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DUST CONTENT, RADIOLOGY, AND PATHOLOGY IN SIMPLE PNEUMOCONIOSIS OF COALWORKERS

Part I: GENERAL OBSERVATIONS

BY

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Lungs from 45 coalworkers with simple pneumoconiosis have been compared with chest films obtained within two years of death. The carbon, quartz, mica, and kaolin content of the lungs was determined chemically. Large lung sections were used to assess the type and severity of emphysema and the presence of fibrous dust nodules. Histological sections were used to grade the amounts of reticulin and collagen in the simple dust foci. By using averages of four independent readings of each radiograph, subdivisions of the I.L.O. 1950 scale of categories were related to amounts of dust in the lungs.

It was found that the mean weight of total dust in the right lung was: category 0, 4·3 g.; category 1, 10·5 g.; category 2, 14·5 g.; category 3, 26·7 g.; and that the mineral and carbon contributed about equally to the radiological changes but, weight for weight, mineral contributed about nine times more than carbon. A physical explanation for this is suggested, in terms of relative absorptions of x rays by carbon and mineral; the coefficients of absorption of the various dust components and "wet tissue" are compared at various wavelengths, and the effects on the radiograph are discussed. An explanation in terms of tissue reaction to dusts was also investigated but was not found to be plausible. "Mean ages of dust foci" (periods of dust retention) were studied from records of work underground, and compared with the radiological changes, the gradings for reticulin and collagen, and the presence of fibrous dust nodules. Observer variability in reading the x-ray films was greater when fibrous dust nodules were present. The application of the results to the interpretation of studies of progression of simple pneumoconiosis judged from the radiograph is described.

1.0 Introduction

In the simple form of coalworkers' pneumoconiosis the chest radiograph shows discrete opacities, varying in size from 0·5 to about 5 mm., dispersed widely throughout the lung fields. Pathologically the dust is seen to be deposited in discrete foci uniformly scattered throughout the lung, and the older foci tend to be surrounded by focal emphysema. Microscopically the dust foci consist of dust-laden phagocytes enmeshed in reticulin fibres; in older foci some collagen fibres are also present (Heppleston, 1953). Fibrous nodules heavily impregnated with coal dust, from 2 to 10 mm. in size, may also be present (Meersseman, 1958).

This paper describes a study of the radiological changes during life of simple pneumoconiosis in coalworkers and of the lungs subsequently obtained at necropsy. Complicated pneumoconiosis is not considered in this paper.

The main object was to determine quantitatively the relationship of radiological and pathological features to both the total amount and the composition of dust in the lungs. We also hoped to obtain some information about the possible effects of age, duration of dust exposure, and duration of dust retention on the radiological and pathological features of simple pneumoconiosis. The possible effects of pathological changes themselves on radiological appearances were also of interest.

King and Nagelschmidt (1945), King, Maguire, and Nagelschmidt (1956), and Faulds, King, and Nagelschmidt (1959) have related content and composition of the dust in the lung to pathology, but

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satisfactory radiographs were not available in the cases they reported. Gough, James, and Wentworth (1949) compared radiological and pathological appearances of the lungs but did not carry out any dust analyses. Much previous work on heterogeneous groups of lungs variously described as "silicotic" or "anthracosilicotic" cannot be usefully compared with our own study.

1.1 Choice of Material

The bodies of miners coming to routine necropsy in hospital may form a biased sample, both pathologically and radiologically, because miners are likely to have been more disabled during life than the average. To obtain a more representative sample we wished to limit our cases to fatalities in pit accidents. There are many social and administrative difficulties to be surmounted in obtaining such a group. Much effort was devoted to collecting the material and with some success, but it was clear after about two years that it would take too long to obtain a sufficiently large group of cases in each radiological category. It was, therefore, decided to include in this study lungs chosen from cases coming to routine necropsy at the Welsh National School of Medicine while continuing to collect accident cases. The main criteria of choice, apart from the availability of recent radiographs, were absence of tumour, tuberculosis, and gross discrepancies between right and left lungs. Examples of the various types and severity of emphysema were included.

The group reported here consists of 45 cases, 13 of which were accident cases, collected between the end of 1952 and the end of 1955. A full-sized chest radiograph was available for each man taken within about two years of death.

1.2 Techniques

(a) **Pathology.**—The left lung was inflated with formol-saline for the preparation of a large section (Gough and Wentworth, 1949) and the right lung was sliced sagitally. The hilar and bronchial lymph nodes of the right lung were dissected off, and in some cases were analysed separately.

The large lung sections were used for the assessment of the pathological features by two pathologists (W. R. L. James and D. Rivers), and the results in Table 1 show their final agreed assessment. The severity of emphysema was graded as 0, little or no emphysema; 1, moderate emphysema; 2, severe emphysema. Observations made at the time of the necropsy agreed well with the appearances seen later in the large sections. Only the appearances of the large sections were used in the analysis. The number of fibrous dust nodules was graded from + to +++ by increasing number.

At least three blocks of tissue from the left, and two from the right lung, typical of the whole, were taken for histological examination after fixation. One section from each block was stained with haematoxylin and eosin, its immediate neighbour was stained by a silver impregnation technique for reticulin, and the next by the Weigert and van Gieson method for collagen. The amount of reticulin was graded by the number and thickness of the fibres into three grades illustrated in Figs. 1-3. Sections representative of each grade were selected as standards and used for classifying the sections of the remainder of the series. Grade 0, no trace of reticulin; Grade 1, reticulinosis showing scanty, fine, short, wisp-like fibres; Grade 2 shows a moderate number of thicker and longer fibres with numerous anastomoses; Grade 3 shows even denser and longer fibres with more numerous anastomoses forming an almost complete framework of the reticulin. The collagen fibres in the dust foci were also graded by increasing number from + to ++++.

The histological grading of the reticulin was carried out independently by the same two pathologists. The independent opinions of reticulin grade differed by one grade in only two cases (Nos. 2 and 10, Table 1). In view of this good agreement one pathologist's grading (D.R.) was used in the analysis of the results. Good agreement was also found for independent collagen gradings.

(b) **Dust Analysis.**—The right lungs (excluding the glands) were weighed after drying at 105°C., ground, and used for dust analysis. The coal and acid-insoluble matter was determined on representative samples of the whole dried material; coal by ashing the residue obtained by alkali digestion (King and Gilchrist, 1945) and the mineral matter by ashing a sample at 380°C. and removing the endogenous lung salts from the ash by extraction with 2N hydrochloric acid (King *et al.*, 1956). The total silica was determined chemically on the acid-insoluble residue (King, 1939) and its mineral composition by *x*-ray diffraction technique. The quartz was determined on all samples by G-M diffractometry (Gordon and Harris, 1956). On many samples chemical determinations of Al_2O_3, K_2O, and ignition loss were made to check the estimates of mica and kaolin obtained from *x*-ray diffraction films. All mineral residues contained, apart from quartz, mica as the main constituent, and kaolin was found in some but not all of the samples. The results of the analyses were multiplied by the weight of the dried lung to give the total amount of dust in the lung. The ratio of coal to the sum of quartz and silicates (mica and kaolin) is also given. The reproducibility of coal determinations was approximately 0·2%, when the coal percentage of the dried lung varied between 2 and 26 (King and Gilchrist, 1945). Twenty-one coal analyses were carried out in parallel in two laboratories. The results of one laboratory were consistently slightly higher; the difference averaged 0·6 g. in 100 g. dried lung. After allowing for this bias, the standard error of a single determination was 0·36 g. of coal in 100 g. of dried lung. In the analyses we have used the results of one laboratory only.

The estimation of the mineral residue is of the same

order of accuracy as the coal determinations, and the estimation of total silica is reproducible to better than 1%. The iron content was determined in a sample of the cases.

(c) **Radiographs.**—The chest films were read as a complete series according to the International Labour Office Classification (1950) on two separate occasions, and also separately for right and left lungs, by two pairs of readers independently. The films were then read once by all four readers together to obtain a final agreed reading again for each lung separately. The films of the routine necropsy cases were rather more difficult to read than the accident cases because of complications resulting from illnesses. The film readers knew no details of the cases. The effect of technique of reading on the interpretation of the results is of importance and is discussed in Part II.

(d) **Industrial Histories.**—The reliability of available records was checked by taking account of age of entry into the pits, periods of the two world wars, and periods of industrial depression. Data on years spent underground were consistent, but details of occupations underground appeared to be unreliable.

2.0 Results

The material consists of lungs of coalworkers from 32 routine necropsy cases, and 13 from fatalities in pit accidents. Detailed results are given in Table 1. They are arranged in order of the average reading for the right lung radiograph. Since only the right lung was analysed for dust the radiological reading of the left lung is not tabulated but is discussed in section 6.3. Table 2 shows the age distribution of both groups. The pit accident cases make up the bulk of the younger men but the series as a whole contains more older men.

2.1 Radiological Categories

The final agreed reading of the right lungs showed 17 category 0, nine category 1, 10 category 2, and nine category 3. The distribution of pit accident cases was as follows: Six category 0, two category 1, four category 2, and one category 3. There was disagreement of paired independent readings in 27 cases (see Table 1).

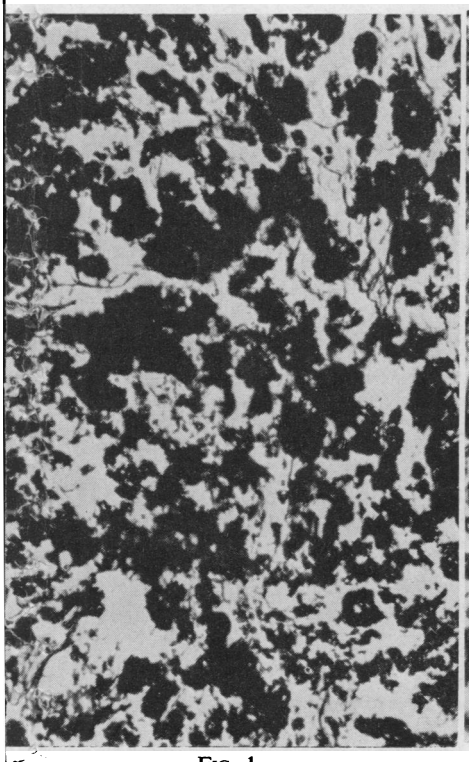


FIG. 1

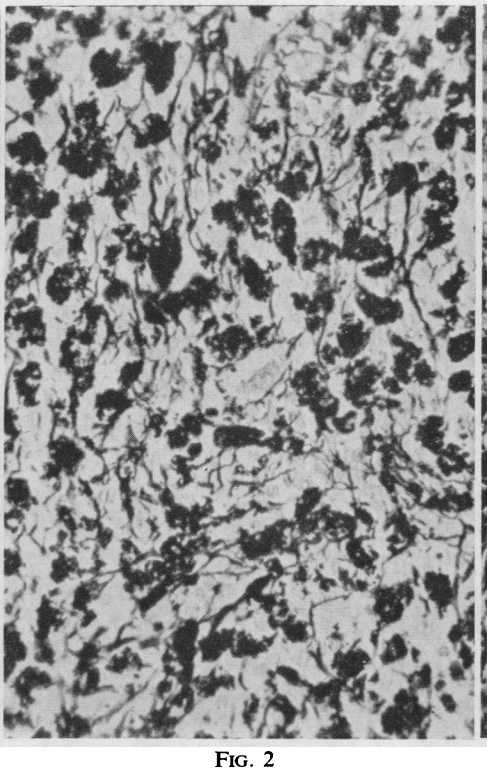


FIG. 2

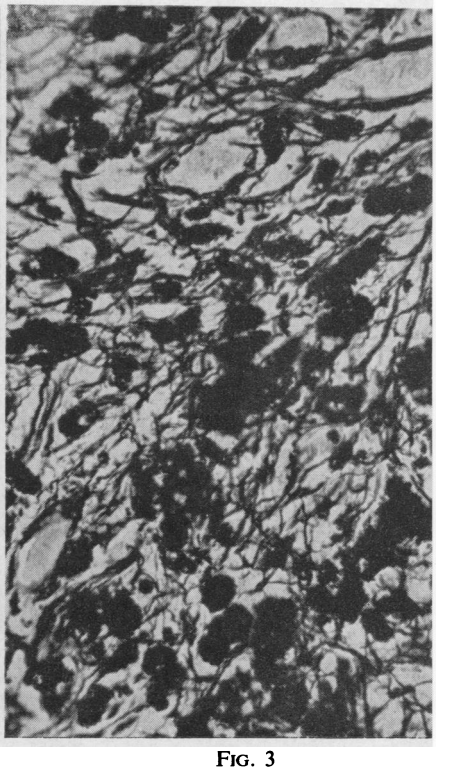


FIG. 3

FIG. 1.—Histological section of lung stained by silver impregnation technique for reticulin. Grade 1 reticulinosis (× 400).
FIG. 2.—Histological section of lung stained by silver impregnation technique for reticulin. Grade 2 reticulinosis (× 400).
FIG. 3.—Histological section of lung stained by silver impregnation technique for reticulin. Grade 3 reticulinosis (× 400).

TABLE 1

MAIN RESULTS

Case No.	Age (Yr.)	Radiological Reading of Right Lung: Readers A and B, First Reading	Readers A and B, Second Reading	Readers C and D, First Reading	Readers C and D, Second Reading	Final Agreed Reading	4x	Dust Exposure Radiological Interval (Yr.)†	No. of Years Underground T_G	Total Weight of Dust in Right Lung (g.): Total	Coal	Quartz	Silicates	Coal-Mineral Ratio	Pathology: Focal Emphysema	General Emphysema	Fibrous Nodules	Reticulin Grade	Collagen Grade
1	60					0	2	19·5	14	1·4	0·9	0·05	0·47	1·7			++	—	—
2	58					0	2	0·2	29	1·7	1·25	0·06	0·39	2·8		1		2(3)	+
3*	58					0	2	0·5	40	2·0	1·5	0·05	0·43	3·2				2	+
4	59					0	2	6·0	28	2·5	2·0	0·05	0·45	4·5		1		1	+
5	58	All Readings 0				0	2	−1·0	15	2·5	2·0	0·06	0·45	4·0		1		0	+
6	46					0	2	1·5	14	2·6	2·0	0·08	0·55	3·1				0	+
7	54					0	2	3·25	36	2·65	1·8	0·13	0·72	2·1		1		1	+
8*	36					0	2	−3·0	16	2·7	2·3	0·05	0·32	6·4				0	0
9*	34					0	2	−1·0	17	3·0	2·6	0·05	0·33	6·9				1	+
10*	52					0	2	−0·75	38	3·1	2·1	0·03	0·95	2·1				1(0)	+
11	56					0	2	8·4	34	3·3	2·7	0·08	0·51	4·6		1	+	1	+
12*	33	1	0	0	0	0	3	0·25	17	5·1	4·3	0·10	0·74	5·0				1	+
13	56	0	1	0	0	0	3	1·5	39	6·1	5·1	0·09	0·88	5·2	1	2		1	+
14*	45	1	0	0	0	0	3	−1·0	30	7·5	6·5	0·16	0·82	6·7				0	0
15	61	1	1	0	0	0	4	1·75	27	4·3	3·2	0·15	0·93	3·0		2	+	1	+
16	61	1	1	0	0	1	4	−1.25	38	5·3	4·5	0·11	0·70	5·5				2	+
17	61	1	1	0	0	1	4	9·0	26	7·5	6·6	0·08	0·96	6·4	2	2		3	+
18	58	0	0	1	1	0	4	8·25	36	7·9	6·6	0·18	1·09	5·2				1	+
19*	39	0(A) 1(B)	0) 1)	0	1	1	4	−1·0	23	10·3	9·4	0·15	0·75	10·5			+	1	+
20	61	1	1	0	0	0	4	19·5	25	14·2	12·3	0·28	1·66	6·3	2		++	2	+
21	38	1	1	1	0	1	5	3·4	20	11·7	10·6	0·13	0·95	9·7				2	+
22*	49	1(A) 2(B)	1	0	1	1	5½	−1·0	35	10·4	9·0	0·10	1·28	6·6				1	+
23	57	1	1	1	1	1	6	7·0	35	5·7	3·6	0·19	1·93	1·7				1	+
24	55	1	1	2	1	1	7	17·0	25	12·0	10·5	0·24	1·26	7·0	1	1		3	+
25	55	1	2	1	1	1	7	0	35	12·7	11·9	0·08	0·69	15·5				1	+
26	54	2	2	0	1	1	7	3·4	29	19·2	17·3	0·20	1·70	9·1	1		++	1	+
27	61	2	2	1	1	2	8	9·4	34	11·3	9·9	0·33	1·86	4·5	1	1	+	1	+
28*	35	2	(A)1 (B)2	1	2	2	8½	−2·0	6	10·1	8·4	0·26	1·48	4·8				2	+
29	60	2	2	1	2	2	9	−0·75	45	5·0	3·2	0·22	1·59	1·8				—	—
30*	41	2	2	1	2	2	9	−1·0	26	14·9	13·4	0·22	1·26	9·1				0	+
31*	48	2	2	2	2	2	10	−1·0	28	16·2	13·8	0·26	2·13	5·8				2	+
32	48	2	2	2	2	2	10	3·5	27	25·0	23·0	0·31	1·73	11·2				1	+
33*	54	3	2	2	2	2	11	−1·0	40	12·8	10·8	0·34	1·68	5·4			+++	0	0
34	62	3	3	1	2	2	11	9·5	38	14·1	11·1	0·41	2·56	3·7	1		++	2	+
35	55	3	3	1	2	2	11	1·25	32	30·8	29·7	0·15	0·91	28·0				1	+
36	57	3	3	2	2	3	12	10·8	16	17·0	15·0	0·35	1·69	7·3	1		++	1	+
37	54	3	3	2	2	3	12	—	34	31·2	29·6	0·21	1·51	18·1				1	+
38	50	3	2	3	3	2	13	7·5	26	4·5	3·3	0·18	1·06	2·6			+	1	+
39	56	3	2	3	3	3	13	−2·5	30	18·8	17·9	0·21	1·50	10·0			+	2	+
40	37	3	3	2	3	3	13	−1·8	15	27·9	26·1	0·23	1·59	1·43				1	+
41	60	3	2	3	3	3	13	3·0	41	34·3	32·8	0·18	1·32	21·8	1		++	3	+
42	70					3	14	0	46	16·2	6·2	1·70	8·32	0·6	2			3	+
43*	49					3	14	−1·5	34	16·9	15·2	0·10	1·60	8·9				1	+
44	58	All Readings 3				3	14	−2·2	44	33·5	29·5	0·55	3·48	7·3	1		++	3	+
45	53					3	14	5·7	28	44·1	39·8	0·65	3·63	9·3	2		+	3	+

x = Average of 4 readings + ½ (see text)
* = Pit accident fatalities

Emphysema, Focal and general: 1 = Moderate; 2 = Severe

Fibrous dust nodules: + = Few; ++ = Moderate number; +++ = Numerous

( ) = Individual readings with no agreed reading

Reticulin grades: 1 = Scanty fibres; 2 = Moderate number of fibres; 3 = Numerous fibres

Collagen grades: + = Scanty fibres; ++ = Moderate number; +++ = Numerous; ++++ = Very numerous

† Negative value for interval between end of dust exposure and date of radiograph indicates the period of dust exposure after the date of radiograph.

TABLE 2

AGE DISTRIBUTION OF THE 45 CASES

Cause of Death	Age Distribution: 30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-	Total No. of Cases
Fatal pit accident	2	3	1	4	1	2	0	0	13
Natural causes	0	2	0	2	6	12	9	1	32
Total	2	5	1	6	7	14	9	1	45

2.2 Interval Between the End of Dust Exposure and Date of Chest Radiograph

In 28 of the men dust exposure had ended before the date of the chest film, usually within two years, but in a few cases this period was much longer, the longest being 19·5 years. In the remaining 17 cases some dust exposure occurred after the chest film had been taken (indicated by a negative sign in column 9 of Table 1), but it was a very small proportion of the whole exposure. A large error in correlating dust in the lungs at death with the appearance of the chest radiograph is, therefore, very unlikely.

2.3 Years Underground and Dust Retained

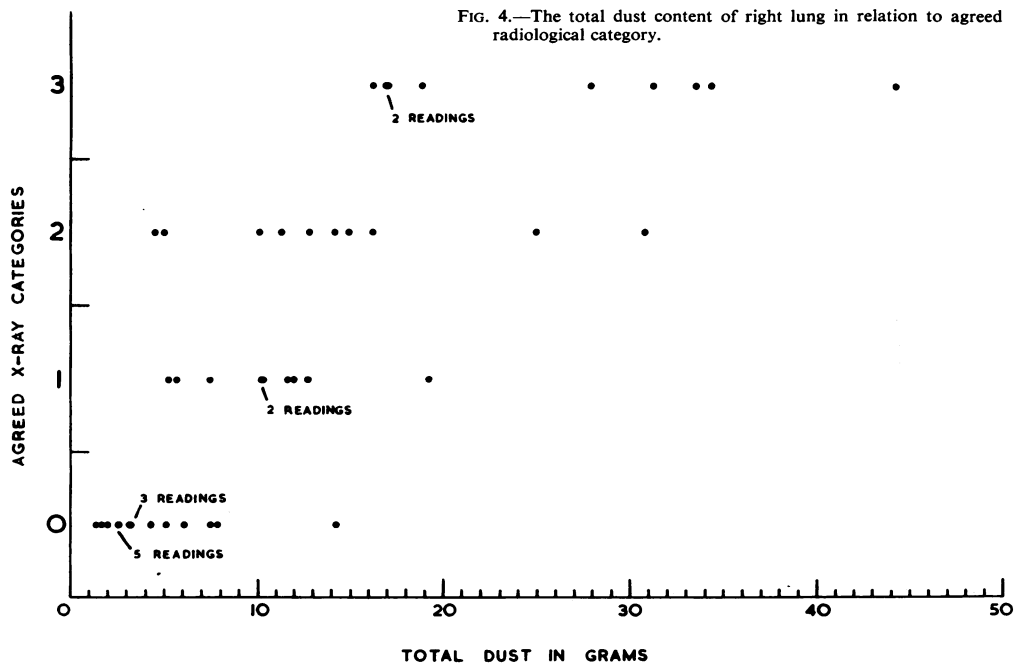
Most of the men had worked more than 20 years and only one man less than 10 years underground. There is a surprisingly poor correlation between the number of years worked underground and the age of the subjects in this group of cases. The wide range of time spent underground made it possible to compare the average amounts of dust retained in the lungs per year for different periods of work. The results are shown in Table 3. These rates doubled represent approximately the calculated annual dust retention in both lungs per man, and range from 0·10 to 3·7 g. per year. Although there is a slight decrease in the average yearly retention of dust with increasing number of years underground, it is small compared with the wide scatter within each group. The distributions of rates of retention per year for the four groups are similar. These results are in accord with those of King *et al.* (1956) who calculated that the average coalworker retained about 1 g. of dust per year in both lungs. Within each age group there is also a wide scatter of rates of dust retention but little difference in the averages. For the age groups 30-44 and 45-59 years the average dust retention per man per year in one lung is 0·61 g. and 0·58 g. respectively. Therefore, age was not an important variable influencing the rate of dust retention in our series.

TABLE 3

AVERAGE AMOUNT OF DUST RETAINED IN RIGHT LUNG PER YEAR

No. of years worked underground	10	10-19	20-29	30-39	40-49
No. of cases	1	8	14	16	6
Average amount of dust retained per year (g.)	1·7	0·50	0·51	0·34	0·41
(Range)	(—)	(0·1-1·86)	(·06-1·58)	(·07-0·96)	(·05-0·84)

FIG. 4.—The total dust content of right lung in relation to agreed radiological category.



2.4 Dust Content of the Lungs and Radiological Category

In Fig. 4 the total dust in the right lung has been plotted against the "agreed" radiological reading. There is a clear increase in the average weight of total dust with increasing radiological category, but considerable overlapping between the categories. Pit accident cases are too few to be treated separately but they did not differ strikingly from the remainder. The range of dust content for radiological category 0 is 1·4-14·2 g.; for category 1, 5·3-19·2 g.; for category 2, 4·5-30·8 g.; for category 3, 17·0-44·1 g. of dust. The means of each radiological category and the ranges are shown in Table 4. Blacklock, Kennaway, Lewis, and Urquhart (1954) have analysed the lungs of adult town dwellers; the largest amount of dust found was 1·33 g. in both lungs and the average amount found in one lung was 0·4 g. The average amount of dust in one lung of a miner with radiological category 0 (4·3 g.) is about 10 times higher.

The dry weights of the lungs varied from 60 to 260 g. but the variation was smaller in the pit accident cases (80-160 g.).

2.5 Mineral Content of Dust

The quartz content of the total lung dust varied from 0·5 to 4·8%, average 2·8%, with one exceptional value (Case 42) of 10·5%. It is of interest that this case showed no specific (silicotic) pathological response to this relatively high quartz content. The quartz was usually about $\frac{1}{7}$ of the silicate mineral content. There was, however, considerable variation in the total mineral content of the lungs in each radiological category. This is seen in the ratio of coal to total siliceous minerals listed in Table 1. It made possible a more detailed analysis of the data, which is given in Part II.

2.6 Pathology

(i) **Emphysema.**—Eight lungs showed moderate and four severe focal emphysema in association with dust foci. Seven lungs showed moderate general vesicular emphysema and three severe emphysema of the same type. In four of the latter both focal and general vesicular emphysema were present. Table 1 shows that there was a tendency for focal emphysema to increase with radiological category and with total amount of dust, but the converse was suggested for general emphysema, those with little dust showing the most general emphysema. In both types of emphysema there is a relation to age. The mean age of cases without focal emphysema was 50 years; for grade 1, 58 years and grade 2, 61 years. The corresponding means for general emphysema were grade 0, 51 years, grade 1, 56 years, and grade 2, 59 years.

(ii) **Amount of Reticulin, Collagen, and Fibrous Dust Nodules.**—Histological sections were available from 43 cases. Six showed no reticulin in the dust foci, 22 were assessed as grade 1, nine as grade 2, and six as grade 3. The results of the reticulin grades and corresponding collagen gradings are set out in Table 5. Half the cases with dust foci of reticulin grade 0 showed collagen +; all the reticulin grade 1 cases showed the presence of collagen, about a third showing collagen +++. Again all the cases with reticulin grade 2 showed collagen and about half of these were collagen +++; all grade 3 reticulinoses showed collagen, one showed collagen ++, three collagen +++, and two collagen ++++. One of these was Case 42 where quartz formed 10·5% of the total lung dust, but in the other case (24) there was only 2·0% quartz. There is a definite trend for increase in amount of collagen fibres with increasing grade of reticulinosis. Study of Table 1, however, does not suggest any

TABLE 4

TOTAL DUST IN RIGHT LUNG AND AGREED RADIOLOGICAL CATEGORY OF COALWORKERS

Agreed radiological categories	0	1	2	3	Male Town Dwellers*
Number of cases	17	9	10	9	26
Average total dust in right lung (g.)	4·3	10·5	14·5	26·7	0·4
(Range)	(1·4-14·2)	(5·3-19·2)	(4·5-30·8)	(17·0-44·1)	(0·12-0·66)

*Calculated from the results of Blacklock *et al.* (1954).

TABLE 5

RELATION OF COLLAGEN AND RETICULIN GRADINGS

Reticulin Grade	Collagen Grade					No. of Cases
	0	+	++	+++	++++	
0	3	3	—	—	—	6
1	—	3	12	7	—	22
2	—	2	3	4	—	9
3	—	—	1	3	2	6
No. of cases	3	8	16	14	2	43

simple correlation between grades of reticulin or collagen and any of the basic data. These results are considered in greater detail in Part II.

Fibrous dust nodules are often seen in dusty lungs, and were present in 15 cases. They appear to occur mainly in those lungs which contain most dust but the lung of Case 1 with only 1·4 g. of total dust contained a moderate number of nodules. Cases 11 and 15 also contained a few nodules despite relatively low dust content and this suggests that the nodules are probably not produced by dust alone. Infection is considered to be a likely additional factor, and, since nodules are more prevalent in the apex of the lung, tuberculous infection was suspected (Gough, 1947).

None of the cases showed macro or microscopic changes suggesting silicosis.

Analysis of Results

3.0 Possible Hypotheses

In this series of coalworkers' lungs, tissue reaction to the dust was only slight and no case showed a silicotic type of reaction. There is abundant evidence that coal and silicates are relatively non-fibrogenic (Worth and Schiller, 1954). This suggests as a simple hypothesis that radiological changes in the chest are produced by inert dust and so depend only on the amounts of some or all the different dust components in the lung. If the tissue reaction to the dusts, although small, does influence the radiological picture and if the reaction is a very slow one, lasting many years, the period of retention will also be important; on the other hand, if tissue round a particular dust focus is formed over, say, one or two years only, and no more is formed after that, then the radiological changes would again depend on total amounts of dust and not directly upon periods of retention. It is possible, too, that one kind of dust is inert and another active. Finally nearly half the cases had emphysema and/or nodules and these might affect the radiographs. The data provide an opportunity of assessing these hypotheses quantitatively. The details of this are in Part II.

3.1 Main Conclusions

There is a better correlation of radiological changes and lung dust content when all independent readings for each radiograph are used instead of the "agreed" value.

Contributions to the radiological changes from the coal and silicate minerals have to be allowed for separately.

The radiological scale was transformed into a more nearly linear one in which equal intervals correspond to equal amounts of dust of a given composition. One gram of silicates was found to contribute about as much to the radiological changes as 9 g. coal and an explanation of this difference based on unequal absorption of x rays is suggested. The possible contribution of the quartz content to the radiological changes could not be reliably assessed as it was too highly correlated with the silicate content. The correlation between radiological change and dust content is not improved by allowing for the period of dust retention in the lung and the amount of tissue reaction to this dust. Thus it appears that in this type of simple pneumoconiosis the radiological changes are due to the amounts of coal and silicates in the lung and not to tissue reaction.

Data on the concentration and size distribution of the airborne dust to which the 45 men were exposed during their work underground are not known. Hence we cannot estimate the proportion of dust deposited in the lungs which is permanently retained. Our results show wide variation of rates of dust retention but provide no evidence on how these rates depend on differences in average dust concentration, different abilities to eliminate dust from the lungs, or other variables.

Estimates are given of the rate dust is permanently retained in the lungs and how this is related to the radiological progression of simple pneumoconiosis.

Part II: DETAILED ANALYSIS OF THE DATA

BY

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4.0 Comparison of Weight of Dust in Lung with Radiological Category

Of all the variables given in Table 1, the total weight of dust seemed to be most closely associated with radiological change. The first detailed analysis indicated wide variation among individuals combined with astonishing simplicity in the average behaviour. This is seen as follows: The bottom of category 0, although not defined by a standard film, corresponds to a lung quite free from dust and can reasonably be called zero on a scale x of continuous radiological change. The top of category 0, that is