

REPORT
on an
Inquiry into the Occurrence of Disease of
the Lungs from Dust Inhalation in the Slate
Industry in the Gwyrfai District

BY
C. L. SUTHERLAND, M.D., D.P.H.
AND
S. BRYSON, D.P.H.

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INTRODUCTION.

THE EFFECT OF SLATE DUST ON THE LUNGS.

Evidence was gathered by a Departmental Committee as long ago as 1895 which suggested the possibility that an unduly high death-rate from phthisis experienced by slate workers in Merionethshire was, to some extent, due to inhaling slate dust.¹

The subject remained, however, without further investigation until 1927, when a report by Dr. Wade was published, which dealt in particular with the occupational and domestic environment of slate quarrymen and workers in the Gwyrfai Rural District of Carnarvonshire [Caernarfonshire], and with their mortality from pulmonary tuberculosis and other respiratory diseases.² Mortality records concerning all slate workers in England and Wales for 1921-23 were there given for comparative purposes.

Dr. Wade found that all slate workers in England and Wales experienced an unduly high mortality from phthisis occurring late in life, associated with high mortalities from bronchitis and pneumonia; and that mortality records for Gwyrfai slate workers exhibited similar characteristics. Further, when slate miners and quarriers were distinguished from slate masons (millmen), higher mortalities were found to be exhibited by the group which was more exposed to dust (i.e. the masons).

Penrhyn slate, worked by these men, was found to contain from 25 to 42 per cent. of quartz; while dust arising therefrom contained from 50 to 80 per cent. of fine quartz. Further analyses carried out since by the Government Chemist give the following results: (i) Dust collected from a ledge eight feet above the floor and directly above the heads of a splitter and hand dresser contained 46.5 per cent. of free silica and 9.5 per cent. of combined silica, and (ii) dust collected at another quarry from a beam nine feet above the floor contained 39.7 per cent. free silica and 10.3 per cent. combined silica.

Additional mortality data, bringing the records up to the end of 1928, have also been obtained through the courtesy of Dr. Parry Edwards (see Appendix A). These data display the same characteristics as those collected by Dr. Wade, and may therefore be said to support, so far as statistical evidence can do so, the conclusion he came to that "with regard to the slate workers the problem of prevention of lung disease among them arising out of their occupation is the dust problem."

Dr. Wade held, however, that a clinical and X-ray investigation of a number of workers should be undertaken,

¹ Report of Departmental Committee upon Merionethshire Slate Mines, 1895. (O. 7692), Eyre & Spottiswoode.

² Ministry of Health Reports on Public Health and Medical Subjects. No. 38. Investigation into the alleged high mortality rate from Tuberculosis of the Respiratory System among Slate Quarrymen and Slate workers in the Gwyrfai Rural District: T. W. Wade. H.M. Stationery Office. 1927.

By arrangement with the Refractories Industries Compensation Fund, the services of Drs. C. L. Sutherland and S. Bryson, members of the Medical Board under the Refractories Industries (Silicosis) Scheme, were obtained, and the inquiry was entrusted by the Mines Department to these gentlemen.

Their report is now presented. Definite indications were found both through clinical and X-ray examinations that the dust exposure in the industry is harmful. Thus out of 120 men examined, chosen from among those who were actively employed at the time, clinical evidence suggestive of pulmonary fibrosis was found in 56. Forty-seven of these 56 cases were found among millmen, the group most exposed to dust. These 47 together with five other millmen were X-rayed; as the result of the additional evidence so obtained, silicosis was definitely diagnosed in 14 of these men, that is to say in 14.6 per cent. of the 96 millmen examined (see Table I). All these cases of silicosis had more than twenty years' service in the industry. Eight of the cases had more than forty years' service (see Table IV).

The evidence here given appears to corroborate that obtained from mortality records, and to indicate that, as met with industrially, slate dust, if the exposure is sufficient, is definitely harmful; but that it takes longer to exert its effect than does dust composed wholly of silica.

*Mines Department,
June, 1930.*

REPORT ON AN INQUIRY
into the
Occurrence of Disease of the Lungs from Dust Inhalation in the Slate
Industry
in the Gwyrfai District.

Object and Nature of the Inquiry.

This inquiry was instituted by the Mines Department to ascertain the possible relationship between the high death rate from pulmonary disease in the Gwyrfai Rural District and the chief local occupation of slate quarrying. The inquiry consisted of the medical examination of a number of workers engaged in slate quarrying and was confined to the slate quarries in this district. A total of 120 workers was chosen for examination of the chest, and after clinical examination 61 of these were selected for radiological examination.

Selection of Workers.

Arrangements had been made as to the quarries which were to be visited and the employers at these quarries gave every assistance possible for the carrying out of the investigation. The representatives of the North Wales Quarrymen's Union had informed the workers of the object of the proposed medical examination and this materially facilitated the proceedings.

As many of the workers had no great command of English the assistance of Mr. Rhys Williams, H.M. Inspector of Quarries, was invaluable as an interpreter. Dr. S. W. Fisher, H.M. Medical Inspector of Mines, attended the inquiry and gave great assistance in arranging for the X-ray examinations of the selected workers.

The Clinical Examinations.

The workers examined were all at work at the time of the examination and the investigators themselves selected the workers to be examined. All the examinations took place on the quarry premises and in the most suitable rooms that the managements could provide. Very few of those approached with a view to being examined refused to submit themselves. The various processes in the getting and manufacture of slate were viewed and only those workers who were engaged in dusty occupations were selected for examination.

A full personal, family, and industrial history was taken in each case and each investigator then examined the chest.

The Radiological Examinations.

These were carried out at Bryn Seiont Hospital by Dr. Emrys Jones and the films were forwarded to the investigators. Each investigator examined the films and then a joint decision was come to as to the result.

Description of the Processes in Slate Production.

In the Gwyrfai district, slate is obtained from large open quarries, and is transported from the quarries to sheds or mills where the finished article is produced. The getting of slate here is carried out entirely in the open, although drifts may occasionally be driven for prospecting purposes. Large masses of slate are broken off from the quarry face by means of blasting and wedging. Suitable sizes of slate so obtained are carried to the mills by aerial railway, and the waste material is dumped on tips outside the quarry. As the quarry expands a varying amount of overburden has to be removed and this may include inferior slate, igneous rock, and soil.

In the mills the large blocks of slate are placed on the sawing machine tables and sawn into the required sizes. The smaller blocks of slate are then split to varying thicknesses and trimmed or dressed to the different sizes. In some mills the latter processes of splitting and dressing are carried out in the main shed or sawing mill, but in others cubicles off the main shed are set apart for this purpose. At the smaller quarries there may be no mills and the work is carried out by manual labour in the open. In the larger quarries a few of the older workers are employed in salvaging better classes of slate from the waste tips, and making slates from these.

Description of Occupations.

The *Rockmen* are employed in the quarries in the getting of large blocks of slate, by breaking these off the quarry face by means of pick and crowbar. They may also take part in the drilling and shot firing and assist in the trimming of these large blocks of slate to suitable sizes for transport to the mills.

The *Labourers* in the quarry or "pit" are engaged in assisting the rockmen in any of the above operations, and in removing any overburden.

Drillers may be employed in manipulating the pneumatic drill apart from any other work.

In addition to the above, other workers are employed in connection with the aerial railway and in loading and unloading slate, and other material.

The *Millmen* are those workers employed in sawing, splitting and dressing. They usually work in pairs in close proximity, one as a dresser, the other as a splitter, and both attend to the sawing of their own blocks of slate. They are skilled in both splitting and dressing, having served an apprenticeship which covers both processes. The dressing may be done by hand or by machine but in either case the splitter works in close juxtaposition to his partner.

There are also a few general *labourers* in the mill, and one or two saw sharpeners work inside the sheds and act as general fitters.

The above is a brief description of the occupations met with during the investigation. No crushermen, polishers, nor miners were seen. The workers examined have been classified into five groups as follows :—

- (1) Rockmen.
- (2) Labourers to Rockmen.
- (3) Drillers.
- (4) Millmen.
- (5) Saw sharpeners.

Method of Examination.

The following particulars were taken in each case :—(1) Name, (2) Address, (3) Age, (4) Name and address of employer, (5) Present occupation and its duration, (6) Duration and precise nature of any other work in the slate industry, (7) Duration of occupations outside the slate industry, (8) Family history, (9) Personal history, (10) General Physique,³ (11) Chest measurement, (12) Symptoms :— dyspnoea, cough, expectoration, pain, (13) Condition of nose and throat, (14) Clinical examination of the lungs, (15) Radiographic examination, (16) Condition of other organs.

Grouping and Tabulation of the Results.

Table I gives for each of the five occupations, the number of clinical examinations, the number of radiological examinations, the number of cases of fibrosis, and of silicosis. Table II summarises the particulars of each of these occupations. They are arranged in groups according to the number of years of employment, viz., 0-9, 10-19, 20-29, 30-39, 40-49, 50 years and over. The particulars given are as follows :—

- (1) Number in each group.
- (2) Average age.
- (3) Average number of years in the occupation.
- (4) Average number of years in the slate industry.
- (5) Average chest measurement at full inspiration in inches.
- (6) Average chest expansion in inches.
- (7) General physique.
- (8) Number of cases of fibrosis.
- (9) Number examined radiographically.
- (10) Number showing definite silicosis, radiographically.

The diagnosis of fibrosis was based on the following physical signs :—limitation of movement of the chest, changes in the shape of the chest, diminution of air entry with alterations in the quality of the breath sounds, especially at the bases, the presence of adventitious sounds, viz., coarse rales or rhonchi, impairment of percussion note

³ This was based on a general summing-up of the development, musculature, and nutrition. The individuals were classified as follows :—Average normal individual (+1), excellent physique (+2), fair physique (0), much less than ordinary (-1), bad (-2). For a group of 20 individuals comprising 10 of the normal average (= 10), 3 of excellent physique (=6), 4 of fair physique (=0), 2 much less than ordinary (= -2), and 1 bad (= -2), the average would be $+10+6+0-2-2=12\div 20=+0.6$

generally. All of these need not be present for a diagnosis of fibrosis : the earlier stages may only show slight variations in the breath sounds and slight impairment of percussion note.

The diagnosis of silicosis was made entirely on the radiographic appearances detailed in Appendix B.

Results of Examinations.

(1) *Rockmen*.—Fifteen Rockmen were examined clinically and six of these submitted to X-ray examination. No case of silicosis was found among those X-rayed. The average age for the group was high, viz., 52.53 years. The age of the youngest was 40 years and that of the oldest 69 years, The average number of years spent as rockman was low compared with the time spent in the slate industry as a whole, viz., 18.60 as against 30.86 years. However, in the latter age groups of the occupation these periods more closely correspond, viz., 32.33 as compared with 37.66. The other occupation at which these men had been employed was mainly that of millmen, and in the case of the oldest workman, 33 years had been spent at this occupation and 20 as a rockman. Some of the rockmen had spent some time as labourers in the quarry. With regard to the occupations worked at outside the slate industry, five of the rockmen had at one time been engaged in stone work in coal mines. None of these workers was sent for radiographic examination.

(2) *Labourers to Rockmen*.—This group consisted of two workmen who acted as labourers for the rockmen, but were not engaged in drilling. Both were found to be healthy.

(3) *Drillers*.—Six drillers were examined clinically and three of these X-rayed. An average of only three years had been spent in drilling, most of those in this group being really labourers to the rockmen. No silicosis was revealed by the X-ray examinations.

(4) *Millmen* formed the largest occupational group, the total number examined clinically being 96, of whom 52 were examined radiographically. Of those X-rayed 14 were found to be suffering from silicosis. The average age for this group was 46.37 and the ages ranged from 19 to 71 years. The average period in the occupation as millmen corresponds very closely to the average total time spent in the slate industry. A number of the millmen had worked in coal pits for a few years and of these seven had been employed in hard heading work. None of these was included among those X-rayed.

(5) *Saw Sharpeners*.—One saw sharpener was examined. Nothing of any interest was found.

Radiographic evidence of silicosis was found, therefore, only in the group of millmen. In none of the other groups did the radiograph show silicosis. This condition of affairs is no doubt related

to the fact that the processes of sawing, splitting and dressing are carried out in a confined space in the mill sheds. On the other hand the rockman works in the open air and in addition, except when engaged in drilling, does not seem to be exposed to

so much dust. It must be remembered, however, as already noted, that many of the rockmen had worked as millmen in the mill sheds. With regard to the drillers the duration at the occupation was not sufficiently long to enable any conclusion to be drawn. The saw sharpener is exposed to the same atmosphere as the millman. In the case of the labourers to the rockmen there would appear to be little risk.

The clinical examinations show that severe fibrosis exists amongst the older millmen. Fibrosis is also present in the older rockmen but to a less extent. In the drillers there is evidence of fibrosis of a slight degree, but in the remaining two occupations no evidence was found.

Degree of Silicosis Found.

The classification adopted was similar to that adopted in the Report on the Occurrence of Silicosis among Sandstone Workers.⁴* In that Report three stages of the disease were defined, and the first two of these stages were further subdivided into three stages according to the radiological appearances. (Details of this classification will be found in Appendix B.)

The fourteen cases of silicosis found among the millmen could be placed as follows :—twelve in the first stage, one in the second, and one in the third stage. By the further subdivision the twelve first stage cases were found to be grouped into four in the stage Ia, six in the stage Ib, and two in the stage Ic. The one case in the second stage was placed in stage lib.

Tables III and IV show these stages of the disease according to age groups and period of occupation groups respectively. The earliest age at which silicosis was found was 40 years. Most of the cases, however, occurred in the 50 to 59 years age group.

The earliest period of occupation group to show silicosis was the 20 to 29 years group but the majority of cases occurred in the 40 to 49 years group.

History and Symptoms of the Positive Cases of Silicosis.

Among the positive cases a family history of tuberculosis was elicited in three instances. In the personal histories, pneumonia was found in one instance and pneumonia and bronchitis in another. In the remaining 12 cases no history of previous chest illness was given.

In four of the cases no symptoms were complained of. In six cases the sole complaint was shortness of breath, a further two had cough and dyspnoea, and the remaining two complained of cough, spit and dyspnoea.

Dyspnoea was therefore the most common symptom. Pain was not complained of in any of the cases.

Tuberculosis.

Tuberculosis apart from silicosis was diagnosed in three instances, one rockman and two millmen. The radiograph in these three cases showed no definite indication that silicosis was present. The case of silicosis in stage III was also probably accompanied by tuberculosis. Three of these cases were in the age group 60-

⁴ Report on the Occurrence of Silicosis among Sandstone Workers. C. L. Sutherland and S. Bryson. H.M. Stationery Office, 1929.

69, and one in the 40-49 years group. The number of years employed in the slate industry in the four cases was 26, 42, 47 and 53 years.

Examples of Cases.

No. 1, age 40, had worked as a splitter and dresser from the age of 14, with the exception of 2½ years' Army service. He gave a family history free from tuberculosis and he had had no illnesses. He had no symptoms. The chest expansion was 3 inches. Clinical examination revealed fibrosis and X-ray silicosis (Ia).

No. 2, aged 55, had been in slate quarries as a splitter and dresser for 37 years, having been away 3½ years on munitions and six months as a repairer in a coal pit. There was no tuberculosis in the family history and the personal history was negative. He complained of cough, spit, and shortness of breath. His chest expansion was 2½ inches. On clinical examination there was fibrosis and on X-ray silicosis (Ib).

No. 3, aged 53, had been a splitter and dresser for 33 years, and in addition had spent seven years in a cotton factory. There was no family history of tuberculosis. He had had typhoid fever 25 years ago. He complained of considerable shortness of breath on going uphill. The chest expansion was ¾ inches. Fibrosis was found on clinical examination and silicosis on X-ray (Ic).

No. 4, aged 58, had been employed as a splitter and dresser for 45 years. The family history and personal history were negative. The only symptom was shortness of breath. The chest expansion was ¼ inches. The clinical examination revealed fibrosis and X-ray showed silicosis (Iib).

No. 5, aged 61, had been a splitter and dresser for 42 years and had been employed as a general labourer outside the slate industry for five years. The family history was negative for tuberculosis. He had had pneumonia at the age of 19 and a year ago had had an attack of bronchial catarrh which kept him off work for 21 weeks. The symptoms were cough and severe dyspnoea. The chest expansion was 3 inches. Severe fibrosis was present on clinical examination and the X-ray revealed silicosis (III) and probably a superadded tuberculosis.

No. 6, aged 42, had been employed for 26 years as a splitter and dresser and had also spent two years in a coal mine as a repairer. There was no history of tuberculosis in the family. A year ago he had had an attack of bronchial catarrh which lasted for four months, for two of which he was confined to bed. He admitted that he suffered from a slight cough but had no other symptoms. The chest expansion was ¼ inches. There was fibrosis on clinical examination and on X-ray pulmonary tuberculosis was diagnosed, but no evidence of silicosis was seen.

Conclusions.

Silicosis was revealed among millmen but no definite evidence was obtained so far as other occupations were concerned. The earliest age at which silicosis was found was 40 years, but the disease appears to be most common after 50 years of age and after 30 years in the occupation.

(Signed) CHAS. L. SUTHERLAND,
SAMUEL BRYSON.

TABLE 1.

Summary, showing the number of workers examined in the various occupations, and the number of cases of Fibrosis and of Silicosis.

Occupation.	Clinical Examinations.		Radiological Examinations.	
	Total.	Cases of Fibrosis.	Total.	Cases of Silicosis.
Rockmen ...	15	8	6	-
Labourers to Rockmen ...	2	-	-	-
Drillers	6	1	3	-
Millmen	96	47	52	14
Saw sharpeners ...	1	-	-	-
Total ...	120	56	61	14

TABLE II.
DETAILED RESULTS OF THE EXAMINATIONS.

Period of employment in occupation.	Number in each group.	Average age.	Average number of years in occupation.	Average number of years in slate industry.	Average chest measurement at full inspiration.	Average chest expansion.	Average physique.	Number of cases of fibrosis.	X-ray examination.		
									Number of cases X-rayed.	Number of cases showing Silicosis.	Number of cases showing pulmonary tuberculosis.
1. Rockmen	15	52.53	18.60	30.86	36.48	2.73	+1.06	8	6		1
0-9	2	47.00	7.50	26.00	35.00	2.50	+0.50	--	—	—	—
10-19	6	47.83	13.50	25.33	36.12	2.83	+1	5	2	—	—
20-29	4	57.00	21.50	36.50	37.87	2.62	+1.25	1	1	—	1
30-39	3	59.66	32.33	37.66	36.33	2.83	+1.33	2	3	—	—
2. Labourers to Rockmen.	2	28.00	7.25	13	36.12	4.12	+1	—	—	—	—
0-9	2	28.00	7.25	13	36.12	4.12	+1	—	—	—	—
3. Drillers	6	40.50	3.00	20.16	36.12	3.08	+1	1	3		
0-9	6	40.50	3.00	20.16	36.12	3.08	+1	1	3	—	—
4. Millmen	96	46.37	27.08	28.35	34.90	2.84	+0.50	47	52	14	2
0-9	4	24.50	7.25	8.50	34.06	3.62	+0.25	1	1	—	—
10-19	29	35.75	14.51	16.03	34.92	3.14	+0.58	5	9	—	—
20-29	24	44.54	24.04	25.95	34.82	2.78	+0.37	10	14	2	1
30-39	19	52.05	33.68	34.73	35.09	2.69	+0.52	12	13	3	—
40-49	15	61.33	44.40	44.86	35.66	2.41	+0.86	14	12	8	1
50 and over	5	67.80	53.40	53.40	32.95	2.55	-0.40	5	3	1	—
5. Saw	1	46.00	18.00	30.00	36.25	2.75	+1	—	—	—	—
10-19	1	46.00	18.00	30.00	36.25	2.75	+1	—	—	—	—

TABLE III.

Stages of Silicosis in Millmen arranged according to Age Groups.

Age Groups.	Stages of Silicosis.						
	Stage I.*			Stage II.*			Stage III.*
	(a)	(b)	(C)	(a)	(b)	(c)	
40-49 ...	1	—	—	—	—	—	—
50-59	2	5	1	—	1	—	—
60-69	1	1	—	—	—	—	1
70 and over ...	—	—	1	—	—	—	—
Totals ...	4	6	2	—	1	—	1

* See page 4 and Appendix B for details of the classification.

TABLE IV.

Stages of Silicosis in Millmen arranged according to number of years in the occupation.

Number of years in occupation.	Total number examined	Total number X-rayed.	Stages of Silicosis.						
			Stage I.*			Stage II*			Stage III. ^m
			(a)	(b)	(C)	(a)	(b)	(C)	
0-9	4	1	—	—	—	—	—	—	—
10-19	29	9	—	—	—	—	—	—	—
20-29 ...	24	14	2	—	—	—	—	—	—
30-39 ...	19	13	1	1	1	—	—	—	—
40-49 ...	15	12	1	5	—	—	1	—	1
50-59 ...	4	2	—	—	—	—	—	—	—
60 and over	1	1	—	—	1	—	—	—	—
Totals ...	96	52	4	6	2	—	1	—	1

* See page 4 and Appendix B for details of the classification.

APPENDIX A
DEATHS OF QUARRY WORKERS (GWYRFAI DISTRICT), 1924-28,
CLASSIFIED ACCORDING TO AGE AND CAUSE.
(From information supplied by the Medical Officer of Health for Caernarfon),

	Under						Total.
	15.	15-20.	20-30.	30-40.	40-50.	Over 50.	
Pulmonary	2	4	11	4	18	44	83
Pneumonia	—	—	—	—	—	3	3
Other lung Diseases	—	1	1	—	9	44	55
Heart Disease	—	—	3	—	6	124	133
Cancer	—	—	—	1	3	48	52
Kidney	—	—	—	1	—	37	38
Arteriosclerosis	—	—	—	—	2	36	38
Senile Decay	—	—	—	—	—	37	37
Accidents	—	—	1	5	3	17	26
Nerves	—	—	—	—	1	6	7
Influenza	—	1	—	—	2	4	7
Anaemia	—	—	1	—	—	3	4
Rheumatism	—	—	—	—	—	1	1
Liver	—	—	—	1	—	2	3
Bowels	—	—	—	—	1	1	2
Glands	—	—	1	—	—	2	3
Fever	—	—	—	1	1	—	2
Haemoptysis	—	—	—	—	—	2	2
Diabetes	—	—	—	—	—	—	—
V.D. ...	—	—	—	—	—	1	1
All Causes	2	6	18	13	46	412	497

APPENDIX B.
METHOD OF DISTINGUISHING STAGES OF SILICOSIS ADOPTED BY
THE INVESTIGATORS.

The investigators in making radiographic examinations, distinguish three stages of silicosis, namely, "first," "second," and "third," corresponding approximately to the "ante-primary," "primary," and "secondary" stages of the South African Miners' Phthisis Medical Bureau.

The First Stage is defined as being characterised by the appearance of the earliest detectable physical signs of the disease, with radiographic appearances not less than the presence of nodular shadows, together with an increase of hilum shadows, linear shadows and pulmonary reticulum; with or without impairment of capacity for work.

The Second Stage is characterised by the further development of the physical signs with an increase in the area of the nodular shadows and a tendency to the confluence of the individual nodules; and the presence of some degree of impairment of capacity for work.

The Third Stage it is considered unnecessary to define, but it implies a condition equivalent to total incapacity for work. Third Stage films show massive consolidation.

A further sub-division of the First and Second Stages is made, based on the radiographic appearances. First Stage cases are grouped into three types :—

- (a) Where the nodules are present but localised.
- (b) Where the nodules are more numerous.
- (c) Where the nodules are distributed generally throughout the film, but are still discrete.

Similarly, Second Stage cases are sub-divided into three types :—

- (a) Where the nodules are generalised and in addition show coalescence in places.
 - (b) Where coalescence of the individual nodules is a feature of the films.
 - (c) Where extensive coalescence is shown.
-