient in the present series (Case I) was approximately 1,600 c.c. The dyspnœa may be accompanied by cyanosis and the complexion of most patients has a slightly leaden hue. Wasting is a notable feature and may proceed to emaciation. As patients suffering from fibroid phthisis are often well nourished, the degree of wasting in pneumoconiosis is a point of some diagnostic value.

Cough is a variable symptom, but is seldom excessive and may be slight. Expectoration is usually moderate and may be altogether absent over long periods. Particles of asbestos are apt to penetrate the superficial layers of the skin of the arms and legs of workers. The irritation of these causes keratinisation and "asbestos corns" are produced around a central core of fibre.

Physical Signs.

If pulmonary tuberculosis supervenes the signs and symptoms of this condition will obviously modify the clinical picture. In the absence of such a complication the physical signs are those of a bilateral pulmonary fibrosis chiefly affecting the lung bases. The adventitious sounds have a dry crackling quality and in the axillary regions are often superficial. The latter probably have a pleural origin. A friction rub may be heard over the same area. As the disease affects both lungs, cardiac displacement, if present, is usually slight. Early clubbing of the fingers may occur but is seldom well marked, and when seen is usually represented by slight swelling of the skin surrounding the proximal ends of the nails.

Differential Diagnosis.

Features which serve to distinguish asbestosis from pulmonary tuberculosis, though a combination of the two conditions may be often suspected and sometimes proved, are the leaden or dusky complexion, extreme

dyspnœa, wasting or emaciation out of all proportion to physical signs and the dry quality of the adventitious sounds. These, with an absence of tubercle bacilli from the sputum and a history of prolonged exposure to asbestos dust, indicate the probable diagnosis. In one instance (Case VI) the result of sputum examination suggests that tuberculosis may have supervened some time after the onset of a non-tuberculous fibrosis.

Prognosis.

When the disease is established the prognosis appears to be grave. As noted above, three of the patients of the present series died during the present winter. Autopsy proved that broncho-pneumonia was the terminal event in one case, "bronchitis" was given as the cause of death in another, while in the third it is probable that broncho-pneumonia was the proximate cause.

Duration of Exposure to Asbestos Dust.

In the gold mines of South Africa the average time of exposure to silica dust before the development of pulmonary disease can be recognised is given by R. R. Sayers as seven and a half years [4]. A shorter period, even one of a few months, has resulted in pneumoconiosis where conditions are unfavourable. In the present series of cases the shortest period of working was one year (Case IX) and the longest fourteen years (Case II). One patient (Case XII) was exposed to dust for a period of eight years before the onset of the cough. Another (Case VII) remained in fair health for five years after commencing work, although frequent colds and a tendency to winter cough were apparent. It is significant that a patient may only complain of symptoms of pulmonary distress some time after ceasing work (Cases I and X). A reference to the radiograms will show that in general the density and extent of the lung shadows is proportional to the duration of the exposure to the dust.

Radiological Appearances.

Deductions from a small series of films must obviously be made with caution. Most of the cases described below have only been under my observation for short periods, and though the presence of complicating tuberculosis has been noted in all cases in which the tubercle bacillus was demonstrated, negative sputum or absence of sputum on one or two occasions obviously does not rule out infection of this type. All that is possible at this stage is to draw attention to what appear to me to be the salient features of the films. It is further obvious that reduction in size, absence of illumination and difficulties of reproduction must prevent a convincing demonstration of some details which are present in the original films, as seen in the viewing box.

The most noticeable feature of skiagrams of workers exposed longest to asbestos dust is the presence of shadows suggesting a diffuse fibrosis affecting chiefly the lower two-thirds of the lungs. The fine quality of the shadows is worthy of note. Some of the cases exhibit a "ground glass" appearance, though on close inspection fine mottling is evident. The bronchial striations towards the lung bases are prominent and seem to spread out to form a fine network, giving an appearance like that of a cobweb. As the striations radiate outwards from the lung roots they cut the

edge of the cardiac shadow, especially on the left side, giving a shaggy appearance as if the heart were encased in coarse felt. When more definite mottling is present it lacks the coarse quality described in the skiagrams of chests showing pneumoconiosis, e.g., in South African coal miners. I have been able to include a typical skiagram of the latter condition kindly lent to me by Dr. F. G. Chandler. Reference may also be made to articles by Sir Thomas Oliver [11] and W. Steuart [12].

Another feature is evidence of basal pleurisy, and the frequency with which the costo-phrenic angle on one or both sides is obliterated will be noted. Many of the cases also exhibit thickening of the apical pleural cap. Annular shadows suggesting possibility of cavitation are only seen in three cases (William H., Barbara L., Violet S.) and in only one of these (Violet S.) tubercle bacilli had been found in sputum. The region of the lungs most apt to show marked changes in pulmonary tuberculosis of the fibroid type is usually spared.

I am indebted to Drs. V. S. Hodson and A. J. Scott Pinchin, for allowing me to see cases under their charge; to Dr. F. G. Chandler for the loan of a skiagram of miner's phthisis; to Dr. J. V. Sparks, under whose supervision the skiagrams were taken; to Dr. Roodhouse Gloyne for helpful suggestions; and particularly to Dr. Leonard Williams, Medical Officer of Health for Barking, without whose cordial co-operation the present series of cases could not have been brought together.

CASE NOTES AND SKIAGRAM REPORTS.

CASE I.

Frederick S., aged 59.—Admitted to Victoria Park Chest Hospital, January 1929, complaining of severe shortness of breath on slight exertion.

Family History.—Two brothers died of phthisis. One brother, a stone mason, died of malignant disease of the chest.

History.—Seven years ago the patient started a factory for grinding up crude asbestos into fibre. He wore a respirator at work, but dust used to cause severe coughing and expectoration. He abandoned work about the end of 1927 for business reasons. After giving up work he remained free from cough till August, 1928, when it returned and "his breath failed him," even walking causing dyspnœa. In November, 1928, he coughed up "quite a pint" of dark blood mixed with phlegm. He had been losing weight since leaving the factory.

Physical Signs.—The patient is a fairly healthy-looking man. Finger nails are curved, but there is no definite clubbing. The face slightly cyanosed. The chest is emphysematous. There is impairment of percussion note at base of right lung and fine fibrotic crepitations are heard at both bases. No T.B. found in sputum.

SKIAGRAM.

The skiagram shows a "ground glass" appearance of both lungs, more noticeable on the right and most marked at the right base. There is some contraction of the right apex where the pleural cap appears to be thickened.

The original skiagram shows fine diffuse granular mottling of the right lung. The costophrenic angle is obliterated and there is a marginal shadow due to thickened pleura at the right base. The periphery of the cardiac shadow is blurred.

CASE II.

William H., aged 46.—Admitted to Victoria Park Chest Hospital, May 31, 1928, complaining of severe shortness of breath and cough.

History.—The patient had worked at an asbestos factory for fourteen years (up to time of admission). He remained under observation in hospital for a period of seven weeks. Expectoration very slight. There had been cough, worse during the winter, for the last three years. Morning cough had occasionally caused vomiting. He attended the

tuberculosis dispensary at the end of November, 1927, at which time he was suffering from bronchitis, the sputum being negative for T.B. He had suffered from "pleurisy" as a boy.

Family History.—Nothing abnormal.

Physical Signs.—The patient is emaciated. Face cyanosed. Fingers clubbed. Percussion note is poor generally. There is harsh breathing and prolonged expiration at the base of right lung. Fibrotic crepitations are heard all over the lungs and are especially marked at the bases.

SKIAGRAM.

There is thickening of the right apical pleural cap.

Above and behind right clavicle there is a circular area, probably caused by small cavity.

An annular shadow is seen over the anterior end of third rib on the right.

There is a "ground glass" haze over the middle third of each lung field. Fine granular mottling is disseminated over both lungs. Towards the right base there is an aggregation of these shadows leading to fairly dense opacity.

The trachea is slightly displaced towards the right.

The mediastinal shadow is wide.

The edge of cardiac shadow indistinct, and on left side has a "felted" appearance.

The costophrenic angles are obliterated.

CASE III.

Ellen L., aged 29.—First attended tuberculosis dispensary in September, 1925, complaining of cough accompanied by much frothy sputum and shortness of breath.

History.—Asbestos worker, 1919-1923. The patient remained on the books of the dispensary up till November, 1928. The case was diagnosed as pulmonary fibrosis involving both lungs. No definite evidence of T.B. was found, but in 1927 the patient was admitted to sanatorium where she remained for two months. Temperature normal during this period, and she was able to take short walks, but complained of dyspnœa.

Previous History.—Influenza, 1919. No history of pleurisy or pneumonia.

Physical Signs.—Extremely thin (weight 6 st., 3½ lb.) Slight cyanosis. No clubbing. There is some retraction at both lung apices. Percussion note is impaired at both apices and also at left axillary region where breath sounds are weak. Fibrotic crackling crepitations are heard in both inframammary regions and at both bases posteriorly. Sputum negative for T.B., 1924, 1925, 1928 (3).

SKIAGRAM.

There appears to be slight thickening of the apical pleural caps.

The upper portion of mediastinal shadow is somewhat widened.

Edge of cardiac shadow shows "felted" appearance, most marked along the left margin.

CASE IV.

Barbara L., aged 40.—First attended dispensary in September, 1926, complaining of cough with a little sputum and occasional shortness of breath. Diagnosis of pulmonary tuberculosis was made, but sputum was negative for T.B.

History.—The patient had originally been a worker on the land, at which time she developed a "tissicky" cough. She worked as a sweeper in an asbestos factory for about ten years, 1917-1927. Cough during this time was never severe but was worse when she was at work. During the last year at the factory she had pain at front of chest, cough and dyspnœa. Increase of these symptoms caused her to give up work. Slight cough without expectoration has persisted.

Previous History.—Nothing abnormal.

Physical Signs.—Patient poorly nourished (weight 6 st., 11 lb.) Not cyanosed. Fingers slightly clubbed. Chest is emphysematous. There is marked retraction of the right apex. Percussion note impaired over left upper lobe. There is also impairment of right base. Bronchial breathing, whispering pectoriloquy over a small area below right clavicle, suggesting cavity in this region.

SKIAGRAM.

This shows some slight scoliosis, with displacement of the trachea to the right.

Right apex is retracted and covered by thickened pleura.

Over the second intercostal space on right side there is an annular shadow, possibly due to a cavity. Internal and external to this is a slight haze.

At the right base there are some fine linear shadows and fine granular mottling.

The right costophrenic angle is obscure, and there appears to be some thickening of the pleura towards right base.

CASE V.

Mary P., aged 49.—Attended tuberculosis dispensary March, 1927, complaining of cough and shortness of breath of four years' duration.

Family History.—One brother said to have died of pulmonary tuberculosis.

History.—Patient worked in an asbestos factory, 1917-1926. About 1924 she began to have a cough. This was associated with expectoration in 1925 and has continued ever since.

Physical Signs.—The patient is extremely thin and in a very debilitated condition. Fingers slightly clubbed. Chest emphysematous. Some impairment of the percussion note at right apex. Fibrotic râles are heard all over both lungs. Expiration prolonged at right apex. Sputum T.B. negative four times, 1927-1928.

SKIAGRAM.

The cardiac shadow is enlarged transversely and the left auricular region is prominent.

The trachea is slightly displaced to the right.

There is some relative clouding of right apex. In the right mid and lower zones there are numerous rounded opacities of moderate density. Some of these have a diameter of 4 mm.

There are numerous small granular opacities. Some of these towards base of the lung are very dense and probably represent calcifications. Similar changes, but to a less degree, are found on left side. The haziness of the mid-zones is partly accounted for by breast shadows.

CASE VI.

Herbert Hilder H., age 42.—Complaining of spasmodic cough with expectoration.

Family History.—Nothing abnormal.

History.—Patient first attended tuberculosis dispensary in 1924. At that time sputum was negative. Sputum again negative in 1925. T.B. positive 1927. T.B. positive 1928. Patient worked in asbestos factory at intervals from December, 1918, to November, 1928. (Total period in factory about seven years.)

Physical Signs.—Patient is a moderately well-nourished man. Weight 9 st. 12¾ lbs. Face slightly cyanosed. Fingers clubbed. Chest expansion barely one inch. Percussion note impaired over both upper lobes, specially on right side. There is also marked impairment of percussion at the base of left axilla. Crepitations are heard all over right lung posteriorly. Breath sounds at base are harsh. Crepitations also heard in left axillary region.

SKIAGRAM.

Trachea markedly displaced towards right.

Cardiac shadow slightly enlarged. Right border merges with mediastinal shadows which are very dense. Left border of heart has a "felted" appearance.

The outer zone of each lung shows a fairly uniform "ground glass" opacity. In the original film this is seen to be partly due to numerous granular opacities.

Upper surface of diaphragm is obscure on both sides and right costophrenic angle is obliterated, appearances suggesting thickened pleura in this area. At the bases some clearer areas are seen which are probably bronchial. There is clouding of right apex.

CASE VII.

Nora C., age 34.—Patient first attended tuberculosis dispensary in July, 1928, complaining of dry cough of three years duration, and marked shortness of breath.

Family History.—Nothing abnormal.

History.—Patient began to work in asbestos factory at the age of 21. During the first five years she remained in fair health except for frequent colds and some winter cough. No respirators were worn at the factory, and as far as she knows, no precautions were taken against dust. After the first five years "her chest began to be stuffy" and she lost appetite for food. She remained at the factory for eight or nine years. The breathlessness was first noticed three years ago about one year after leaving the factory. At the same time she also began to lose weight. At the end of 1928 admitted to Victoria Park Chest Hospital where she remained till death, which occurred on March 1 of this year as the result of an attack of broncho-pneumonia of one week's duration. Whilst in

hospital cough very slight. There was no sputum and temperature normal. The fæces were examined for T.B. eight times with negative results.

Physical Signs.—Patient is emaciated. Face has slightly violet tinge. Fingers very slightly clubbed. Chest expansion barely one inch. There is marked retraction at right apex. Percussion note impaired at right apex and is poor all over left lung. Fibrotic crepitations are heard all over lungs, behind and in front at right base, also all over left front. Pleural friction sounds are heard below angle of left scapula, heard over upper third of chest on right side, front and back. Harsh breathing and prolonged expiration at right apex. Few crepitations also heard at left apex near angle of scapula and under left axilla.

SKIAGRAM.

The trachea is central.

The cardiac shadow is apparently somewhat displaced to the left.

There is marked thickening of right apical cap.

The lower half of right lung is hazy, and numerous small discrete opacities are seen. At the base numerous fine linear opacities radiate outwards from lower end of hilum.

Upper edge of diaphragmatic shadow is obscured, and costophrenic angle is obliterated. Lung generally hazy and in middle third numerous small granular opacities are seen.

Left edge of cardiac shadow obscure and merges into dense haze which occupies whole of lower third of lung.

There is abnormal projection from upper part of left hilum with convex, sharp outer margin.

CASE VIII.

Violet S., aged 20.—Admitted to sanatorium in January, 1929, complaining of cough.

Family History.—Nothing abnormal.

Previous History.—Pneumonia at the age of six months.

History.—Had had cough "off and on" since leaving school in 1922. This had become worse during the last six months. In May, 1928, haemoptysis of ½ pint, followed two or three days later by second attack (about 1 pint). Shortly after this had convalescent holiday at Bournemouth. No sputum was available for examination till December, 1928, when tubercle bacilli were found. Previous to this, fæces had been negative for T.B. three times. At the age of 16, went to work in an asbestos factory as spinner, remaining eight months. After a years interval, worked for a further year in asbestos factory.

Physical Signs.—Patient a fairly well-nourished girl and looks well. Temperature normal after admission to sanatorium. No clubbing, but finger nails slightly curved. Percussion note impaired over right upper lobe. Numerous crepitations.

SKIAGRAM.

Trachea central. Heart outline well defined.

Mottled fine granular opacities are seen over whole of right lung, producing general hazy appearance.

Below right clavicle band of interlobal thickening is seen.

Behind right clavicle annular shadow suggests possible cavity in this region.

Right costophrenic angle obscured.

CASE IX.

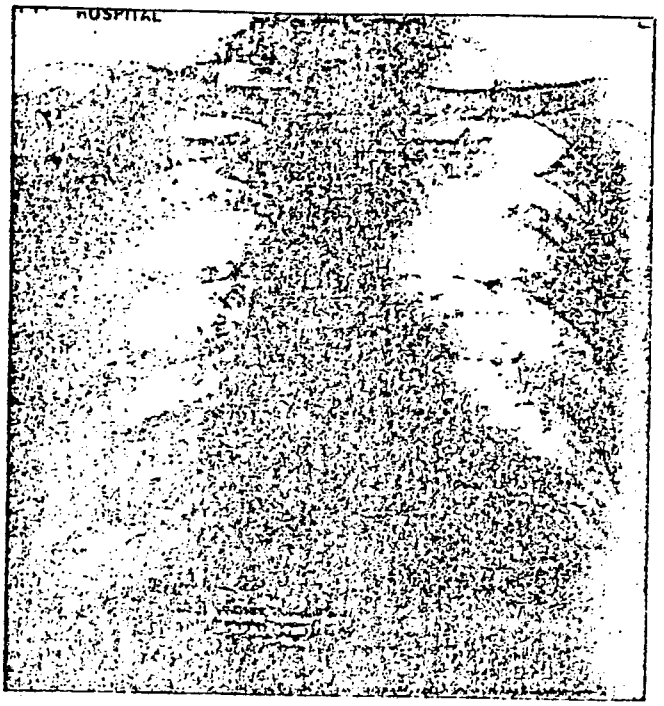
Chrissy M., aged 18.—Attended tuberculosis dispensary, June, 1928, complaining of cough and slight expectoration.

Family History.—Father suffered from phthisis.

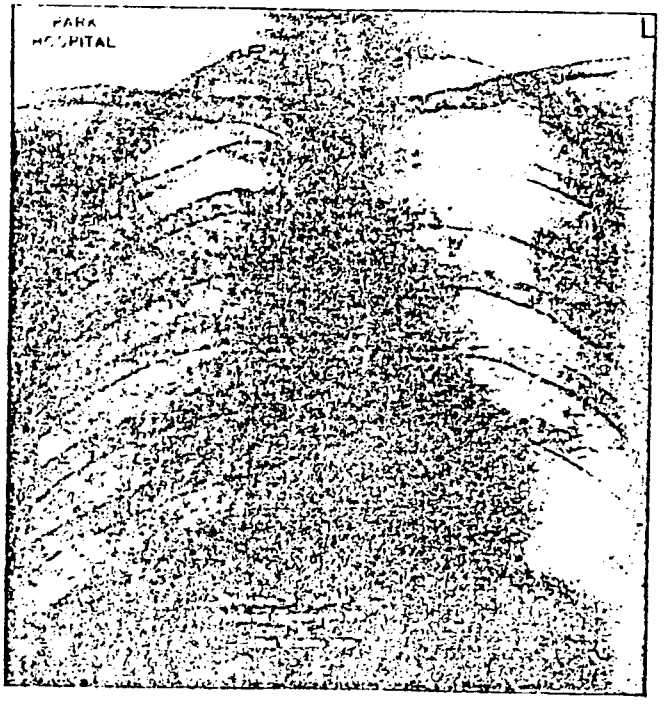
Previous History.—Had a delicate childhood. First attended Barking dispensary, aged 7½ years, and was sent to East Anglian Children's Sanatorium, where she remained for nine months on account of enlarged cervical glands. Discharged in apparently good health. She continued to attend dispensary on account of bronchial catarrh, cervical glands, &c. Later sent to open-air school. In 1925, domestic work at Westcliff. 1926, pneumonia. February, 1927, cough and expectoration, which was sometimes stained, but no abnormal signs found in lungs. October, 1927, commenced work in disintegration department of asbestos factory. About two months after starting work recurrence of cough with slight expectoration. Cough became progressively worse during the year, and she stopped work October, 1928.

Physical Signs.—(January 1929).—Some impairment of percussion note at right apex, where breath sounds are slightly blowing. No adventitious sounds heard.

PLATE I.



CASE I.

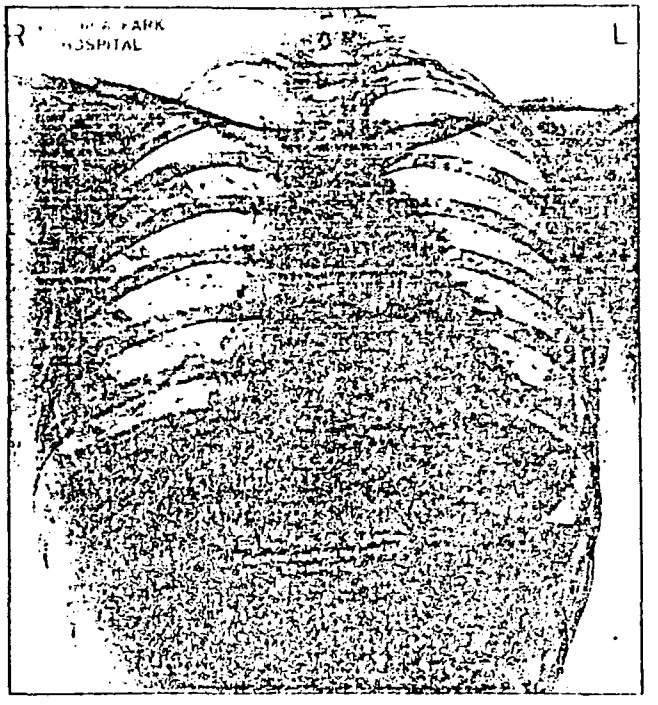


CASE II.

To illustrate article "Pulmonary Asbestosis," by W. BURTON WOOD, M.A., M.D., D.P.H.(Cantab.), M.R.C.P.(Lond.).

Face p. 330.

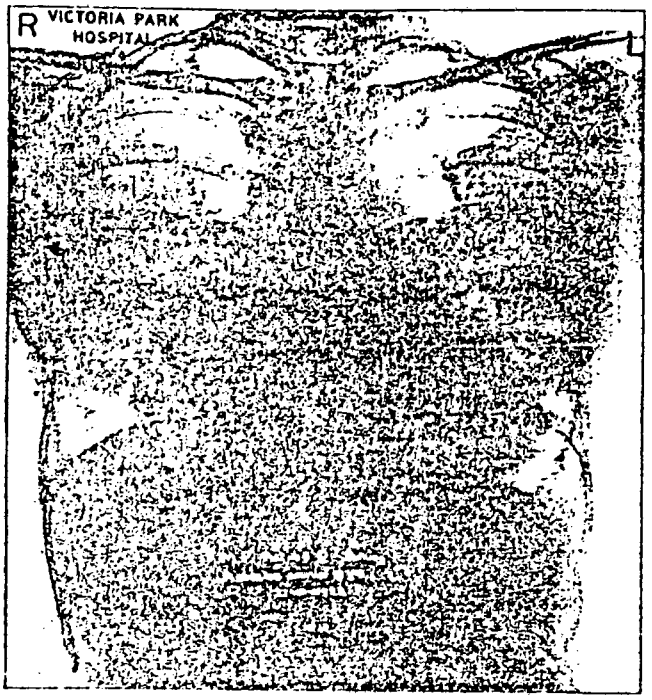
PLATE II.



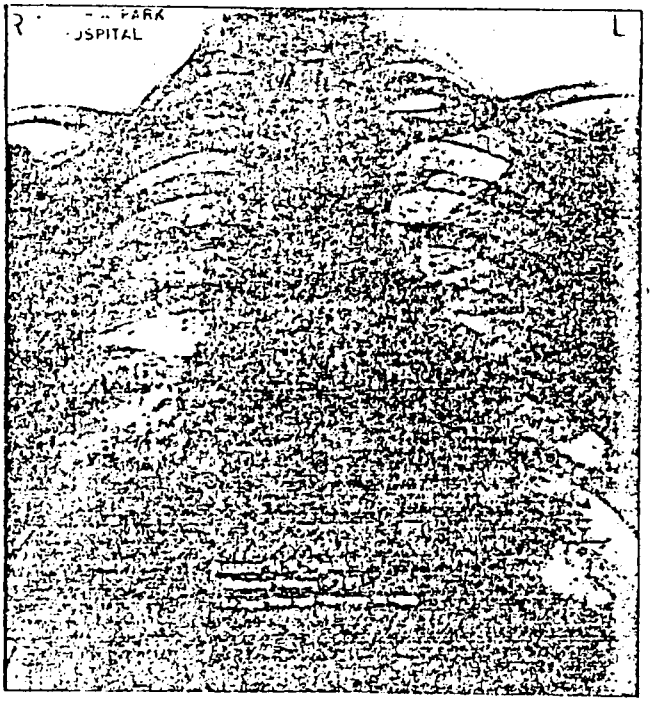
CASE III.

CASE IV.

PLATE III.

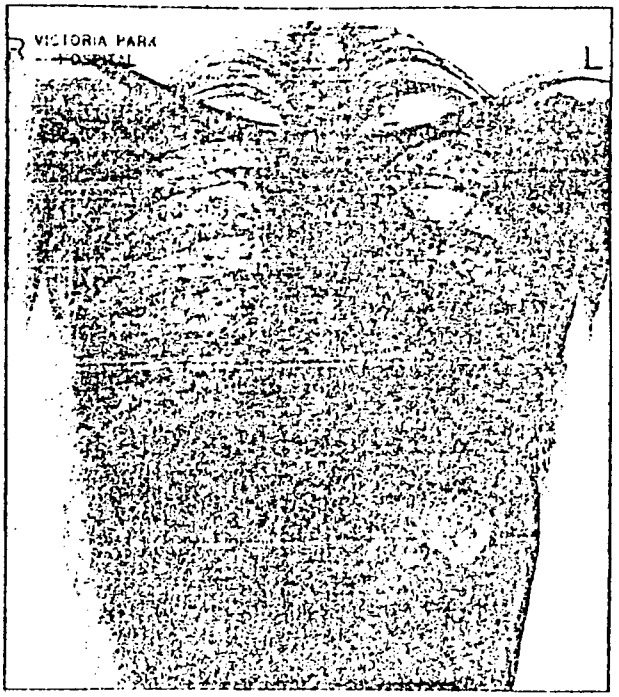


CASE V.

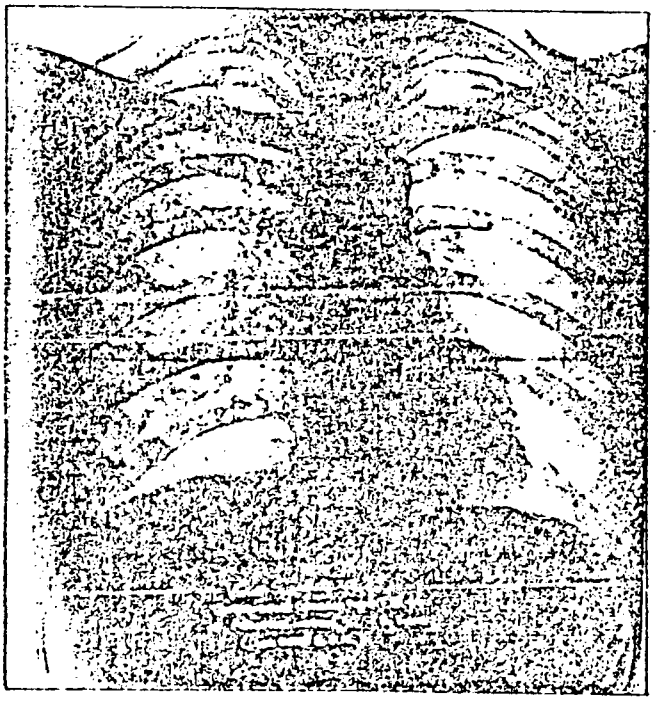


CASE VI.

PLATE IV.

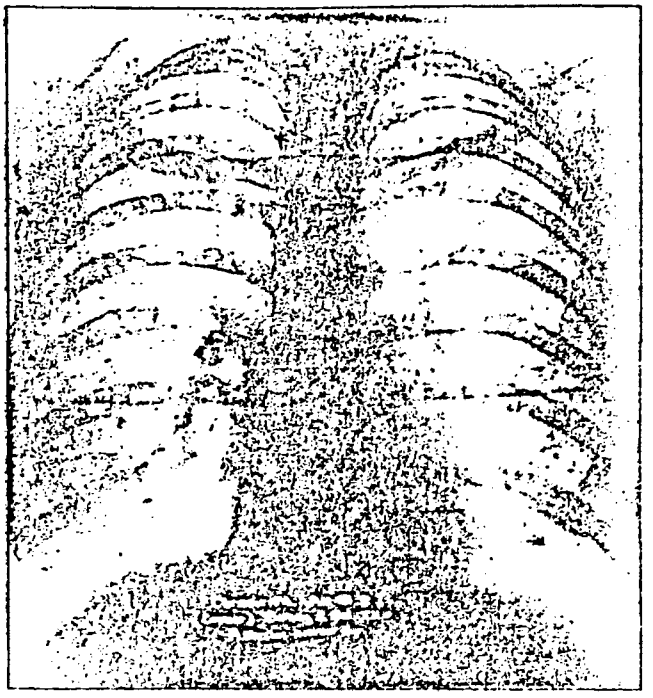


CASE VII.

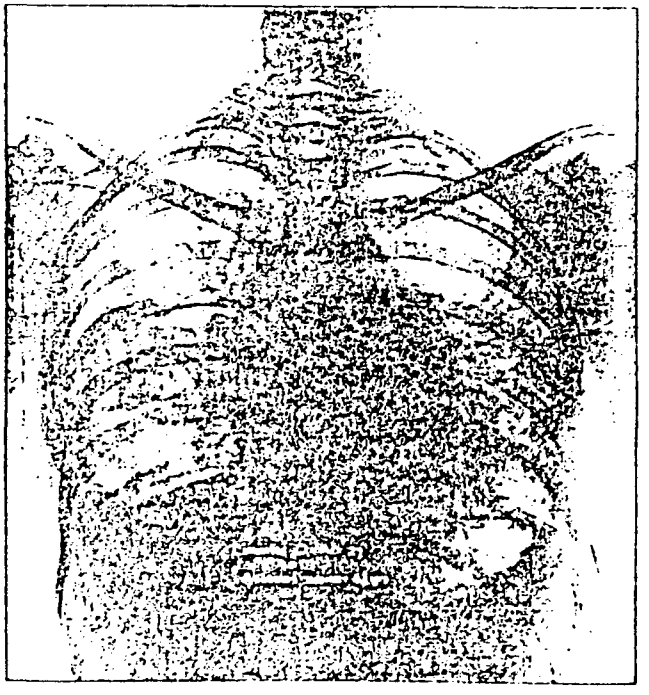


CASE VIII.

PLATE V.

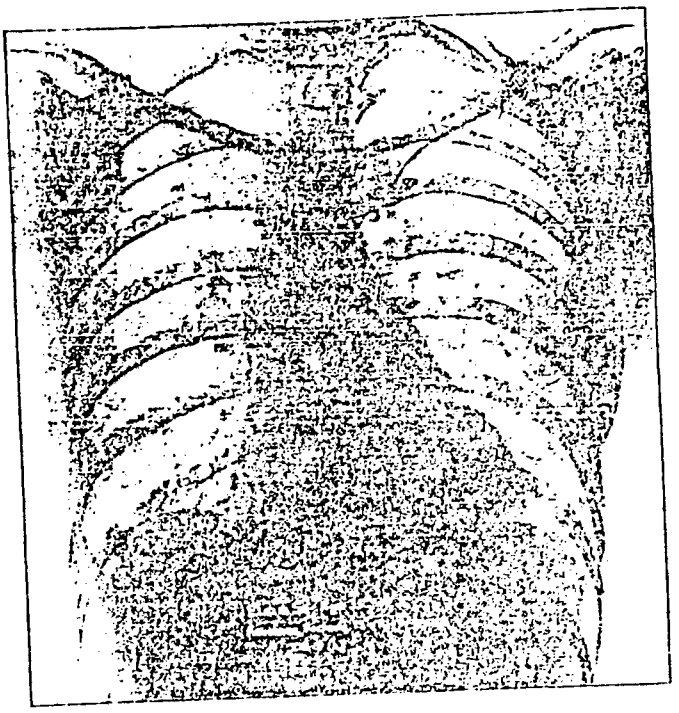


CASE IX.

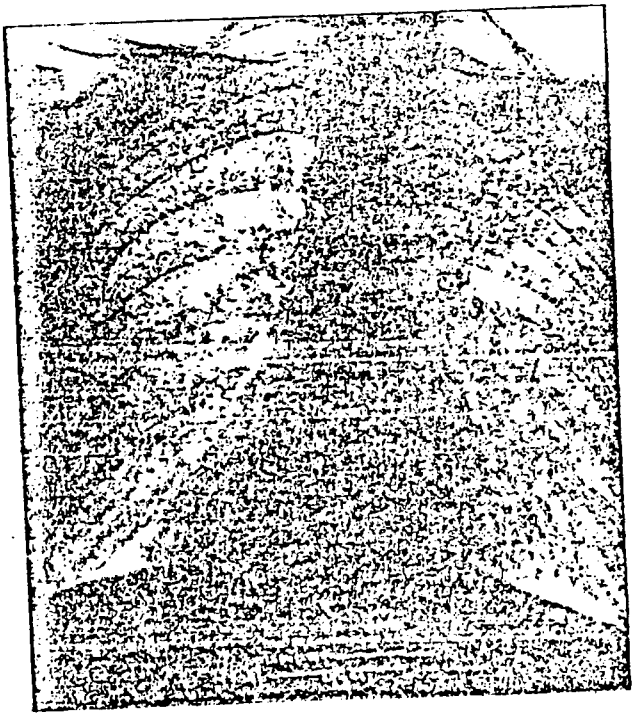


CASE X.

PLATE VI.



CASE XII.



CASE XVI.

SKIAGRAM.

Bronchial striations unusually thick and emphasised for a patient of 18 years.

Numerous calcified foci around right hilum and many small opacities in the lower half of right field, some of which appear to represent calcification.

About the middle of right hilum a small triangular shadow projects towards the right, and probably represents pleural adhesion.

CASE X.

Catherine O., aged 27.—First attended tuberculosis dispensary, December, 1928, complaining of shortness of breath and occasional cough and expectoration.

Family History.—Nothing abnormal.

History.—Patient had worked at an asbestos factory for six and a half years continuing till 1924. She was quite well all the time she was at the asbestos works. It was only during the last six months that she had had dyspnœa, slight cough and expectoration. She had, however, been losing weight for the last two years. Weight: 1927, 7 st.; 1929, 5 st. 12 lb.

Physical Signs.—January 10, 1929: Patient is extremely thin and dyspnœic. Not cyanosed. There is no clubbing. Retraction of chest below both clavicles and some flattening at the right base. Breath sounds over the right upper lobe in front are blowing, vocal resonance is increased. There is some impairment of percussion note at right base. Fibrotic crepitations with a dryish quality and squeaky sibili are heard in both lungs, especially towards the bases. T.B. negative five times, 1928-1929.

SKIAGRAM.

Thickening of pleura at both apices.

There is haziness of middle zone of right lung, with marked thickening of interlobar septum. There is fine discrete mottling and some very fine linear shadows at the base.

The hilar glands appear to be enlarged.

Lower half of left lung is cloudy. Fine linear shadows seen similar to these on the right side.

The left edge of cardiac shadow shows very marked "felting."

Upper surface of diaphragm obscure on right, invisible on left.

Right costophrenic angle obliterated.

CASE XI.

Rosetta N., aged 60.—Seen at dispensary on January 10, 1929, complaining of tightness across chest, severe cough without expectoration and marked shortness of breath.

History.—First attended dispensary 1914 for cough with expectoration. In 1916 diagnosis of emphysema with pulmonary fibrosis was made. There is no record of the finding of T.B. in the sputum, and patient has apparently remained in the same condition for many years. About 1912 commenced work as spinner at asbestos works. Cough commenced towards end of first year of working, after which she had recurrent coughs every two or three months. These increased in severity and her doctor advised her that her work was "not doing her any good."

Physical Signs.—Patient is poorly nourished. Chest emphysematous. No clubbing. Sharp post-tussic crackles are heard in both axillary regions and a few at the bases posteriorly.

SKIAGRAM.

Heart is slightly displaced towards the left and there appear to be some adhesions in the region of the cardiac apex.

The right lower lobe is apparently contracted. The interlobar septum occupies a lower position than usual.

The striations at the right base are denser than normal.

Towards lower end of right hilum there are some rounded opacities about 4 mm. in diameter.

CASE XII.

Elsie S., aged 35.—Attended Victoria Park Chest Hospital in November, 1928, complaining of cough, expectoration, shortness of breath, wasting, fever and debility.

Family History.—Sister died of phthisis when patient was 8 years old.

History.—Commenced work as spinner in asbestos factory, aged 20. Worked con-

tinuously for thirteen years. Cough commenced five years before ceasing work and gradually got worse. On entering factory, weight 10 st., now 7 st.

Physical Signs.—Patient extremely thin. Not cyanosed. Slight clubbing of fingers. Slight impairment of percussion note over upper half of right lung. Dry fibrotic cracklings are heard all over right lung. Harsh breath sounds and prolonged expiration below right clavicle. Sputum T.B., negative four times 1928.

SKIAGRAM.

Cervical rib on left. Trachea displaced towards right.

Below centre of right clavicle in first intercostal space there is a dense, rounded shadow about 4 mm. in diameter, apparently due to calcification. A few other smaller calcified areas in same region. There are dense calcifications at upper end of right hilum.

Right interlobar septum very thick. Immediately below inner end of septum is a large oval shadow about $1\frac{1}{2}$ in. by $\frac{5}{4}$ in.

Outside left hilum are a few small calcifications.

There is a rounded opacity above left clavicle and a few small dense spots.

Left edge of cardiac shadow clear-cut except at apex, where it is striated.

CASE XIII.

May H., aged 20.—Attended Victoria Park Chest Hospital, February, 1929, complaining of cough, pains in right side of chest and "terrible shortness of breath."

History.—August, 1925, commenced work as spinner at asbestos factory where she continued till the present time. Cough commenced February, 1928. There had been no spit. Pains in right side of chest. Dyspnœa of eight weeks' duration.

Physical Signs.—Impaired percussion note at right base, with dry friction rub also heard in right axillary region. Chest expansion, 1 in.

SKIAGRAM.

Bronchial striations slightly more obvious than usual. Otherwise no abnormality seen.

CASE XIV.

Alice M., aged 18.—Attended Victoria Park Chest Hospital February, 1929, complaining of cough and pains round lower part of chest.

Family History.—Nothing abnormal.

History.—Patient has been working at an asbestos factory for one and a half years. Has had no shortness of breath, and is not losing weight. There is no expectoration, but she complains of feeling of phlegm in the throat. Cough worse when she is at work. As far as she knows no precautions against dust taken in the factory.

Physical Signs.—No abnormality detected, but finger tips are slightly shining above nail-base suggesting earliest stage of clubbing. There are asbestos "corns" on the hands.

SKIAGRAM.

Nothing abnormal detected.

CASE XV.

Raymond G., aged 30.—Attended Victoria Park Chest Hospital February, 1929, complaining of shortness of breath, lassitude, cough and expectoration, sometimes streaked with blood.

Family History.—Brother died in 1923 from pulmonary tuberculosis.

History.—1920 worked at asbestos factory as store-keeper. His work necessitated constant visits to the spinning rooms. 1923 patient had attack of "pneumonia," said to be tuberculous, and kept in bed four months. Then attended tuberculosis dispensary. About this time he coughed up a teaspoonful of bright red blood on two or three occasions. Cough has persisted ever since. During the last two years there has been increasing lassitude, and he has been very short of breath since 1923.

Physical Signs.—Patient slightly cyanosed. Round shoulders. No clubbing. Slight impairment of percussion note over both apices. Creaking sounds, fine sibili and crepitations are heard all over both lungs.

SKIAGRAM.

There is indefinite mottling above both apices.

A few small calcifications in region of both hila.

Edge of cardiac shadow is distinct.

CASE XVI.

R.C. (male), aged 51.

Skiagram shows posterior view of lungs of patient who had worked for eleven years in the South African gold mines.

Sputum negative for T.B.

At the right apex, clear area apparently due to cavity.

All over remainder of both lung fields there are numerous discrete dense opacities. The edge of the cardiac shadow is distinct on the left, but at the right base it is partly obscured by interlacing linear striations which extend from hilum to upper surface of diaphragm.

REFERENCES.

[1] COOKE, W. E. "Pulmonary Asbestosis," *Brit. Med. Journ.*, 1927, 2, 1024.
[2] "Asbestosis," *Encyclopædia Britannica.*
[3] OLIVER, Sir THOMAS. "Pulmonary Asbestosis in its Clinical Aspects," *Journ. Indust. Hyg.*, 1927, 9, 383.
[4] SAYERS, R. R. "The Effects of Silica Dust upon the Lungs," *Amer. Journ. of Public Health*, 1927, 17, 208.
[5] NORRIS, G. W., and LANDIS, H. R. M. "Diseases of the Chest," Third Ed., p. 521.
[6] POWELL, Sir R. DOUGLAS, and HARTLEY, Sir PERCIVAL. "Diseases of the Lungs," Sixth Ed., p. 339.
[7] COOKE, W. E. "Fibrosis of the Lungs due to the Inhalation of Asbestos Dust," *Brit. Med. Journ.*, 1924, 2, 147.
[8] MCDONALD, STUART. "Histology of Pulmonary Asbestosis," *Brit. Med. Journ.*, 1927, 2, 1025.
[9] STEWART, M. J. "The Immediate Diagnosis of Pulmonary Asbestosis at Necropsy," *Brit. Med. Journ.*, 1928, 2, 569.
[10] SEILER, H. E. "A Case of Pneumonoconiosis. Result of Inhalation of Asbestos Dust," *Brit. Med. Journ.*, 1928, 2, 982.
[11] MCFARLAND, WM. "Silicosis and Tuberculosis seen in Granite Workers," *Journ. Industr. Hyg.*, 1927, 9, 315.
[12] STEUART, W. "Radiography in its Relation to Miners' Phthisis on the Witwaterstrand," *Arch. of Radio. and Elect. Ther.*, 1923, 27, 277.

A STUDY OF THE SEDIMENTATION RATES IN 252 CASES OF PULMONARY TUBERCULOSIS.

By R. R. TRAIL, M.D., M.R.C.P.

Medical Superintendent, King Edward VII Sanatorium, Midhurst.

IN a review of 100 T.B.+ cases under observation in the Sanatorium between October 1926 and July 1928 it was possible to show by a correlation of the Sedimentation Rates on admission and discharge with the end result of treatment the value of this test as an indication to prognosis and the response to treatment[1]. A study of 200 T.B.+ cases and 52 T.B.− cases discharged to date seems worth recording, as it strengthens the basis of conclusions then reached and is suggestive of others then hinted at.

The technique employed is that described in the former paper :—

> To two volumes of a sterile solution of 3·8 per cent. sodium citrate eight volumes of blood are added. The unit of volume is one drop of blood from a broad-ended glass pipette; the blood is drawn from an ear or finger and mixed in a watch-glass. A column of the diluted blood, 4 in. (=100 mm.) long, is drawn by capillary

The result was more remarkable when an attempt was made to classify the cases into "exudative" and "fibroid" groups, according to the *x*-ray picture.

	Exudative.		Fibroid.	
	Alive.	Dead.	Alive.	Dead.
No cavity	14	3	7	—
Cavity *x*-ray evidence only	18	5	11	1
Cavity clinically	7	7	10	—
Totals	39	15	28	1

There has thus been a heavy mortality in the exudative group, although many of them did well while under treatment. But I believe that the results in exudative cases could be improved on, if treatment were prolonged over a period of several months. Frequent *x*-ray examinations are necessary in such cases, and the patient should be kept at rest as long as any exudative foci can be seen on the *x*-ray film.

Possibly it may prove to be best to give several courses at short intervals. In any case, if active disease is present after sanocrysin treatment, artificial pneumothorax or phrenic avulsion should be considered, even if the temperature and pulse rate are normal. I think also that some exudative cases with cavitation should have a period of rest and tonic treatment before trying sanocrysin, which might be employed when the limit of improvement has been reached.

In the fibroid group, however, the results have been more satisfactory, as there has been only one death among 29 patients. It might be suspected that these patients would have done equally well without sanocrysin, but most of them had the treatment because they had failed to respond to routine measures. Of this group, 55 per cent. were discharged without tubercle bacilli in the sputum, as compared with 43 per cent. in the exudative group. Excluding 10 "cavity" cases, 72 per cent. of the fibroid cases were without tubercle bacilli on discharge.

Tuberculosis of the larynx was present in 8 cases of my series, and I do not think it contraindicates sanocrysin treatment, as the laryngeal condition usually improved, and 6 of the 8 cases are alive.

Cachexia, intestinal tuberculosis, and disease of the kidneys are contraindications.

It is often advantageous to combine sanocrysin and collapse therapy, especially in cases where there is widespread disease of one lung, with some active trouble in the better lung. If the case is acute, and the lung tissue is breaking down rapidly on one side, it will probably be necessary to collapse the worse lung immediately and try sanocrysin afterwards.

In another kind of case, when the patient has passed through the acute stage and shows some resistance, I have found it more satisfactory to give a long course of small doses of sanocrysin first, and to try artificial pneumothorax later.

When the disease is almost entirely unilateral, and collapse therapy is clearly indicated, I think sanocrysin should not be employed; later, if fresh foci of disease develop in the functioning lung, it may be of service. In my series 19 patients had artificial pneumothorax treatment, and satisfactory collapse was attained in 7, all of whom are alive at the time of writing. The collapse was only partial in 11 patients, and 5 of these are alive.

There are two types of pulmonary tubercle in which I think sanocrysin may be of value. One is the early exudative case in which the disease in the lungs is severe or widely spread, but in which there is some evidence of resistance. The other is the predominantly fibroid type of disease, when symptoms and tubercle in the sputum persist after several months of sanatorium treatment. In the exudative case I think it is important to begin sanocrysin treatment as soon as possible. In the fibroid case sanocrysin should be withheld until sanatorium treatment has had a trial.

When there is disease of long duration, combined with an exudative *x*-ray picture, sanocrysin treatment is not free from danger, but in such cases it may be possible to combine it successfully with artificial pneumothorax.

In judging the results, it should be remembered that the type of pulmonary tuberculosis seen in hospital patients in Ireland is commonly severe.

I have been encouraged to persevere with sanocrysin treatment by the opinions expressed by my colleagues in Belfast and elsewhere. Certainly it is not a cure for tuberculosis of the lungs, but it is a valuable aid to treatment, if used with caution and discrimination.

ASBESTOS DUST AND THE CURIOUS BODIES FOUND IN PULMONARY ASBESTOSIS.*

BY

W. E. COOKE, M.D., F.R.C.P.Ed., M.R.C.P.Lond., D.P.H.

(From the Pathological Department, Wigan Infirmary.)

Asbestos was woven into cloth before the time of Herodotus 450 B.C., but the history of the industrial disease pulmonary asbestosis dates only from A.D. 1900.

In 1899 a man was admitted to Charing Cross Hospital under the care of the late Dr. H. Montague Murray. The patient was suffering from pulmonary fibrosis of obscure origin. He had worked for ten years in an asbestos factory, and his occupation was suspected as being the cause of death, which occurred in 1900. The case was not published, but Dr. Murray, in his evidence before the Departmental Committee on Industrial Diseases in 1906, referred to the presence of spicules of asbestos in sections of the lungs.

The next case, and the first published, was recorded in 1924. The clinical history and histological appearances have been the subjects of papers in the *British Medical Journal* (1924–27), and in the *Journal of the Royal Microscopical Society* (1927). The findings upon which the diagnosis of pulmonary asbestosis was made in that case, and the results of further work on the curious bodies that have been found in the lungs in all necropsies in the disease are the subjects of this paper.

Asbestos and Asbestos Dust.

Asbestos belongs to the pyroxene or hornblende group of minerals, and is classed with syenite, granite, and porphyry. I scarcely need remind you that the igneous rocks were originally silicate solutions—compounds of silicic acid with earthy bases. Under certain physico-chemical conditions hornblende and serpentine pass into fibrous varieties and are then given the technical name "asbestos."

The infinite varieties of asbestos differ in their chemical constitution and physical characters, but I propose to deal with one type only—chrysotile—the average composition of which is:

Silica	40.87 per cent.
Magnesia	41.50 ,,
Ferrous oxide	2.81 ,,
Alumina	0.90 ,,
Water	13.55 ,,

The iron content may be important. It will be interesting to see whether the effects of the iron-free dusts of some Italian, Arizona, Finland, and Chinese asbestos are the same as in chrysotile workers.

Microscopically, chrysotile fibre consists of colourless refractile translucent strands, but intermingled with the fibre are masses of black angular particles, brown particles of all shades from light yellowish-brown to deep golden brown, and particles the colour of sapphire blue. The dust generated during the process of manufacture consists of fragments of fibre and translucent spicules split off from it.

* A paper read in a discussion in the Section of Occupational Diseases at the Annual Meeting of the British Medical Association, Manchester, 1929.

These spicules are of varying lengths and thicknesses, some of them being beyond the limits of resolution and ultra-microscopic. The dust contains also the black, brown, and blue fragments seen in the raw asbestos. The colourless translucent particles and the brown and blue particles of the dust are refractile by polarized light. The black particles are biotite and magnetite, and do not transmit light. These iron-containing minerals are responsible for the varying percentages of iron in different specimens of asbestos, and, as would be expected, the dust containing the greater number of these black particles has the greater iron content. Microscopically, the finished woven article contains very few black particles, whereas the dust from the carding room is grey in appearance and contains them in abundance. The iron content of chrysotile, the finished article, and the dust is as follows:

Chrysotile: iron (as ferrous oxide) ...	2.81 per cent.
Finished article: iron (as ferrous oxide)	0.1 ,,
Dust from carding room: iron (as ferrous oxide)	18.4 ,,

In addition to the angular pieces a fine black granular dust is generated during the process of manufacture.

Asbestos Dust in the Lungs.

Sections of lung and the results of digestion of the lung with trypsin show an enormous amount of fine black granular dust, much of which is carbonaceous. In addition there are two striking features. The first is the almost complete absence of the very fine translucent spicules of fibre which make up the great proportion of asbestos dust in factories. This point will be referred to later. The second feature is the presence of large fragments varying in length from 10 to 360 microns. They are found in fibrotic and necrotic areas, singly and in groups. The particles are so large—masses of them are seen in some sections—that they must have occluded small bronchi and resulted in fibrosis of the surrounding area with, later, necrosis.

Comparing these large particles in the lung with those found in asbestos dust the close resemblance in sizes, shapes, and colours is apparent. There are the same black, blue, brown, and translucent fragments. In fact, it is easy to take each single particle from the lung and immediately find its brother in a slide made from the dust.

The question I had to answer with regard to the 1924 case was, "Did the deceased's occupation cause or contribute to her death?" Upon the foregoing evidence one answer only was possible.

The Curious Bodies found in Pulmonary Asbestosis.

In addition to the fine granular dust and larger fragments of asbestos, sections of the lungs show curious bodies, some of which are illustrated in Figs. 1–5. They are found in alveoli, bronchioles, fibrous and necrotic areas, and in phagocytes, in sections of both lungs. If a portion of lung be teased and extracted with water, or digested with trypsin, or, as Professor Stewart pointed out (1928), a smear is made from the cut surface of the fresh lung, these bodies are seen in myriads. The larger bodies measure from 20 to 100 microns or more in length, are of a golden brown colour, and some are shaped as seen in the illustrations. They may have single clubbed ends or appear as elongated dumb-bells, some as filaments, while others suggest a series of discs. Single coccal and spore-like forms, and aggregations of these, and streptococcal forms are not uncommon, and the colour varies in the smaller types from a very pale yellow to a yellowish-brown. The bodies do not stain with any of the aniline dyes, but, in chrysotile workers, give the Prussian blue reaction for iron in varying degrees of intensity. These curious bodies have been found in every necropsy in pulmonary asbestosis, and the problems we have to decide are, first, what the bodies are, and secondly, whether they are diagnostic of asbestosis. It would be unprofitable to retrace all the steps which led down the many by-lanes during the course of the work, but I might mention a few pertinent details of interest.

Professor Stewart suggested to me that a better method than simple extraction of the lungs with water or saline would be to digest portions with trypsin. During this process it was found that if the specific gravity was kept about 1070 the black dust and larger fragments of asbestos, as well as the partially digested lung tissue, sank to the bottom of the tube. By decanting the apparently clear supernatant liquid, centrifugalizing, neutralizing, and washing the deposit, the curious bodies could be obtained in a pure state. This was done, and sufficient material for *x*-ray examination obtained. The bodies were attached to a hair with gum and subjected to a seven hours' exposure by Professor Bragg's method. If the bodies were mineral the *x*-ray film would have shown a definite translatable atomic pattern. The films, however, did not do so, and we were then able to exclude the suggestion that the bodies were altered asbestos fibre. The result definitely pointed to the greater proportion of their composition being of non-mineral origin.

The bulk of the curious bodies is soluble in strong acids and alkalis, and if solution be observed under dark-ground

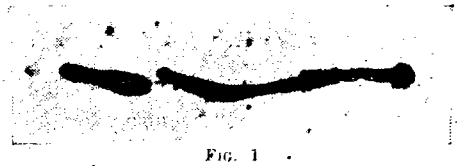


FIG. 1

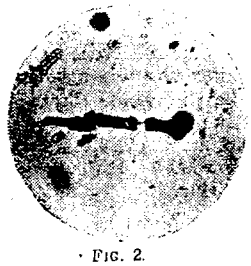


FIG. 2.

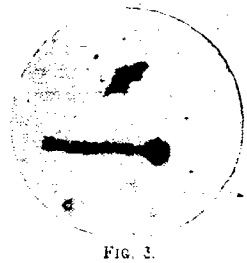


FIG. 3.

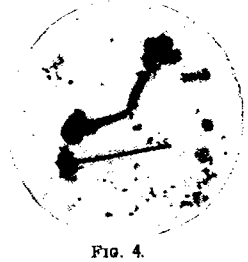


FIG. 4.

FIG. 5.

FIGS. 1 AND 2.—"Curious bodies" showing the colloidal aggregates separated, mechanically, from the slender filaments of asbestos fibre on which they are adsorbed. (× 500.)

FIGS. 3, 4, AND 5.—"Curious bodies," the nuclei of which consist of spicules of biotite. (× 400.)

(Photomicrographs by C. F. Hill and W. E. Cooke.)

illumination their bases are seen as extremely fine spicules, some of which, by transmitted light, would probably be invisible.

Under a dissecting microscope it is possible partially to fracture the larger bodies and to show a central fine core, as in Figs. 1 and 2.

I have mentioned that the greater portion of asbestos dust consists of slender translucent fibres. In sections and extracts of the lungs there is a remarkable paucity of these fine spicules. The end-results of digestion show the fine granular dust and the large black, blue, and brown particles, and what appear to be pieces of quartz. Relatively few fine spicules are found, but curious bodies of all descriptions are present in enormous numbers.

All these facts lead us to imagine the bodies to consist of central nuclei of asbestos spicules upon which colloidal aggregates of blood proteins, *plus*, possibly, soluble fractions of asbestos, and in the case of chrysotile workers an iron salt, have been adsorbed and moulded by currents in the bronchi and alveoli.

Occasionally biotite fragments into fine black spicules, and if our reasoning be correct, some at least of the millions of curious bodies should show a central core of this mineral. Figs. 3, 4, and 5 illustrate this condition, and are, I think, the final proof of our theory.

The method of formation would appear to be as follows. The fine spicules of asbestos cause, by mechanical action on the bronchioles and alveoli, either minute extravasations of whole blood, or serous exudates, which envelop them. Solution of any soluble fraction of asbestos takes place. The total amount of asbestos that is soluble must be extremely small, as proved by the *x*-ray pattern of the curious bodies, but in the case of chrysotile workers some solution is suggested by the free iron reaction. We must remember, however, that the Prussian blue reaction may be due to the iron of haemoglobin. Any surface in contact with a colloidal solution may act as an adsorbent, and in the present case the fine spicules must be considered to do so. Interaction between the soluble fraction of chrysotile and plasma proteins takes place, syneuresis occurs, and, with the loss of water, the adsorption is rendered irreversible. The adsorbent is permanently ensheathed with stable colloidal aggregates which become moulded into the familiar shapes by alveolar and bronchial currents.

Some support of this is adduced by the fact that micro-organisms adsorb colloidal material in the presence of blood serum and colloidal asbestos. Staphylococci so treated appear as large round yellowish-brown discs, and in the process their property of staining with aniline dyes has been lost. The organisms coalesce and form masses, and I think it probable that some of the coccal and spore forms of the curious bodies are similar organisms.

Finally, the answer to our second question must be found. Are the curious bodies diagnostic of pulmonary asbestosis? Asbestos is unique among the minerals in being fibrous, and the dust generated during the manufacturing process is also unique. As can be imagined from the formation of the curious bodies, there is no reason why any fine spicule of mineral should not have colloidal matter deposited around it and become moulded into a curious body. But, as no other mineral dust is fibrous, this occurrence must be so rare as to be negligible from a diagnostic point of view. The conditions which, apparently, must obtain for the formation of the curious bodies are the presence of plasma proteins and fine spicules of difficultly soluble material. These conditions are ideally found in asbestos workers, and for this reason I believe the curious bodies, if found in any numbers, are pathognomonic of pulmonary asbestosis.

I must express my gratitude to Dr. S. A. Henry and Dr. E. R. A. Merewether of the Home Office for their stimulating interest in the work, and for providing me with many specimens of asbestos, and to Mr. T. H. Byrom, F.I.C., and Mr. J. A. Darbyshire, M.Sc., for their invaluable assistance in the chemical and physical side of the work.

LITERATURE.

Cooke, W. E.: *British Medical Journal*, 1924, ii, 147.
Cooke, W. E., and Hill, C. F.: *Journ. Royal Micros. Soc.*, 1927, 232.
Cooke, W. E., McDonald, S., and Oliver, T.: *British Medical Journal*, 1927, ii, 487.
Stewart, M. J.: *British Medical Journal*, 1928, ii, 585.

CLINICAL ASPECTS OF PULMONARY ASBESTOSIS.*

BY

A. C. HADDOW, M.B., CH.B.,

LEEDS.

History.

DURING 1926 Dr. Ian M. D. Grieve, who was then with me in general practice at Leeds, drew my attention to the fact that several patients under our care of late with chest troubles were asbestos workers, and we agreed that they exhibited features sufficiently in common to justify investigation of what seemed an uncommon type of pneumonoconiosis. We accordingly examined every asbestos worker who came our way, some fifteen in all, and had most of these radiographed. Then, in March, 1927, a female patient with long-standing disease died in hospital, and Dr. Grieve attended the post-mortem examination. With Dr. A. L. Taylor he examined the sections of fibrosed lung, and found a remarkable condition which Professor Stewart recognized as similar to the case described by Dr. Cooke in 1924.

Sir Thomas Oliver came to see our cases, and he described the clinical findings before this Section of the British Medical Association at Edinburgh in 1927. The two patients he reported on (both women) have since died, one in March, 1928, and the other in February of this year. One male patient died in March, 1928, and it was the certification of this case as death from "broncho-pneumonia, secondary to chronic asbestos poisoning, causing pulmonary fibrosis," which brought about the publicity of a coroner's inquest and official recognition of this disease.

Fatal Cases.

Of these four fatal cases the average age at death was 41, and the average years actually spent in the factory were under twenty, all in asbestos mattress-making for most of the time. The male patient had worked until two days before death (on a light job), but the three others had been incapacitated for an average of two and a half years (three years and five months, two years and five months, and one year and ten months). Only in one of them had tubercle bacilli been found in the sputum. She was one of those reported by Sir Thomas Oliver, and at her own request no necropsy was held.

I cannot personally trace any other death of an asbestos worker in my practice except that of a woman who died of perforated gastric ulcer in Leeds Infirmary, and whose lungs were examined by Dr. A. L. Taylor, with positive findings, two years ago. No death had ever been traced to asbestos dust in Leeds until the present series, and the only asbestos workers recorded by the medical officer of health for Leeds as having died of phthisis were found to have worked at a gas-mantle factory where asbestos is not employed in any department. I know that many workers had drifted away from the asbestos factory because they believed it was unhealthy, whilst many women had ceased work to attend to their homes, and any fibrosis present would readily be overlooked in later years when death overtook them.

Advanced Cases.

In practice these workers do not call for much attendance until they reach the stage of total incapacity. Until then they are naturally more prone to chest troubles during the winter months, and are sometimes unfit for weeks at a time, but at the present moment I have only four cases under treatment. These are all permanently incapacitated. They are all women, and are fairly well at present, though they were very ill in February and March. Three of them have been away from work for eighteen months and the fourth for four and a half years. They were all in the mattress department. Their average age is 35, and their average of years spent in the factory is fourteen, dating back to their teens. They average three children apiece, which accounts for most of the time lost from work. The children are healthy enough.

Clinically, they all suffer from shortness of breath on exertion, have cough without expectoration, are lean, although not losing weight at present, and complain of anorexia with resulting weakness (for in Yorkshire one is only as strong as one's appetite). Pain is variable, and occurs from time to time with signs of localized pleurisy. Night sweats are absent, and there has been no haemoptysis. No tubercle bacilli have been found. Their hearts are normal, with a pulse rate approaching 90 at rest. The average full range of chest expansion is only one inch in the upper thorax and even less around the lower ribs. On percussion there is always some dullness at both bases, and usually over the lower lobes generally. The breath sounds are diminished over the same area, and the voice sounds are usually well conducted. The respiratory murmur in the upper lobes is broncho-vesicular. Friction sounds can be heard at the bases and sometimes in the flanks. Moist rales and crepitations are for the most part absent now, but were abundant at the bases during the winter. These exacerbations have a serious bearing on the cases, and it will be noted that all the deaths have occurred at the end of winter.

Onset of Symptoms.—It is very difficult to ascertain the date of onset of symptoms, but the patients generally believe it was after five years of work. Depending as it does on so many factors, it must be extremely variable.

* Read in the Section of Occupational Diseases at the Annual Meeting of the British Medical Association, Manchester, 1929.

The method of formation would appear to be as follows. The fine spicules of asbestos cause, by mechanical action on the bronchioles and alveoli, either minute extravasations of whole blood, or serous exudates, which envelop them. *Solution of any soluble fraction of asbestos takes place.* The total amount of asbestos that is soluble must be extremely small, as proved by the *x*-ray pattern of the curious bodies, but in the case of chrysotile workers some solution is suggested by the free iron reaction. We must remember, however, that the Prussian blue reaction may be due to the iron of haemoglobin. Any surface in contact with a colloidal solution may act as an adsorbent, and in the present case the fine spicules must be considered to do so. Interaction between the soluble fraction of chrysotile and plasma proteins takes place, syneuresis occurs, and, with the loss of water, the adsorption is rendered irreversible. The adsorbent is permanently ensheathed with stable colloidal aggregates which become moulded into the familiar shapes by alveolar and bronchial currents.

Some support of this is adduced by the fact that micro-organisms adsorb colloidal material in the presence of blood serum and colloidal asbestos. Staphylococci so treated appear as large round yellowish-brown discs, and in the process their property of staining with aniline dyes has been lost. The organisms coalesce and form masses, and I think it probable that some of the coccal and spore forms of the curious bodies are similar organisms.

Finally, the answer to our second question must be found. Are the curious bodies diagnostic of pulmonary asbestosis? Asbestos is unique among the minerals in being fibrous, and the dust generated during the manufacturing process is also unique. As can be imagined from the formation of the curious bodies, there is no reason why any fine spicule of mineral should not have colloidal matter deposited around it and become moulded into a curious body. But, as no other mineral dust is fibrous, this occurrence must be so rare as to be negligible from a diagnostic point of view. The conditions which, apparently, must obtain for the formation of the curious bodies are the presence of plasma proteins and fine spicules of difficultly soluble material. These conditions are ideally found in asbestos workers, and for this reason I believe the curious bodies, if found in any numbers, are pathognomonic of pulmonary asbestosis.

I must express my gratitude to Dr. S. A. Henry and Dr. E. R. A. Merewether of the Home Office for their stimulating interest in the work, and for providing me with many specimens of asbestos, and to Mr. T. H. Byrom, F.I.C., and Mr. J. A. Darbyshire, M.Sc., for their invaluable assistance in the chemical and physical side of the work.

LITERATURE.

Cooke, W. E.: *British Medical Journal*, 1924, ii, 147.
Cooke, W. E., and Hill, C. F.: *Journ. Royal Micros. Soc.*, 1927, 232.
Cooke, W. E., McDonald, S., and Oliver, T.: *British Medical Journal*, 1927, ii, 487.
Stewart, M. J.: *British Medical Journal*, 1928, ii, 585.

CLINICAL ASPECTS OF PULMONARY ASBESTOSIS.*

BY

A. C. HADDOW, M.B., CH.B.,

LEEDS.

History.

DURING 1926 Dr. Ian M. D. Grieve, who was then with me in general practice at Leeds, drew my attention to the fact that several patients under our care of late with chest troubles were asbestos workers, and we agreed that they exhibited features sufficiently in common to justify investigation of what seemed an uncommon type of pneumonoconiosis. We accordingly examined every asbestos worker who came our way, some fifteen in all, and had most of these radiographed. Then, in March, 1927, a female patient with long-standing disease died in hospital, and Dr. Grieve attended the post-mortem examination. With Dr. A. L. Taylor he examined the sections of fibrosed lung, and found a remarkable condition which Professor Stewart recognized as similar to the case described by Dr. Cooke in 1924.

Sir Thomas Oliver came to see our cases, and he described the clinical findings before this Section of the British Medical Association at Edinburgh in 1927. The two patients he reported on (both women) have since died, one in March, 1928, and the other in February of this year. One male patient died in March, 1928, and it was the certification of this case as death from "broncho-pneumonia, secondary to chronic asbestos poisoning, causing pulmonary fibrosis," which brought about the publicity of a coroner's inquest and official recognition of this disease.

Fatal Cases.

Of these four fatal cases the average age at death was 41, and the average years actually spent in the factory were under twenty, all in asbestos mattress-making for most of the time. The male patient had worked until two days before death (on a light job), but the three others had been incapacitated for an average of two and a half years (three years and five months, two years and five months, and one year and ten months). Only in one of them had tubercle bacilli been found in the sputum. She was one of those reported by Sir Thomas Oliver, and at her own request no necropsy was held.

I cannot personally trace any other death of an asbestos worker in my practice except that of a woman who died of perforated gastric ulcer in Leeds Infirmary, and whose lungs were examined by Dr. A. L. Taylor, with positive findings, two years ago. No death had ever been traced to asbestos dust in Leeds until the present series, and the only asbestos workers recorded by the medical officer of health for Leeds as having died of phthisis were found to have worked at a gas-mantle factory where asbestos is not employed in any department. I know that many workers had drifted away from the asbestos factory because they believed it was unhealthy, whilst many women had ceased work to attend to their homes, and any fibrosis present would readily be overlooked in later years when death overtook them.

Advanced Cases.

In practice these workers do not call for much attendance until they reach the stage of total incapacity. Until then they are naturally more prone to chest troubles during the winter months, and are sometimes unfit for weeks at a time, but at the present moment I have only four cases under treatment. These are all permanently incapacitated. They are all women, and are fairly well at present, though they were very ill in February and March. Three of them have been away from work for eighteen months and the fourth for four and a half years. They were all in the mattress department. Their average age is 35, and their average of years spent in the factory is fourteen, dating back to their teens. They average three children apiece, which accounts for most of the time lost from work. The children are healthy enough.

Clinically, they all suffer from shortness of breath on exertion, have cough without expectoration, are lean, although not losing weight at present, and complain of anorexia with resulting weakness (for in Yorkshire one is only as strong as one's appetite). Pain is variable, and occurs from time to time with signs of localized pleurisy. Night sweats are absent, and there has been no haemoptysis. No tubercle bacilli have been found. Their hearts are normal, with a pulse rate approaching 90 at rest. The average full range of chest expansion is only one inch in the upper thorax and even less around the lower ribs. On percussion there is always some dullness at both bases, and usually over the lower lobes generally. The breath sounds are diminished over the same area, and the voice sounds are usually well conducted. The respiratory murmur in the upper lobes is broncho-vesicular. Friction sounds can be heard at the bases and sometimes in the flanks. Moist rales and crepitations are for the most part absent now, but were abundant at the bases during the winter. These exacerbations have a serious bearing on the cases, and it will be noted that all the deaths have occurred at the end of winter.

Onset of Symptoms.—It is very difficult to ascertain the date of onset of symptoms, but the patients generally believe it was after five years of work. Depending as it does on so many factors, it must be extremely variable.

* Read in the Section of Occupational Diseases at the Annual Meeting of the British Medical Association, Manchester, 1929.

Our earliest clinical diagnosis is also in the neighbourhood of five years of work.

X-ray Findings.—Excellent radiographs of these four advanced cases were taken for me by Dr. Rowden recently. Exposure was for two-fifths of a second. All the chests showed abnormal radiolucency and marked limitation of diaphragmatic movement. The radiographs show this translucency above the level of the ninth rib posteriorly and the fourth rib in front. Below that level, roughly, in all of them there is definite infiltration, particularly on the right side. The outline of the diaphragm tends to be irregular and flattened, and the root shadows to be enlarged in a downward direction. Without going into further detail, the picture is that of asbestosis. But the shadow of the fibrosed zone is in itself characteristic. It is devoid of radiations from the root shadow and presents an amorphous, flocculent appearance, in which small cavities are indicated in some of the cases. In estimating the respiratory handicap we must not forget that the bases extend below the shadow of the dome of the diaphragm.

Lung Puncture.—Another line of investigation, suggested by Dr. Henry, has been carried out—namely, lung puncture. Asbestosis bodies can be extracted from the patients' lungs during life by means of a hollow needle and syringe. I punctured all these four cases, and Professor Stewart has found "bodies" in two of them. We do not recommend it as a routine method of diagnosis. No tubercle bacilli were found in any of them.

Sputum.—Much preferable is the examination of sputum by the antiformin method, which Professor Stewart has applied with striking success, and the only difficulty is to get the sputum. This is often available in winter, and if the patient has a receptacle in readiness the sputum will turn up some time. Three of these cases yielded the "bodies" in sputum, and the fourth had no sputum but was positive on lung puncture.

Conclusions.

The following conclusions have been established:

1. That the inhalation of asbestos dust will "in the long run" produce a state of fibrosis, the distribution being peripheral and mainly basal, the right base becoming most advanced and the upper lobes tending to develop compensatory emphysema as first the diaphragmatic and gradually the entire pleural surfaces become obliterated.
2. That the disease is not as a rule complicated by tuberculosis.
3. That the disease is usually first recognized after more than five years' exposure, although systematic examinations might reveal it earlier.
4. That the condition is usually found first during an attack of influenza or winter cold, when exacerbations of the disease occur.
5. That even in the advanced cases there is marked abatement during the summer months.
6. That the onset of anorexia signalizes to the worker that work is no longer possible.
7. That the patient may then live for several years and continue to bear children, but becomes progressively weaker and more emaciated, more hopeless, sleepless, and exhausted, until an attack of broncho-pneumonia or bronchitis brings death at last.
8. Further, that asbestosis bodies can be found in the sputum, if any, in all advanced cases, as well as in most early cases.
9. That they can be demonstrated by lung puncture in advanced cases; but since no patient is likely to permit more than one puncture to be made a negative finding is inconclusive.
10. That radiography is of great value in diagnosis and in observing progress.
11. That the treatment of these cases, being purely palliative so far, calls for great patience and vigilance over several years, and much relief can be afforded.
12. Finally, that the disclosure of the danger arising from asbestos dust has brought home to the workers the need for observing the measures provided for their protection, and is bound to be salutary, although the mortality statistics will probably be swelled by the wider recognition of this disease.

Memoranda:

MEDICAL, SURGICAL, OBSTETRICAL.

A METHOD OF EXAMINING THE SPUTUM FOR ASBESTOSIS BODIES.

HALF an ounce of so of sputum is added to an equal quantity of undiluted antiformin. This is gently agitated until the sputum is completely dissolved, after which it is diluted down with two or three ounces of water and allowed to stand in a large test tube for three or four hours. The bulk of the supernatant fluid having then been decanted, the remainder is centrifuged at a moderate speed for ten to fifteen minutes. The whole of the supernatant is now poured off, and the deposit transferred to an albuminized slide by means of a pipette. After thorough drying on a hot plate and final fixation over a bunsen, the film is very gently washed in water, dried, and mounted in Canada balsam. After a little experience the asbestosis bodies are readily picked up with the low power, and their true nature is then confirmed with the 1/6 inch or oil immersion lens. As a rule they are present in very small numbers, perhaps only one or two in a whole film. In the case of some of the older workers, however, numerous bodies, up to one or two per field in certain portions of the film, have been found. It is obviously necessary to cleanse thoroughly all glassware, etc., used in making these examinations, otherwise there is a risk of contamination of subsequent specimens.

The films can be treated with hydrochloric acid and potassium ferrocyanide to demonstrate the Prussian blue reaction given by the bodies.

Pathology Department, School of Medicine, University of Leeds. M. J. STEWART.

FOREIGN BODY IN THE LARYNX.

THE following case illustrates some of the difficulties of diagnosing the presence of a foreign body in the larynx, and the need, whatever the history may be, for making the most complete examination when this condition is suspected.

The patient, a waitress at a country hotel, consulted Dr. Frend of Hurstpierpoint on January 24th, stating that on the previous evening, as she got up from her chair, where she had been engaged in sewing, she felt a sudden pricking in the throat. After repeated questioning she admitted that she was in the habit of holding pins in her mouth, but stoutly denied that she had done so on this occasion. The meal which she had taken two hours previously contained nothing that could be impacted as a foreign body in the throat. Dr. Frend could see no abnormality in the larynx or pharynx, but with great difficulty he persuaded the patient to go to the Sussex Throat Hospital for further examination.

My examination by indirect laryngoscopy yielded negative findings, but as the patient still complained of the pricking sensation I asked Dr. Prowse to make an *x*-ray examination. I confess that I was surprised to see in the radiogram that a pin was lying, horizontally and in an antero-posterior plane, opposite the sixth cervical vertebra—that is, on a level with the entrance to the larynx. The laryngeal mirror had failed to reveal the presence of this pin, although the patient's larynx had presented no difficulty in examination. I decided to examine with the endoscope, and did so the same evening with the patient under general anaesthesia. I used Lynah's oesophageal spatula, and at once discovered a longitudinal tear about one inch in length on the posterior oesophageal wall. This discovery was soon followed by the sight of a pin-point abrasion on the posterior aspect of the right arytenoid. By making the necessary adjustment in the patient's position I brought the larynx into view, and was able to see the pin transfixed through the right arytenoid, with most of it lying free in the middle of the larynx. I grasped the pin with forceps and inserted the tube a little deeper; by this manœuvre I was able to draw the pin forward wholly into the tube and thus eliminate any possibility of damage to the tissues. The patient wrote on February 17th that she had suffered no soreness or hoarseness, and that she had not felt the least discomfort.

The following features of this case are of special interest: (1) The absence of symptoms, even of the wheezing respiration described by Chevalier Jackson. (2) The unusual position of the pin—foreign bodies in the larynx usually lie with the long axis in the sagittal plane. (3) The failure to see the pin by indirect laryngoscopy. One concludes that it must have been tucked under the aryteno-epiglottidean fold and brought into view as a result of

PULMONARY ASBESTOSIS.*

BY

W. E. COOKE, M.D., M.R.C.P.,

Director of the Pathological Department, Wigan Infirmary.

(With Special Plate.)

IN the BRITISH MEDICAL JOURNAL of July 26th, 1924 (p. 147), I published a short note on the woman who is the subject of this paper. The only similar case on record was that of a man admitted to the Charing Cross Hospital in 1899, where he died in 1900. Dr. E. L. Middleton of the Home Office kindly lent the notes of the case, and of the evidence given before the Departmental Committee on Industrial Diseases in 1906 by the late Dr. H. Montague Murray, under whose care the man had been. This patient, a man aged 33 years, had worked in the carding room of an asbestos factory for ten years prior to his admission to hospital. He informed Dr. Murray that he was the sole survivor of ten men who started work with him in the carding room; the others had died, presumably as the result of their occupation. A *post-mortem* examination was held and the diagnosis of pulmonary fibrosis was confirmed. Dr. Murray in his evidence refers to photomicrographs of lung sections which show "spicules of asbestos." These are the salient facts of the first and, down to 1924, the only record of a death due to asbestos.

That these two cases stand alone is very surprising. The asbestos industry is more than 2,000 years old, and we know that asbestos factories, up to quite recent years, have been devoid of any appliances for the prevention and extraction of dust. The remark of Dr. Murray's patient is suggestive, and medical men have long suspected asbestos dust to be the cause of lung conditions in workers in badly ventilated factories.

Asbestos is a physical paradox—a mineralogical vegetable, both fibrous and crystalline, elastic, and brittle; as capable of being carded, spun, and woven as wool, flax, or silk. A single strand can be spun to weigh less than an ounce to 100 yards, and a cloth manufactured which weighs less than 8 ounces to the square yard. It occurs in every country, but is never found in any two countries alike, nor, indeed, in any two parts of the same country.

Historical.

Asbestos is apparently indestructible, and its fire-resisting qualities were known to the ancients. The Romans mined it from the Italian Alps and the Ural Mountains. Herodotus (*circa* 450 B.C.) described a cremation cloth made from asbestos. Pliny (*circa* A.D. 50) mentions the difficulty in weaving it. Strabo (*circa* 30 B.C.) and Plutarch (*circa* A.D. 70) both speak of the wicks of the lamps of the Vestal Virgins being made from asbesta, so called because they maintained a perpetual flame without being consumed. Pausanias (*circa* A.D. 175) refers to a gold lamp made by Callimachus of Athens for Minerva, the wick of which was made of Carpasian linen, "the only linen which is not consumed by fire." Later (A.D. 1250) Marco Polo writes that he had seen Tartars using cloth that withstood fire which was made of a "Certaine Minerall of Earth found in a Mountayne."

Although its valuable properties have been known for thousands of years the modern adaptation of asbestos to the industrial arts dates from only a few years ago.

Composition.

Asbestos is one of the silicates, and its varieties are numerous. Wherever it occurs it is found associated with other minerals, more especially with chrome iron and magnetite. The composition of the well known Italian and Canadian fibres is as follows:

	Italian Fibre.		Canadian Chrysotile.
Silica	40.30	.....	40.87
Magnesia	43.57	.....	41.50
Ferrous oxide	0.84	.....	2.81
Alumina	2.27	.....	0.90
Water	13.72	.....	13.55

The purest asbestos, having fibres of extraordinary length, occurs in Northern Italy. Asbestos may contain from 0.5 to 15 per cent. of iron oxide, but asbestos yarn is prepared from mineral as free as possible from iron. To get rid of the difficultly soluble iron, asbestos is soaked in orthophosphoric acid solution and washed in water before manufacture. The percentage of iron, then, is of recognized importance.

Manufacturing Process.

The process of manufacture resembles that of cotton. The crude mineral is subject to mechanical treatment in a grinding machine. The heavier rock is separated by gravity, and the remaining asbestos passed through carding, roving, and spinning machines, and from these to the weaving sheds.

During the carding process, and to a less extent in all the processes, a very considerable amount of dust is generated. In up-to-date factories all machines are fitted with extractor covers and the dust removed. In the first factory where the patient the subject of this paper was employed no method of dust removal was used, and the atmospheric conditions were occasionally so bad that workers in her particular room could not see each other.

Asbestos Fibre and Dust.

Microscopically asbestos fibre is seen to consist of two very different elements. The bulk of the fibre is translucent and glistening, with here and there black opaque angular particles (Fig. 1). Minute black granules also are present. These black particles are actually part of the fibre, but their appearance suggests a different chemical composition and different physical characters from the translucent portion. The dust generated during manufacture is seen to consist of these sharp angular particles and minute granules, suggesting, of course, that they are more brittle than the translucent part of the fibre. These particles are found in very small numbers in the finished article. Mr. T. H. Byrom, F.I.C., analysed several samples of dust, and found that the dusts containing the greater numbers of these black particles contained the largest amount of iron. The iron content of the finished article, raw material, and dust is as follows:

Finished article: Iron (as ferrous oxide)	0.1%
Crude raw material: Iron (as ferrous oxide)... ...	2.61%
Dust from carding room: Iron (as ferrous oxide) ...	18.6%

From these results it appears conclusive that the blackened brittle parts of the asbestos fibre are the iron-containing particles—the bugbear of the manufacturer, the cause of "dust," and a danger to the health of workers in the process of manufacture.

Clinical History of the Case.

The deceased, a woman aged 33 years, commenced work at the age of 13 years in an asbestos factory in which no provision was made for the extraction of dust. From an early age, soon after commencing work, she suffered from a cough, which did not interfere with her general health until 1917. She was then 28 years of age, and had been working thirteen years. From this time until 5 years later (1922) her attendances at work were intermittent owing to ill health. She missed occasional days and one or two periods of some weeks, until she finally ceased work in July, 1922.

Up to this she complained of cough, dyspnœa, expectoration,

DESCRIPTION OF PLATES.

FIG. 1.—Asbestos fibre, the bulk of which is translucent and in which are black angular iron-containing fragments. These constitute a large proportion of the dust generated in manufacture. (× 150.)

FIG. 2.—*Large particles of asbestos in fibrotic area of lung.* (× 150.)

FIG. 3.—Part of asbestos 300 microns in length in necrotic area of lung. (× 150.)

FIGS. 4, 9, AND 12.—Curious bodies. (× 400.)

FIGS. 5, 6, 10, AND 11.—Curious bodies showing discoid arrangement and globular cells. Fig. 6 shows particles of these bodies and granular dust in a phagocytic cell. (× 1000.)

FIG. 7.—Fibre in lung with clusters of the curious bodies lying free in alveoli.

FIG. 8.—*Fibro-caseous area with giant cells.*

Figs. 1 to 6 are reproduced by kind permission of the Editor of the *Journal of the Royal Microscopical Society.*

*This and the two following papers on this subject were read in the Section of Preventive Medicine at the Annual Meeting of the British Medical Association, Edinburgh, 1927.

British Medical Journal 2:1024-1025, December 3, 1927

(*Illustrating the papers by* DRS. W. E. COOKE *and* STUART MCDONALD.)

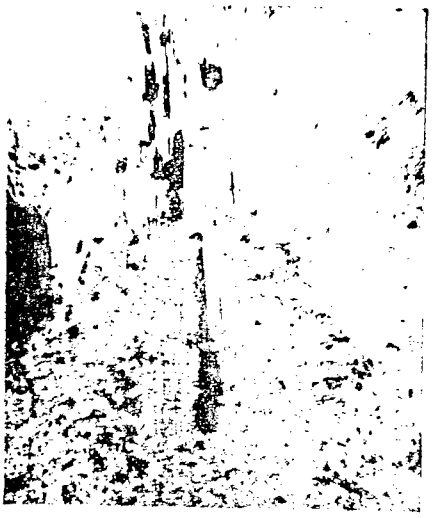


FIG. 1.

FIG. 2.

FIG. 3.

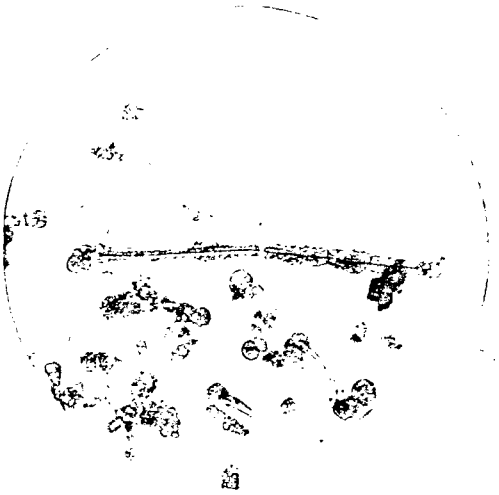


FIG. 4.

FIG. 5.

FIG. 6.

(*Illustrating the papers by* DRS. W. E. COOKE *and* STUART MCDONALD.)

FIG. 7.

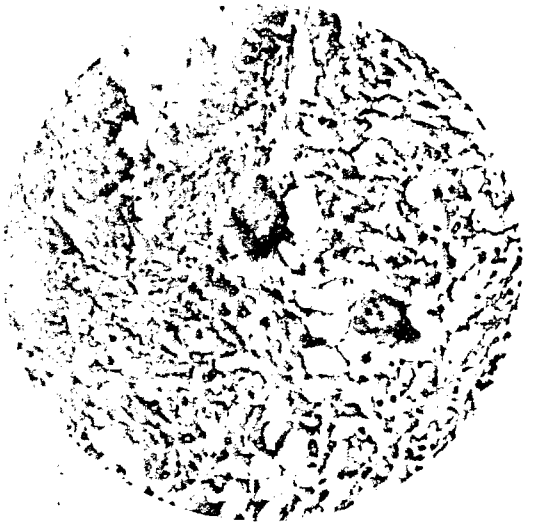


FIG. 8.

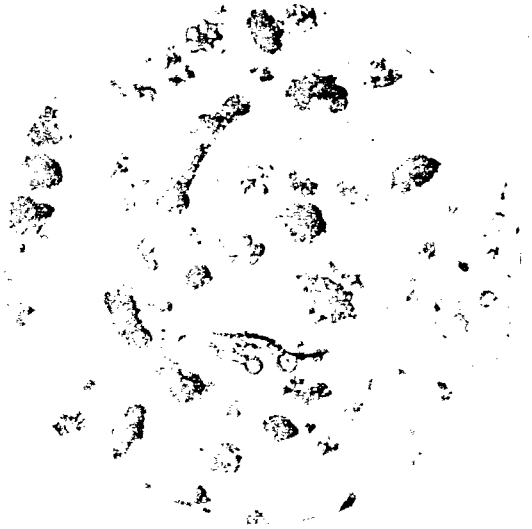


FIG. 9.

FIG. 10.

FIG. 11.

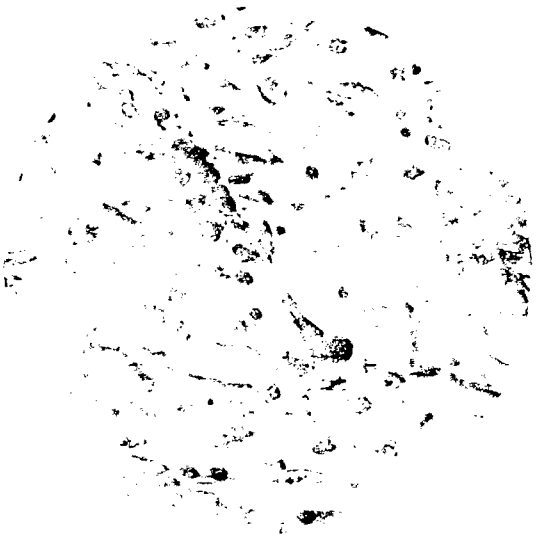


FIG. 12.

and lassitude. The physical signs in her chest were those of fibrosis of the right lung. In July, 1922, signs of cavitation were noticed, the sputum became more profuse, with sweats and irregular temperature, and she died on March 14th, 1924.

An *x*-ray plate showed extensive fibrosis, more marked in the right lung, two calcareous glands at the root of the left lung, and two small calcareous particles in the base of the left lower lobe.

Macroscopical Appearances.

Right Lung.—The pleura is thickened over the entire surface of the lung, and shows the remains of dense adhesions to the chest wall and pericardium. The lung is firm and small. The glands at the root of the lung are large, and on section are black, show a thickened capsule, and some calcareous particles. On section, the lung is seen to be fibrosed and to a large extent airless, the lung tissue being replaced by fibrous tissue. Dense strands of fibrous tissue from the pleura intersect the lung. In the apex there is a large cavity, the size of a peeled tangerine orange. The middle and lower lobes show numerous small areas—varying in size from a hazel-nut to a pin's head—of caseation, some of which have proceeded to cavitation. The bronchi are dilated.

Left Lung.—The pleura is thickened and shows the remains of adhesions to the chest wall. The thickening and adhesions are not so marked as in the right lung. The lung is firmer than normal. At the root of the lung are two large calcareous masses, one the size of a large hazel-nut, the other about half that size—calcified tuberculous glands. The other glands are black and show periadenitis. In the left apex there is an area of old scar tissue about the size of a sixpenny piece, and a cavity the size of a walnut. Scattered throughout the lung are small areas of denser consistence than the rest of the lung, some of which show definite calcareous particles, others small areas of caseation. There is a considerable increase in the fibrous tissue.

Three outstanding features are presented by sections from this case. The first is the enormous amount of fine granular pigment in the peribronchial fibrous tissue, walls of alveoli, and in phagocytes scattered through the sections. The particles of this dust are similar in size and shape to the black granules seen in the asbestos fibre.

The second unusual feature is the presence of large solid angular particles (Fig. 2). These are situated in areas of fibrosis and in caseating areas. They vary in size from 3 to 360 microns in length. The particles are so large—masses of them are seen in certain areas—that they must have occluded small bronchi. Fibrosis of the alveoli supplied has taken place and later necrosis, as seen in Fig. 3.

We have never seen anything parallel to this in pneumonoconiosis due to other dusts, nor have we been able to find such occurrence in literature. On comparing these large particles with asbestos dust there is a striking resemblance in sizes, shapes, and colour. In fact, it is very easy to take each single particle found in the lung sections and immediately find its brother in a slide made from the dust.

We cannot think there is any reasonable doubt that the particles in the lungs are the heavy, brittle, iron-containing fragments of asbestos fibre. The more extensive involvement of the right lung is thus explained. The heavy particles would pass more easily down the more vertical right bronchus than the horizontal left bronchus.

HISTOLOGY OF PULMONARY ASBESTOSIS.

BY

STUART McDONALD, M.D., F.R.C.P.,
Professor of Pathology, University of Durham.

(*With Special Plate.*)

My remarks are confined to the histological appearances in the lungs in this condition, with special reference to certain foreign bodies of most unusual appearance which are present both in the alveoli and interstitial substance of the lungs. The observations are based almost entirely on material supplied from the case described by Dr. Cooke. The investigation has been conducted in the pathological department of the University of Durham College of Medicine.

I may state, however, that the appearances are practically identical with those observed in a second case of this condition, sections of which I have had an opportunity of examining through the courtesy of Dr. J. M. D. Grieve of Armley, Leeds.

Histology.

Numerous sections have been made from both lungs. The changes are more marked on the right side, but the appearances in the two lungs only differ in degree. They may be summarized as follows:

1. There is well marked diffuse interstitial pneumonia with chronic bronchitis and some emphysema.
2. There is well marked anthracosis.
3. There is an extensive tuberculous condition with chronic phthisis.
4. In the alveoli, bronchi, and bronchioles, and also in the interstitial fibrotic areas, are certain foreign bodies which will be described in detail later (Fig. 7).

As this communication deals specially with the nature of the foreign bodies, the general histological features will be dealt with very briefly.

The interstitial fibrosis is such as might be expected as a result of a combination of a pneumonoconiotic condition and a chronic tuberculous infection. The typical whorled formations seen in a more purely silicotic condition are not present. There is a marked endarteritis in the smaller branches of the pulmonary arteries; some are thrombosed and organized. Many of the smaller bronchi are obliterated; some have still caseous-looking centres. Some of the alveoli show the usual metaplasia of their lining cells into cuboidal form. The fibrosed and thickened walls of the bronchi in many places gradually merge into the areas of diffuse fibrous overgrowth. There are numerous foci of lymphocytic cells among the fibroblasts. Some of these seem obviously derived from lymphoid tissue in the bronchial walls. The interstitial fibrosis is progressive. The tuberculous condition is obvious histologically. Tubercle bacilli were not detected, but the histology is characteristic. The lesions are chronic in character, and there is no special indication of an acute exacerbation. There is well marked caseous bronchitis with lymphatic spread and numerous fibro-caseous deposits with giant cell systems (see Fig. 8). The bronchi, which are not specially the seat of tuberculous change, show catarrh with peribronchial thickening. There are numerous emphysematous areas. The alveoli show, in the majority of cases, some thickening of their walls, and contain many catarrhal cells, apparently derived from the lining cells; a similar catarrhal change is seen in the terminal bronchioles, some of which are dilated.

The Foreign Bodies.

The larger black and irregularly fragmented bodies which have been described by Dr. Cooke were not very obvious in the material I examined, but were clearly seen in some microscopical preparations of his which I had the opportunity of examining. I shall not refer to them specially, but confine my attention to certain highly characteristic and much smaller bodies which are abundant in all the sections examined. Some of these are free, but many are phagocytosed by the large mononuclear cells in the alveoli (Fig. 5). Some are easily included in comparatively small phagocytic cells, but the majority are larger, varying in size from 20 μ to 70 μ, or even more in the case of certain elongated forms. The smaller bodies are rounded and homogeneous, and all have a distinct yellowish-brown colour suggesting blood pigment. The longer forms have a highly characteristic appearance, strongly suggestive of some organic structure. Most have an annular appearance, which on closer examination can be resolved into a closely set series of rounded discoid bodies (Figs. 4, 5, 10, and 11). In some cases the globular forms are arranged along the more filamentous forms and occasionally are clustered at the ends of the rods, simulating sporangia of a hyphomycetes (Figs. 5, 6, 10, and 11). Some have club-like extremities at one or both ends of the filaments. Others, again, suggest the appearance of minute crustacean forms (Fig. 10), but closer examination does not support the idea of either vegetable or animal origin. These bodies do not stain with the ordinary aniline stains, but preserve their original yellow-brown colour. They are seen well in unstained sections. They give a characteristic prussian-blue reaction with potassium ferrocyanide and dilute hydrochloric acid. The reaction is not so obvious unless the solutions are slightly warmed. Where the bodies are too large to be phagocytosed by individual cells they tend to become surrounded by plasmodial masses. Many of the phagocytes contain much carbon pigment in addition. Though these bodies are mainly found in the alveoli and

infundibular passages, they are also present in the caseous areas, in the neighbourhood of the phthisical cavities, and some can be demonstrated in the fibrotic areas surrounded by definite fibroblasts. One in particular (see Fig. 12) measured about 75 μ. It is clear and segmented in its middle part, but the extremities are nodular and clubbed. It is difficult to imagine that a foreign body of such length could be transported by phagocytes, but they may represent larger bodies left in a bronchus which has become obliterated. The bodies have been examined with the micro-spectroscope, but so far no clue as to their nature has been obtained by this means. They are not refractile by polarized light.

Nature of the Bodies.

We have shown these preparations to several pathologists, but the appearances are new to them. To confirm our own opinion we have submitted them to experts in zoology, who are unanimous that they are not of animal nature. We have also submitted them to botanical and chemical authorities, and though there has been a considerable difference of opinion, some regarding them as hyphomycetes, the general opinion has been that they are not vegetable forms.

The fact that exactly similar bodies have been found in the lungs of another asbestos worker, and, so far as I can ascertain, have not been found elsewhere, would seem to indicate that they are essentially derived from or associated in some way with the asbestos itself. It is also certain that they do not in any way resemble concretions, largely composed of calcium and other salts, and also containing iron derived from blood, such as have been described as streptothrix forms in the spleen, and which may closely simulate mycelial filaments. The hypothesis advanced is that these bodies are portions of asbestos fibres in the process of alteration and absorption by hydrolysis, either by direct chemical action or by enzymes. The particular variety of asbestos with which this patient worked was a Canadian serpentine (chrysotile). It would probably contain silica and a magnesium salt in about equal proportions (40 per cent.) with up to 3 per cent. ferrous oxide, 1 per cent. of alumina, and water. From its high resistance to heat we are apt to regard asbestos as indestructible, but, given time, it is possible for hydrolysis of such silicates to occur, even in pure water. Such hydrolysis would be hastened and intensified by the presence of CO_2 in the pulmonary alveoli, and the warm moist atmosphere there would, no doubt, accelerate the process. Even under these conditions the process would necessarily be a slow one. The magnesium could be separated out as relatively insoluble carbonate, or more soluble bicarbonate, which in turn would be converted into any other salt for which there happened to be the appropriate acid available.

The iron existing in a ferrous condition in the presence of an oxidizing agent might be converted into the ferric state, and subsequently precipitated as hydroxide. The silica might pass into a colloidal state, at first in sol form (orthosilicic acid), later passing into a gel (metasilicic acid). If this were so in sol form, it would tend to remain associated with the surface of the asbestos fibre by adsorption, and might be held there till it became a gel. In time the gel might adsorb the solution, and so gradual conversion of the fibre into a mass of gel would occur. There might be in the tissues sufficient albuminoid material to effect rapid gelatinization of the sol, particularly if, as would be the case here, the sol was being slowly produced. The fact that the gel is of high surface tension, and formed at an irregular rate, would give it a spheroidal structure and account for some of the appearances seen here. Whether this be the exact explanation or no, it is at least an hypothesis which should be capable of experimental verification. As has been held by Gye and others, in cases of silicosis there may be a direct chemical action of silica on the tissues apart from the merely mechanical irritation of the particles, with the production of fibrosis. Orthosilicic acid is, as has been shown, an active poison, but rapid conversion into metasilicic acid would minimize its action.

As to the relative part played by the asbestos and the tuberculous infection in this case, in relation to the fibrotic change, it is difficult to say, but it is a reasonable assumption that the tuberculosis was a superadded infection, and in Dr. Grieves's case referred to above there was in the sections examined a considerable degree of fibrosis without apparent tuberculosis. The immediate cause of death in that case was a terminal broncho-pneumonia. Till some experimental work is completed the exact nature of these foreign bodies must remain in doubt, but their highly characteristic appearance may well prove to be an important diagnostic point in the recognition of the lung of a worker in asbestos.

I am much indebted to Dr. Cooke for material from his case, to Dr. Grieve for an opportunity of examining his microscopical sections, to P. L. Robinson, D.Sc., of the Chemical Department, Armstrong College, for his advice and suggestions on the chemistry of the silicates, and to Professor W. H. Lang, F.R.S., of Manchester, for a reasoned opinion as to the non-botanical nature of the foreign bodies.

CLINICAL ASPECTS OF PULMONARY ASBESTOSIS.

BY

SIR THOMAS OLIVER, M.D., F.R.C.P.,

Consulting Physician, Royal Victoria Infirmary, Newcastle-on-Tyne; Emeritus Professor of the Principles and Practice of Medicine, University of Durham.

DR. W. E. COOKE has given a short account of the history of asbestos, also of the processes of its manufacture into cloth-like structures much in the same manner as raw cotton fibre is woven. He has told us that in the carding department a considerable quantity of dust is evolved. The crushing of the rock is not carried on to any extent in this country; this is usually done in the countries where the mineral is quarried. Canadian rock is crushed in Canada so as to reduce the expense of transport to Great Britain. Our workers are therefore less exposed to the harmful influence of the dust—a fortunate circumstance, since the rock frequently contains as much as from 50 to 60 per cent. or more of silica.

With the exception of Dr. Cooke's paper on pulmonary asbestosis published in 1924, and the details of a fatal case published by Dr. Montague Murray in the *Charing Cross Hospital Gazette* in 1900, there has not been, to my knowledge, anything written in this country upon the subject. I have had, however, the opportunity of visiting asbestos factories in America, and of seeing cases of pulmonary asbestosis through the kindness of Drs. Haddow and Grieve of Armley, Leeds. It may, I think, be safely said that there must have been several deaths of workers in British factories from the malady, but as no autopsy and microscopical examinations of the lungs were made the deaths were probably certified as pulmonary tuberculosis.

Asbestos manufacture is largely a familial occupation. It has been carried on in this country only for a little over thirty years. Carding and spinning of the fibre are important processes in the manufacture of asbestos goods. In these departments many women are employed, mothers being succeeded by their daughters. Where ventilation of the carding and spinning rooms is properly attended to the atmosphere is fairly clear of dust and floating fibre, otherwise in these operations considerable quantities of dust become suspended in the atmosphere. In a British factory the dustiest process is "hand beating" of the finished mattresses used for covering and protecting the internal machinery of automobiles. This work should only be undertaken in a room separated from the main parts of the factory, with open windows at one end and strong down-draughts at the other, but even with this precaution men working therein should wear masks.

Recently, with Dr. Grieve of Armley, I examined two women who are the subjects of pulmonary asbestosis, one aged 48 and the other 39. The older patient was one of the first to commence work thirty years ago in the particular factory I visited. At that date no danger from dust was anticipated, so that no effective ventilation of the workrooms was attempted, such as prevails to-day. Although only 48 the first patient mentioned looks older by several years, and is extremely emaciated. She gave up work a year ago on account of increasing physical

lebility, shortness of breath, and cough. At present she has no expectoration; her respiratory capacity is one inch. Although the apices of both lungs in front are resonant, there is distinct flattening of the percussion note at the bases. The respiratory murmur at the apices and mid-lung is coarser than usual, and the expiratory murmur is prolonged. At the right base the respiratory murmur is feeble, and small dry friction sound is heard. Towards the base of the left lung and extending into the axilla are heard small moist tinkling sounds, suggestive of cavitation having taken place; here also small friction sounds can be heard. Similar physical signs prevail posteriorly. The apex beat of the heart is displaced upwards and outwards; it is felt external to the nipple, a circumstance which, combined with marked accentuation of the second sound of the heart heard over the pulmonary artery, suggests that fibrotic changes have already occurred in this lung. Although the patient states that she has no expectoration, this was present six weeks ago, and when examined was found to be free of tubercle bacilli. There is no enlargement of the external glands.

The other patient, aged 39, has been an asbestos worker for eighteen years. She had no illness until four years ago, when she developed cough and attacks resembling bronchial asthma. After remaining away from the factory for three months she returned to her employment, and followed the occupation for three years, when she married, and as in the early months of her pregnancy she lost considerably in weight she retired from the factory. Although reduced considerably in weight, and the subject of cough all through her pregnancy, her infant daughter, who is 14 months old, is healthy and well developed.

The patient complains of a dragging in the chest without actual pain. There is noticeable shortness of breath on slight exertion, and she complains of morning cough with expectoration. The sputum has been examined and is negative as regards tubercle bacilli. Her appetite is poor. She weighs 8 st., a drop of 3 st. having occurred within the last two years. Her heart is healthy; the apex beat is not displaced, but the second sound over the pulmonary artery is distinctly accentuated. The apices of her lungs are resonant. Here the respiratory murmur is coarser than usual and the expiratory is prolonged, so that the inspiratory and expiratory murmurs approach each other in equality. Moist râles are heard in mid-axillae and small friction with crepitation is heard at the bases. This woman's mother, who is aged 60, is still working in the factory.

From what I have seen clinically of pulmonary asbestosis it resembles silicosis of the lungs in the marked shortness of breath on slight exertion, deficient respiratory capacity, physical debility, and, in examination of the sputa of not too far advanced cases, absence of tubercle bacilli, but since fibrotic changes are developing in both of the patients to whom I have alluded, there is almost sure to develop, if such has not already taken place, pulmonary tuberculosis.

The clinical picture of pulmonary asbestosis differs slightly from that presented by a patient the subject of ordinary tuberculosis of the lungs, in so far as there is a pronounced deadening of the skin varying from mild bronzing to slight blueness, a degree of shortness of breath in excess of the physical signs, a greater amount of general disability, little expectoration, and comparative absence of night sweats.

AN ACTIVE CONSTITUENT OF THE PREPARATION CALLED "GLUKHORMENT."

BY

H. H. DALE, C.B.E., M.D., F.R.C.P., SEC. R.S.,

AND

H. W. DUDLEY, O.B.E., M.SC., PH.D.

(From the Department of Biochemistry and Pharmacology, National Institute for Medical Research, Hampstead, London.)

IN May of this year Professor von Noorden published in the *Klinische Wochenschrift* an account of a new pancreatic preparation which had a controlling effect on carbohydrate metabolism, but, unlike insulin, was effective when administered by the mouth.[1] To this preparation the name "glukhorment" had been given, and the title of the paper made it clear that the substance was regarded by the author as containing a new anti-glycosuric principle, naturally preformed in the body. On information, evidently supplied to him by the chemist responsible for devising "glukhorment," Professor von Noorden stated explicitly that, in spite of indications in the patent specification, which might suggest some connexion of the active principle with a guanidine derivative, no such derivative, and in particular no synthalin,* had been added; and, further, that the finished preparation contained no guanidine derivative of any kind in recognizable amount. Professor von Noorden drew the cautious conclusion that, if the activity were due to a guanidine derivative, it would have to be one of extremely high activity. In July of this year one of us (H. H. D.) received a communication from the Horment Company, who were manufacturing glukhorment, stating that they were sending material in the hope that clinical trials of it could be arranged. In due course this and several subsequent consignments of glukhorment were sent by the Horment Company, with a request for their trial.

A consideration of preliminary reports, on the mode of action of this preparation on the human being and on laboratory animals, suggested a strong similarity between its effects and those with which we had become familiar, through experiments then for some time in progress, on the action of synthalin. Some of the glukhorment was immediately placed in the hands of one physician, who will presumably report his experience with it in due course. The physiological resemblance to synthalin was so pronounced, however, that, before the question of wider clinical trials was considered, it was thought desirable to make a simple chemical examination, in order to confirm the fact that the preparation was free from synthalin and similar guanidine derivatives, as stated in the paper by Professor von Noorden, of which copies had been submitted by the Horment Company in support of their request. The result of this first test showed clearly that a guanidine derivative strongly resembling synthalin was present in substantial amount in the glukhorment tablets as submitted for trial. The evidence thus early obtained was at once so clear and so surprising that it was considered desirable to use a further quantity of the material submitted, in order to obtain precise information as to the nature of the substance in question. The isolation of the substance was made easy by the fact that the nitrate of synthalin is a remarkably insoluble salt.

Chemical Isolation from Glukhorment of a Guanidine Derivative closely resembling Synthalin.

Two hundred glukhorment tablets were powdered; the powder, weighing 60 grams, was thrown into 1 litre of boiling water and the mixture was kept gently boiling for fifteen minutes. The liquid was then filtered, while still hot, from a large mass of insoluble protein.

The filtrate was evaporated *in vacuo*, with the addition of octyl alcohol to prevent frothing, to a volume of 120 c.cm. On standing, it set to a jelly; this was warmed to 40°, when it became fluid, and concentrated nitric acid was added until the reaction of the liquid was strongly acid to Congo red. A white crystalline nitrate separated from the solution on standing, and the liquid no longer set to a jelly when cold. The crystalline material was collected by centrifuging, washed in the centrifuge with a small quantity of dilute nitric acid, and dissolved in about 25 c.cm. of hot water. This solution was boiled with charcoal and filtered. To the hot filtrate 0.5 c.cm. of 6 per cent. nitric acid was added, and the nitrate crystallized on cooling. This was filtered off and dried; it weighed 1.135 grams. It was then converted into the picrate by dissolving it in water and adding a saturated solution of sodium picrate until no further precipitate was produced. The picrate was filtered

* "Synthalin" is the synthetic compound, decamethylenediguanidine, introduced by Frank, Nothmann, and Wagner, as an antidiabetic remedy for oral administration, and already the subject of numerous reports.