COAL DUST.

A CLINICAL AND RADIOLOGICAL REVIEW OF ITS EFFECTS ON THE HEALTH OF COAL TRIMMERS.

by

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INTRODUCTION:-

"The importance of Dust as a factor in Occupational Mortality has attracted the attention of every living authority on occupational diseases from Ramazzini to Sir Thomas Oliver." This statement from a book "Occupational Diseases", by an American author - Goldberg,[3] affords a fitting apology for a study of one of the less well known forms of dust hazard.

The work entailed in writing this Thesis has been carried out by the author while engaged in General Practice. In all branches of Medical work one is brought into close contact with the lives of one's patients, but this is perhaps particularly true in the case of the General Practitioner, and to be of real service to his patients, he must understand something of the work they do and the conditions under which this work is carried out. Above all, he must attempt to give relief to the ailments his patients exhibit, and is often expected to afford this solace in cases where advanced pathological changes render it impossible to do so. The medical problems arising out of Industry naturally vary with the particular occupation involved, and such problems will be of greater or lesser interest to the Medical Profession in general, according to the widespread or

restricted nature of the Occupation, but individual Practitioners, working in an area with one or more basic industry, must thoroughly understand the special effects such occupation or occupations have on the health of their patients employed in the particular industry.

Before this work was commenced, the author was impressed by the large number of men in his own area in South Wales giving their occupation as Coal Trimmers, who presented severe symptoms principally related to the respiratory tract, and to whom relief was afforded with difficulty. This prompted a desire to learn more of the mode of onset and the progress of the disability from which these men suffered, and it was felt that this desire could be gratified by a clinical and radiological review of a series of cases.

A wide interest has been taken in the effects of dust on the Coal Miner. This is due in part to the striking nature of his work and in part to the large number of men involved all over the country. In any study of dust hazards, the miner usually comprises one of the occupational groups considered, and particular attention has been paid to the miner in South Wales in numerous papers by various workers.

The Coal Trimmer has not received such wide attention. This occupation is briefly referred to in several papers and has been the subject of at least one Official Survey by the Medical Research

Council (11), but in view of the fairly widespread nature of the occupation, and the obvious exposure to large quantities of coal dust, it is felt that a special survey of this particular dust hazard cannot be without interest and importance.

It is necessary to emphasise at the outset that the hazards attached to the occupation of Coal Trimming are to a very large extent different from those experienced by men engaged in handling coal at other stages of its production and transit. Were this not so, the study now presented would be a mere reiteration of facts already well known from work done on Coal Miners. The differences in the risks to which the Coal Trimmer is exposed, compared to those experienced by the Coal Miner, can best be appreciated by a note on the respective conditions of work.

The Coal Trimmers upon whom this investigation was carried out were all employed at either the Cardiff or the Barry Docks owned by The Great Western Railway Company. The coal handled is mainly steam coal. Comparatively little anthracite coal passes through the docks at these centres.

The Coal Trimmers work in the hold of the vessel which is being laden. The coal is delivered to them from a hoist; it therefore falls a short distance into the hold. The fall causes an initial very dense cloud of dust, which is quickly accentuated when the men begin to distribute the coal

evenly in all parts of the hold. The area is confined and very largely roofed in. There is no through draught of air, and the dust becomes so dense that the men can barely see their colleagues working only a few feet away. The density of the dust cloud depends also on the size of the coal being shipped - whether large masses at the one extreme or the powdery "Dry Duff" at the other - and also on the efficiency of the watering arrangements. Since 1919 all the hoists are fitted with sprays which moisten the coal as it passes down "The Shoot", in an attempt to lessen the dust nuisance. These are the conditions of their work - a dense dust cloud envelopes them and the coal is frequently damp. Their hours of work are at present eight hour "shifts", but prior to 1919 the men could and often did work for long periods at a stretch, often up to 36 hours with only short breaks for meals, in order to complete the loading of a ship. It follows then, that all the members of this series of cases who were engaged on this work prior to 1919, frequently encountered the dust for prolonged periods, a fact which appears to be of some significance.

If one makes a comparison with the miner who is handling the same type of coal, two important points of distinction arise.

In the first place, the <u>character</u> of the dust to which each class of worker is exposed is different. The Coal Trimmer inhales what is practically pure

coal dust. Chemically this is composed of pure carbon, but may be associated with a small amount of silica. Naturally the presence of silica is of the utmost importance, and the amount present will vary in different areas. Edwards [5] ("Radiographic Diagnosis in Diseases of the Lungs", British Medical Journal Sept. 14th 1935.) states that coal carries 2 to 4 per cent. of silica. Professor S. Lyle Cummins believes that as far as the Coal Trimmers in this area are concerned, the dust they inspire is very nearly free from silica. No actual figure is yet available regarding the percentage of silica in the coal in this area, but it is thought to be small, probably less than one and varying from 0.2 to 0.6 per cent., according to the last mentioned authority.

The Coal Miner, on the other hand, is frequently exposed to dust obviously containing a high percentage of silica. He encounters this when cutting through seams of rock, during boring and repairing operations after shot-firing and from the stone dust used in covering the roadways.

In the second place the <u>amount</u> of the dust to which each is exposed varies. The Coal Trimmer, it is believed, is exposed to a much denser dust cloud. This is due to the fact that his work produces more dust than does the miner's, and also because the ventilation is poor or non-existent. The writer was able, with perfect comfort, to stand at the coal face while the men were at work, but has not had the

temerity to enter a hold while the Trimmers were at work.

It can be seen, therefore, that the Coal Trimmers are exposed to the danger of inhalation of a large amount of a dust which is practically inert, except for the very small silica content noted above. The particular feature which is stressed is the excessive quantity of dust to which the worker is exposed.

The purpose of the present investigation is:-

1. To record the clinical findings in an examination of the chest in men exposed to a dust of this nature.

2. To record the radiological findings in chest radiograms in these subjects.

3. To obtain information on the character of the pulmonary affection in these workers, its mode of onset and development and to form an opinion on the specific nature of the pulmonary condition and on the length of exposure to the coal dust necessary to cause such a condition.

4. To assess the relative importance of the findings in the diagnosis of the condition and in its differentiation from other pulmonary conditions which it may closely resemble.

5. To compare and contrast the findings in this group of cases with the accepted findings in men exposed to dust containing a large percentage of silica.

AVAILABLE MATERIAL.

The material available in this investigation and the way in which the material is handled, must now be briefly considered.

A total of 76 cases was available and X-Rays were obtained in 44 cases. Of the 76 cases, 30 were encountered in General Medical Practice. They were unselected cases, their names and occupation being ascertained from their National Health Insurance record cards. They were then asked to attend for examination, when a full clinical examination, including a detailed Medical history, was made. It was unfortunately impossible to obtain radiograms of the chest in all these cases, and difficulty was also encountered in obtaining sputum for bacteriological examination, chiefly because the men became alarmed that one suspected them of being tuberculous. As many radiograms and sputum examinations as possible were made. The remaining 46 cases had been referred to the King Edward VII Welsh National Memorial Association dispensary in Cardiff for an opinion on the condition of the chest with a view to excluding the presence of a tuberculous infection. All of these had had careful case notes taken, and most had been X-rayed, and sputum tests had been carried out in all except one. The records of the investigations were made available to the author by the courtesy of the Welsh National Memorial Association through the Tuberculosis Officer, Dr. James C. Gilchrist. This

group of cases all revealed chest symptoms and had been referred in order to obtain accurate diagnosis. It may be noted here that none of the 46 cases considered in this paper revealed the presence of an active tuberculous lesion.

ARRANGEMENT OF MATERIAL.

The Thesis is divided into two sections; A dealing with the symptomatology and physical signs displayed by the subjects examined; B - dealing with the radiographic appearances.

The seventy-six cases are subdivided into three groups.

Group I. Comprising 9 cases, was composed of men who were able for full work, without any discomfort, though minor chest symptoms might be present.

Group 2. Comprising 39 cases, was composed of men who were able to carry out their work, despite marked discomfort and disability due to the symptoms they displayed.

Group 3. Comprising 28 cases, was composed of men who were totally unable to work.

In section A, a detailed description of the symptoms and physical signs displayed by each group is given. The conclusions reached are emphasised and comparison is made between the findings in the three groups.

In section B, the radiological appearances are similarly discussed.

Throughout the Thesis an effort is made to exclude all other possible causes for the symptoms and appearances now to be brought forward. As far as possible, every avenue is explored to obtain proof that the facts presented are due to the effects of the inhaled coal dust, and to nothing else.

A general discussion based on the facts presented is then given, in which an attempt is made to give clear answers to the five points already defined as the purpose of the investigation.

The Thesis is completed by a summary of the conclusions reached after consideration of all the evidence presented in the following pages.

SECTION A.

CLINICAL EXAMINATION.

Group. 1.

Group I. Comprises 9 cases, all of whom have full capacity for their work. The age limit is from 27 - 55 years, and the length of service as Coal Trimmers varies from 6 - 34 years.

FAMILY HISTORY.

This has been investigated for two reasons. Firstly the possibility of tracing an hereditary tendency to chest illnesses such as Asthma or Bronchitis and secondly the possibility of the subject having been exposed to the risk of tuberculous infection as a contact.

In this group there is no hereditary tendency to chest illness in any of the cases. In two instances the father is said to have suffered from "bronchitis", but in both instances this condition came on in later life and was partly due to the nature of the occupation they followed.

In only one case is there a history of contact with a person suffering from tuberculosis. A brother suffered from this condition, the pulmonary form, but contact in the later stages was not close as the last year of the infected person's life was spent abroad.

PREVIOUS MEDICAL HISTORY.

Under this heading an attempt was made to trace

as fully as possible the illnesses which had affected members of this group, both as children and during adult life.

In investigating their health as children all were asked if they had suffered from (a) Measles (b) Whooping cough. (c) frequent colds or bronchitis or pneumonia. (d) Scarlet fever. (e) Diphtheria. (f) Rickets. (g) Cervical adenitis.

In this group all were found to be healthy as far as their recollection went.

None had suffered from frequent colds or chest illnesses during childhood.

Three recollected having had measles. One had contracted scarlet fever.

Their previous health in adult life had also been good. Two cases had suffered from a dry pleurisy while working as Coal Trimmers. (22%). Two cases had suffered from pneumonia, in both instances before they began work as Trimmers. (22%). Asked specifically about the frequency and severity of colds, three cases thought they took colds more easily and that the colds were more inclined to "Go to their chests", while two thought that they were more free from colds than in previous occupations. (One was a clerical worker, the other an electrician previously).

In seven members of this group the previous health was checked by reference to their panel records from the time they first came under National Health

Insurance care. The principal object in this was to discover the earliest date at which symptoms of chest disability, however trivial, became apparent.

Before giving tabulated details it should be stated that very few of the men had been engaged in other occupations before becoming Trimmers. Where the previous occupation is of revelant importance a note to that effect is made. This applies to all the cases throughout the investigation.

TABLE I.

Time of onset and character of early symptoms.

No.	Years as Coal Trimmer.	CHEST INVOLVEMENT.
2.	8.	Nil.
*3.	6.	Nil.
4.	12.	Râles in chest 1 and 3 years after work began.
5.	14.	Nil.
7.	34.	Râles 25 years after work began.
8.	28.	Rhonchi 18 years after work began.
9.	14.	Râles 8 years after work began.

* Worked 10 years as a Coal Miner before becoming a Coal Trimmer.

It was ascertained that the average age of the above men at the commencement of Coal Trimming was 25.6 years.

From the table we see that the average time elapsing before symptoms became apparent was 13 years. Also the table shows a definite bronchitis in one case after one year's work. This case was the one giving a history of contact with a tuberculous patient. In all the other cases, at least 8 years, and in two instances a much longer time, elapsed before they required to visit a doctor. In all cases the illnesses were insufficient to make them remain away from work.

It is further seen that in the 4 cases showing early stigmata of chest infection, adventitious sounds in the chest were the earliest detected change.

Two facts of importance emerge from the study of the previous medical history in this group.

1. Two of the men had developed a dry pleurisy after they began work as Coal Trimmers.
2. At least 8 years, and on an average 13 years, elapsed before these men required to consult a doctor, and in all cases signs of bronchial catarrah were elicited on examination.

SYMPTOMATOLOGY.

In this section the symptoms displayed by each patient are reviewed. Attention is given mainly to symptoms referable to the pulmonary or cardiac systems. A symptomatology derived from disease or dysfunction of other systems is only of import if it is the only cause of the patient's disability. Such a symptomatology would not come within the scope of

this Thesis, and such a case could not be reviewed in the strictly limited area of survey included in the present investigation.

All the patients were specially questioned regarding the following symptoms, but were first encouraged to relate their own history:- (a) cough, its character and quality (b) the presence and character of sputum (c) the presence of a blood-stained spit or a frank haemoptysis (d) shortness of breath (3) tightness of the chest (f) pain in the chest (g) swelling of ankles (h) sleep - its character and quality (i) night sweats (j) loss of weight (k) lassitude (l) headaches (m) appetite.

Table II below, shows the principal symptoms found in this group. Any of the above list of symptoms not found in the table did not occur in this group.

A study of this table reveals that the symptoms displayed by this group are few. In view of the definition of the group this was to be expected.

Only two in the group had coughs (22%). These were said to be irritative throat coughs and as the table shows were not accompanied by much sputum. Both were among the older members of the group.

Four cases (44%) said they had sputum. In all cases this was scanty, white and frothy in character, worse after exposure to the dust and contained coal particles then and for several days after. Of these 4 cases two had had the sputum examined for tubercle

bacilli with negative results in both instances.

One case (No.8) gave a history of expectorating sputum containing coal dust after 5 years absence from work during the War. All the other cases only noted coal particles in the sputum immediately after working.

Blood was never present in the sputum in any of the 9 cases, either as streaks or as a definite haemoptysis.

The only case to exhibit a really well-marked symptom was No6, who complained of shortness of breath. This did not seem to interfere with his capacity for full work and had been present for 15 years. The symptom was first noted 10 years after he began Trimming.

Two cases suffered from pain in the chest. One occasionally had dragging pains over the left pectoral muscles, the other had suffered from a right sided basal pleurisy six weeks before examination took place. He had never previously complained of pain in the chest.

Loss of weight of recent onset was present in one case.

TABLE II.

Symptomatology : Group I.

No.	AGE.	COUGH.	SPUTUM. TYPE.	BLOOD.	SHORT-NESS of BREATH.	TIGHT-NESS of CHEST.	PAIN IN CHEST.	SLEEP.	NIGHT SWEATS.	LOSS of WEIGHT.
1	27	None	Scanty: frothy	abs.	-	-	-	Good	abs.	Yes.
2	27	None	Nil.	*	-	-	-	Good	abs.	No.
*3	34	None	Nil.	-	-	-	-	Good	abs.	No.
4	34	None	Nil	-	-	-	-	Good	abs.	No.
"5	39	None except in dust	Frothy: white with coal dust particles.	abs.	-	-	occas. left side	Good	abs.	NO.
6	50	Present slight	Scanty: coal dust present.	abs.	Present 15 years	-	-	Good	abs.	No.
7	52	None	Nil	-	-	-	Right Base. recently	Good	abs.	No.
"8	53	Present 20 yrs	Scanty : frothy. Coal dust present.	abs.	-	Present on walking. Not at work.	-	Poor	Present	No.
9	55	None	Nil.	abs.	-	-	-	Good	abs.	No.

* Miner for 10 years: Coal Trimmer for 6 years

" These two cases had sputum examined for T.B. Negative in both instances.

PHYSICAL EXAMINATION.

The physical examination consisted of a careful survey of all systems, particular attention being paid to the pulmonary and cardiovascular systems. Only the result of the examination of the pulmonary system are recorded in detail, but should details of finding in other systems be relevant, they are noted. A record of the weight of each patient and a note as to the presence or absence of clubbing of the fingers is included in the examination. In as many cases as possible, the shape of the chest, its symmetry and local alterations in symmetry were noted, and a record of the expansion of the chest was made. In certain cases an exercise tolerance test was carried out and results noted.

WEIGHT AND GENERAL CONDITION.

TABLE III

Weight and General Condition.

No	AGE	PRESENT WEIGHT (lbs)	HIGHEST WEIGHT (lbs)	+ Gain - Loss (lbs)	± STAN-DARD. (lbs)	GEN. CONDT.
1.	27	138½	143	-4½	-	F. Good
2.	27	181	181	-	+26	V. Good
3.	34	146	146	-	Stand.	V. Good
4.	34	124	134	-10	-27	Poor
5.	39	154	154	-	Stand.	Good
6.	50	148	158	-10	-	Good
7.	52	164	172	-8	-4	Good
8.	53	157	157	-	-3	Good.
9.	55½	176	176	-	+11	V. Good

"Standard" refers to the standard weight for the age and height as ascertained from published tables.

Five cases show no loss of weight (55.5%).
Four cases show quite a small loss from their highest known weight.
Four cases are approximately at the standard for their age and height and two are above the standard figure.
Only one case is grossly below standard. He was a lightly built man and very thin, who, however, was only 10lbs below his highest known weight.

The men in this group, with the one exception noted, were all of good physique and good muscle development and tone. They appeared to be physically suited to the arduous nature of their occupation.

SHAPE OF THE CHEST.

This was investigated in 7 cases in this group under the headings given in the accompanying table (Table IV).

TABLE IV.

Shape of the Chest.

No.	AGE	ANTERO-POSTr. DIAMETER.	LOCAL CHANGES IN SYMMETRY.	KYPHOSIS
2.	27	Increased	None	Sl. Mid-Dorsal
3.	34	No incr.	None	None
4.	34	No incr.	None	Sl. Mid-Dorsal
5.	39	No incr.	None	None
7.	52	No Incr.	None	Sl. Mid-Dorsal
8.	53	Sl incr.	None	Sl. Mid-Dorsal
9.	55½	No incr.	Sl. Apical bulging.	None

Two cases show a slightly increased antero-posterior

diameter of the chest. One is a young subject who is a good athlete and a rugby footballer and the other, one of the older members of this group.
Four cases show the presence of an early Mid-Dorsal Kyphosis. Two are young men and two among the older men. The change was in all cases very slight and not great enough to cause any detectable increase in the antero-Posterior diameter of the chest.
There was no marked difference in the degree of kyphosis in the four subjects.
The records given are for all practical purposes those of men with healthy chests.

CHEST MOVEMENT.

This was also investigated in the same 7 cases mentioned above under the headings shown (Table V).

TABLE V.

Chest Movement.

No.	AGE	RESPIRATORY TYPE	EXPANS. AT NIPPLE (ins.)	EXPANSION CHARACTER
2.	27	Thoraco-Abdominal	1	Gtr. at base
3.	34	Thoraco - Abd.	1½	Equal
4.	34	Thoraco - Abd.	1¼	Equal
5.	39	Thoraco - Abd.	2	Equal
7.	52	Abdomino-Thoracic	5/8	Equal
8.	53	Abdo - Thoracic	1	Equal
9.	55½	Thoraco - Abd.	1	Equal.

In Five cases the type of respiration was Thoracic

mainly and in two more markedly abdominal.
The chest expansion at the nipple line during a full inspiration was small throughout (Average 1.19 ins) and was smaller in the older men.
Equality of expansion was found in all cases but in one there was better expansion basally than in the upper part of the chest.
The noteworthy feature is the small chest expansion as measured at the nipple line, and also the preponderance of the Thoracic type of breathing which is said to be unusual in men.

PHYSICAL SIGNS IN THE CHEST.

A careful examination of the chest was carried out in each case.

A special note was made of the exact part of the lung at which the physical signs occurred or in which they were best marked with especial reference to (a) the apices and supra-spinous areas (b) the Interscapular regions (c) the basal portion of the lungs.

The area of superficial cardiac dullness was outlined in all the 30 cases personally examined, as it was found possible, with care and practice, to arrive at accurate results and it was felt that this formed a good index of extension of the area of pulmonary resonance.

An analysis of the results of the examination in this group is tabulated (Table VI below).

From the table it can be seen that in the first

five cases, all of whom are young men with a working period of not more than 14 years, very little abnormality is recorded. Cases 4 and 5, with 12 and 14 years' service respectively, show slight basal hyperresonance on percussion, and some slight alteration in the auscultatory signs - case 4 showing diminished air entry, and Case 5 some prolongation of the expiratory sound in the interscapular region. Of these cases No 5 showed a very early diminution of the area of superficial cardiac dullness. Case No 9 an older man, with, however, only 14 years' service as a Coal Trimmer (he was a seaman and a labourer prior to working as a Coal Trimmer) showed some impaired percussion note over both interscapular areas and a blowing respiratory murmur in this region, suggesting a diagnosis of enlargement of the tracheo-bronchial glands. There was no diminution in the area of the superficial cardiac dullness.

The remaining cases Nos. 6,7, and 8 were older men with long service as Coal Trimmers.

They all displayed definite hyper-resonance of the percussion note at the bases of the lungs, and also a generally diminished air entry into the lungs. One showed prolongation of expiration at the right apex. Two of these cases Nos. 7 and 8 showed a diminished area of superficial cardiac dullness.

In no case in this group was there any evidence of finger clubbing

TABLE VI.

Physical. Signs in the lungs. Group I.

No.	Age	Period working (years)	Percussion	Auscultation	Voice Sounds	Superf. Card. Dullness begins at	Diagnosis possible.
1	27	approx 6	Resonant. No def. abnormality.	No definite abnormality	Normal intensity	-	Healthy
2	27	8	Resonant	Nil abnormal	Normal intensity	4th rib	Healthy
3	34	6	Resonant	Nil abnormal	V.F. Sl. dimin. Left side	4th rib	Healthy
4	34	12	Sl. Hyper-resonance basally	Breath-sounds faint lower lobes	Normal intensity	4th rib	Early basal emphysema.
5	39	14	Sl. Hyper-resonance basally	Expir.+ both Interscap Areas	Normal intensity	4th Inter-sp.	Early Emphysema
6	50	25	Basal Hyper-resonance	D.A.E. left apex Expir.+ Rt. apex	Normal intensity	-	Basal. Emphysema ? Fibrosis left apex
7	52	34	Basal Hyper-resonance	Breath sounds. Faint generally.	Normal intensity	5th rib	Emphysema
8	53	28	Basal Hyper-resonance.	D.A.E.generally	Normal intensity	4th Inter-sp.	Emphysema
9	55½	14	Impaired. Note both Interscap. Areas	Blowing. Resp. Sds. Interscap Areas	Generally. usual intensity	4th Rib	Tracheo-bronchial adenitis

D.A.E. = Diminshed Air Entry. Expir. + = Expiration prolonged. V.F. = Vocal Fremitus.

Case No. 5 and Case No. 8 - Sputum T. B. NEGATIVE.

EXERCISE TOLERANCE TEST.

The test was carried out on 7 members of this group. Each member was required to ascend and descend a fairly steep stair of 20 steps and then repeat the journey. The pulse and respiration rate at rest was noted and the rates again taken on completion of the test. The time taken before the rates returned to the resting level was also noted.

A summary of the results is appended (Table VII) From the table it will be seen that in all save one case (No.8) the resting pulse rate was slow. The pulse rate after exercise was not unduly raised, but the increase was greater in the three older members of the group. The time taken to return to the resting level was in all cases well within normal limits, being rather longer in the older members of the group.

The resting respiratory level revealed nothing abnormal in any of the cases and in only one case did the rate after exercise exceed 20. The time of return to the resting level was again within normal limits, but was slower than the time of return of the pulse rate.

The pulse respiration ratio was calculated before and after exercise. One case (No 8) gave a most unusual result.

In 4 cases the pulse rate after exercise increased out of proportion to the respiratory rate, giving an increase in the P:R ratio.

In 2 cases the respiratory rate showed an unproportionate increase, giving a fall in the P:R ratio.

One case remained unchanged.

TABLE VII.

EXERCISE - TOLERANCE TEST.

No.	AGE	PERIOD WORKING (YEARS)	PULSE RATE BEFORE EXERCISE	PULSE RATE AFTER EXERCISE	Time of RETURN (Secs.)	RESPIRATORY RATE BEFORE EXERCISE	RESPIRATORY RATE AFTER EXERCISE	TIME OF RETURN (Secs.)	PULSE:RESP.RATIO RESTING	PULSE:RESP.RATIO EXERCISE
2	27	8	63	90	15	18	20	15	3½:1	4½:1
3	34	6	69	90	40	12	18	60	6 :1	5 ;1
4	34	12	60	84	30	14	16	30	4 :1	5 :1
5	39	14	66	84	45	15	20	60	4½:1	4 :1
7	52	34	69	92	45	16	18	45	4 :1	5 :1
8	53	28	108	134	75	12	15	15	7 :1	9 :1
9	55½	14	72	108	60	18	26	60	4 :1	4 :1

SUMMARY.

The subjects in this group have all full working capacity. Their ages range from 27 years to 55 years and their length of employment as Coal-Trimmers from 6 years to 34 years.

There is no history of familial tendency to chest illness and a tuberculous family history is obtained in one case only.

The previous health of the members of this group, both as children and in adult life was uniformly good. Two cases had suffered from a dry pleurisy after they began work as Coal-Trimmers.

The presence of symptoms and physical signs in this group is minimal. Slight cough, present in two cases. Four cases had sputum, in all cases scanty and mucoid and in one case accompanied by presence of coal dust particles, even when not actively engaged at work. The others had a "black spit" only immediately after a spell of work.

Physical signs reveal (a) no marked alteration in the shape of the chest except for a slight mid-dorsal kyphosis in 4 cases (b) the type of respiration was thoraco-abdominal in 5 cases all with 14 years service or under, and abdomino-thoracic in two cases whose period of service was longer. (c) The expansion of the chest on deep inspiration was generally rather small and somewhat smaller in the men with the longest service as Coal-Trimmers. Expansion of the chest was equal on the two sides in

all cases. No irregularities in expansion were noted. (d) The percussion note was altered in 6 cases, all having over 12 years' service. In all cases except one, the alteration was in the nature of hyper-resonance and was always found at the bases of the lungs. The sixth case showed impairment of the percussion note in the interscapular region. The changes in the auscultatory phenomena were the presence of diminished air entry, some prolongation of expiration at certain definite areas, and in one case a blowing type of breath sound over an area showing impaired percussion note. No case revealed the presence of adventitious sounds at the time of examination. The cases which revealed physical signs on auscultation were the same as those who showed changes in the percussion note. The result of the exercise tolerance test revealed an unduly rapid pulse rate in one case. Generally, the tendency was for the pulse rate to increase slightly out of proportion to the respiratory rate, giving an increase in the P:R ratio.

The earliest period at which even slight symptoms could be detected was after 8 years' work and the average time in this group before symptoms developed was after 13 years' work.

Physical signs of a very slight degree could be detected after 12 years' work and in every patient except one the signs were those of early emphysema. The one exception suggested a diagnosis of enlargement of the tracheo-bronchial glands.

In all these cases the symptoms did not suggest any marked degree of emphysematous change and the emphysema was not produced by a preceding chronic chest infection such as a chronic bronchitis, but appeared to be insidious in origin. All the facts would suggest that early emphysematous changes occur in workers in this occupation and are not due to previous chest disease but may possibly result from working long periods in a heavy dust cloud without proper ventilation and the continued choking and coughing which this entails.

The results of the exercise tolerance test reveal little. Numerically the number of cases is too small. The increase in pulse rate must accelerate the rate of blood flow through the lung tissue, and allow oxygenation of the blood to be more rapidly repeated, thus supplying the extra amount of oxygen required by the tissues during exertion. This reaction appears to conform to what would occur in a healthy individual at the start of any exertion, for it has been shown that moderate increase in the volume of respiration is accomplished by increasing the depth of the respiration only (Flack and Hill[12] Textbook of Physiology 1919 p. 292. quoted by Clark A.J. Applied Pharmacology 1929 p. 319). Hence for the moderate exertion of walking upstairs in healthy men, there would be no need to increase the rate of respiration to any great extent, but the pulse rate would rise. Undue rise in the respiratory rate

would indicate some pulmonary disability preventing the necessary increased depth of respiration. Such an undue rise is noted in one of the cases in this group. He is the oldest member of the group but his experience as a Coal Trimmer has not been extensive. He was not previously in a dusty occupation. All the other cases offer no evidence of any marked pulmonary disability when considered on the evidence of the exercise tolerance test.

CLINICAL EXAMINATION

GROUP II.

Group II comprises 39 cases, all of whom are fit to do their work, but have symptoms which are more or less disabling and very much better marked than the symptoms already noted in connection with Group I.

The age limit in this group is from 30 years to 65 years and the length of employment varies from 6 years to 39 years.

The discussion of the symptomatology and physical signs is presented in the same manner as in group I. and comparisons are drawn in so far as these are possible.

FAMILY HISTORY.

In this group no case gave a family history of predisposition to chest diseases. This is similar to what is found in group I.

On the other hand it was found that out of the 39 members of this group, 9 or 23% gave a history of contact with a tuberculous subject in the family.

Seven of these gave a history of close contact all of them having close relatives suffering from the disease, or who had actually succumbed to it.

Two of the cases gave a history of more remote contact.

PREVIOUS MEDICAL HISTORY.

It was found possible to obtain records of

childish ailments in 27 out of the 39 cases. Fifty-five per cent of this number had suffered from measles as children, 7.5% had contracted whooping cough, 3.5% had suffered from frequent colds with bronchitis, scarlet fever claimed 15 % and diphtheria 7.5% As in group I the health as children appeared quite good, in fact the incidence of respiratory affections is small.

Details of the previous health in adult life were available in all the cases.

The following table (Table VIII) shows the details of these illness and also includes details of the family history.

TABLE VIII.

Family History and Previous Health.

No	AGE	FAMILY HISTORY OF RESP. ILLS	T.B.	PREVIOUS HEALTH.
10	29 10/12	Nil	Nil	Bronchitis: Rheumatism Tonsillitis.
11	30	Nil	Tabes Mesent. (Daughter)	Pleurisy after C.T.: Rheumatism:Tonsillitis
12	31	Nil	Pulm. T.B. (Father).	Bronchitis: Pleurisy after C.T.:Rheumatism: Tonsillitis.
13	33 5/12	Nil	Nil	Pleurisy.
14	34	Nil	Pulm T.B. (2 Uncles)	Bronchitis.
15	37	Nil	Nil	Gall Stones: Otitis Media:Arthritis Rt. Shoulder.
16	37	Nil	Pulm T.B. (Brother in Law)	Pleurisy before C.T.

TABLE VIII (Contd.)

No	AGE	FAMILY HISTORY OF ILLS RESP.	T.B.	PREVIOUS HEALTH.
17	37	Nil	Nil	Bronchitis.
18	38	Nil	Nil	Pleurisy twice, once before once after C.T. Bronchitis:Ac.Rheumatism
19	42 8/12	Nil	Nil	Pleurisy after C.T.
20	43	Nil	Nil	Pleurisy before C.T.: Bronchitis: Sciatica.
21	43	Nil	Nil	No Illnesses.
22	43	Nil	Pulm T.B. (Father and Sister)	Bronchitis:Bronchial Asthma:Pneumonia after C.T.: Myalgia.
23	44	Nil	Nil	Pneumonia after C.T. Bronchitis.
24	45	Nil	Pulm T.B. (Sister)	Dysentery:Malaria: Bronchitis.
25	46	Nil	Nil	No Illnesses
26	46 9/12	Nil	Nil	Pleurisy after C.T.
27	48	Nil	Nil	T.B. testicle removed.
28	50	Nil	Nil	Pleurisy twice afterC.T. Pneumonia twice after C.T.
29	50	Nil	Nil	Ac.Rheumatism:Rheumatoid Arthritis.
30	50½	Nil	Nil	Traumatic Pleurisy after C.T.:Bronchitis.
31	54	Nil	Pulm T.B. (Brother)	Bronchitis:Pneumonia twice-one before one after C.T.
32	55	Nil	Nil	Bronchitis:Pneumonia before C.T.
33	55	Nil	Nil	Bronchitis:Lumbago: Albumin uria.
34	55	Nil	Nil	Pleurisy twice after C.T

TABLE VIII (Concl.)

No	AGE	FAMILY HISTORY OF RESP. ILLS	T.B.	PREVIOUS HEALTH.
35	56	Nil	Nil	Pleurisy:Pneumonia Rheumatism.
36	56	Nil	Pulm T.B. (Mother)	Bronchitis:dyspepsia.
37	57	Nil	Nil	Rheumatism.
38	57½	Nil	Nil	No Illnesses.
39	57 10/12	Nil	Nil	No Illnesses.
40	59	Nil	Nil	Dyspepsia:Dysuria.
41	59	Nil	Pulm T.B. (2 Brothers)	Pneumonia after C.T. Frequent Colds.
42	59½	Nil	Nil	Ac Nephritis:Bronchitis Asthma.
43	60	Nil	Nil	Pneumonia.
44	60	Nil	Nil	Illnesses.
45	60½	Nil	Nil	Bronchitis.
46	61 9/12	Nil	Nil	Rheumatism before C.T. Bronchitis:Bronchial Asthma:Renal-Calculi: Cystitis.
47	64	Nil	Nil	Rheumatoid Arthritis.
48	65	Nil	Nil	No Illnesses.

After C.T. - after beginning Coal Trimming.

From the foregoing table it is noted that the chief previous illnesses are:-

1. Bronchitis, present in 17 (44%) of the group all mainly noted after taking up Coal Trimming.

2. Pleurisy, present in 12 (31%) of the group. Of that number; 9 or 75% had acquired the disease after

beginning work as Coal Trimmers. Two had suffered from it before beginning work and one could not be traced. In only one case was trauma a factor.

3. Pneumonia, present in 8 (20.5%). Of that number 5, or 62% had acquired the disease after beginning work as Coal-Trimmers, one had suffered from it before beginning work and in one case the exact relation to work could not be traced.

4. Rheumatic conditions present in 11 or 28%. The diseases included under this heading are acute rheumatic fever, arthritis, chronic rheumatic pains, sciatica and lumbago. They are noted because they occurred frequently and might conceivably cause some alteration in the efficiency of the myocardium thus affecting the pulmonary circulation.

Table IX below gives a review of 13 of the cases in this group, showing the character and age of onset of the earliest symptoms as ascertained from their National Health Insurance record cards.

TABLE IX

TIME OF ONSET AND CHARACTER OF EARLY SYMPTOMS.

No	YEARS AS COAL TRIMMER	CHEST INVOLVEMENT.
15	11	Râles in chest 2 years after C.T.
18	6	Râles in chest just before C.T.
22	14	Bronchitis + Asthma 2 years after C.T.
23	14	Pneumonia 5 years after C.T.
29	30	Shortness of Breath 20 years after C.T.
33	25	Bronchitis 16 years after C.T.
36	30	Cough and Shortness of Breath 11 years after C.T.
* 40	26	Râles in chest 19 years after C.T.
41	24	Pneumonia 12 years after C.T.
42	34	Cough + Asthma 22 years after C.T.
44	28	No definite history.
46	32	Bronchial Asthma 19 years after C.T.
47	39	No definite history.

* 16 years as Colliery surface worker before he began Coal-Trimming.

After C.T. - after beginning work as a Coal-Trimmer.

The average age at commencement of work in the 11 cases showing chest symptoms was 26.4 years.

The table reveals that the average time elapsing before symptoms became apparent was 11.6 years.

In two cases no definite early history of chest disability could be elicited.
The earliest detected symptoms of disability referable to the chest varied - 5 cases of bronchial catarrh, 3 cases of bronchial spasm, 2 cases of pneumonia, 1 case of shortness of breath.

The facts stated here can be compared with the facts shown in the corresponding table (Table 1) in group 1. Substantial similarity is revealed in the two groups.

A review of this section on previous health, shows that in this group the men had, in the main, a healthy childhood.

Previous illness experienced during adult life revealed:- 1. A high incidence of catarrhal inflammation of the bronchi; 2. A high incidence of pleurisy and pneumonia. These two illnesses were kept distinct. Pneumonia is almost invariably accompanied by pleurisy, but such a combination is classified as pneumonia. In both instances the majority of cases had occurred after the men began to work as Coal Trimmers.

SYMPTOMATOLOGY.

In group I the symptomatology displayed was slight and no conclusions could be made. In group II, in view of the very definition of this group, we have an opportunity to study the symptoms displayed by workers in this occupation and to form some idea

of their frequency and relative severity.

The chief symptoms displayed by each member of the group are tabulated for reference and a résumé of the findings is given below. The details given are partly obtained from the table and partly by means of detailed study of the Medical history of each case individually.

The tabular review is given on a following page.

One fact immediately obtrudes itself; that is the remarkable similarity of the symptoms in all the cases. In the 39 cases considered the numbers of symptoms of sufficient import to demand inclusion was roughly twelve. Naturally a tabular review gives a somewhat stereotyped picture, but even with careful study of the individual case histories one was impressed by the similarity of the symptoms in all the cases. Included in the 12 prominent symptoms were (1) Cough or a frank bronchitis (2) The presence of sputum (3) Haemoptysis (4) Chest pain (5) Shortness of breath (6) Attacks of spasmodic dyspnoea (7) Tightness of the chest (8) Loss of weight (9) Lassitude and Giddiness.

Cough was present in 35 cases (90%) and was the earliest symptom noted in 26 cases (66.6%). In 6 cases it was described as very slight; in the remainder marked and always present. In the slight cases cough only occurred after exposure to the dust and for a short time thereafter. In the

more severe cases it was present at all times. It showed a gradual increase in indidence with increase in the age of the patient, being present in the following percentages in the undermentioned age groups.

1. 30 - 39 years 77%
2. 40 - 49 years 88%
3. 50 - 59 years 93%
4. Over 60 years 100%

Sputum was present in 34 out of the 39 cases (87%). It was described as scanty in 70.6% and copious in 29.4%. In 17% of the cases it was purulent in character, in the remainder mucoid, or white and frothy. It is to be noted that not all those with copious sputum revealed a purulent sputum. In many cases the sputum was most abundant in the mornings. Four cases only (12%) gave a history of coal-dust in the sputum at times other than immediately after work. The 10 cases showing copious sputum were found to be the following age groups.

1. 30 - 39 years 1 case (11%)
2. 40 - 49 years 2 cases(22%)
3. 50 - 59 years 5 cases(33.3%)
4. Over 60 years 2 cases (33.3%)

This again shows a tendency towards greater severity of symptoms in the older men, especially those between 50 and 60 years of age.

Of the 34 cases showing the presence of sputum 19 cases (56%) revealed blood in the sputum. The

blood was present as a streaking in the phlegm in 11 cases (58%) and as a definite though always small haemoptysis in 8 cases (42%-. Six of these cases showed single attacks of haemoptysis and two revealed recurrent attacks. The distribution of this symptom in the age groups already defined was.

1. 30 - 39 years 44.4% (4 cases).
2. 40 - 49 years 33.3% (3 cases).
3. 50- 59 years 60% (9 cases).
4. Over 60 years 50% (3 cases).

This reveals a high incidence in the men between 50 and 60 years of age and a fairly high incidence in the younger men, suggesting that this symptom may be a frequent early symptom of pulmonary damage.

Pain in the Chest was found in 26 of the 39 cases (66.6%) This appeared to be a comparatively common symptom but most of the men suffered only slightly. Only in two cases was the pain discribed as "like a pleurisy". In all other cases only a dull sensation like toothache was complained of. In the majority of cases the pain was not constantly present but varied both in severity and duration. One man had suffered for 15 years and the two youngest members of the group had complained for 5 years. In most however, the symptom had only been noted for a year, suggesting that in the older men previous attacks had been forgotten. A study of the incidence in the four age groups revealed that it was most prominent in the younger men and decreased

in frequency in the older groups. A possible explanation is that chest pain is muscular in origin rather than pulmonary and becomes less frequent as the men acquire the correct method of carrying out their work, and the special muscle groups sonstantly being used become fitted for the greater stress laid upon them.

Shortness of breath and Tightness of the chest were considered as two distinct symptoms. Tightness in the chest was frequently experienced by the patient at rest while shortness of breath was usually though not always, best marked during exertion. In many cases both symptoms were present together, but by no means in all the cases.

Shortness of breath was found in 23 of the 39 cases (59%). The severity and duration of this symptom varied considerably from case to case. One case had suffered for 20 years, one for 15 years another for 10 years and a fourth for 5 years. The remaining 19 cases had suffered from this symptom for less than 2 years. The symptom was most prominent in the older members of this group and 83% of the older men complained of it. Its duration was not more than one year in any of these older members. From this it can be seen that the onset of this symptom appeared to be late even in the older members of the group. The younger men seemed to become affected at an earlier stage, and in them the duration was correspondingly longer. It may be

noted that the youngest member of this group aged 30 had complained of shortness of breath for two years, while the oldest member aged 65 had also complained only for two years.

Many of the men complained of this symptom, but in the majority of the cases it did not appear to be a grossly crippling one. Men examined during an acute exascerbation of bronchitis, naturally felt its presence more.

Tightness of the Chest, was present in 14 of the cases (36%). In 3 cases the tightness was accompanied by acute exascerbations in the form of attacks of asthma. In the rest the symptom was not of long standing and occurred with as great frequency in the younger as in the older members of the group. The severity of the symptom was, however, much better marked in the older members and was one of the most distressing of the symptoms encountered. The complaint was usually of a feeling of constriction around the lower chest, and an inability to take a breath of adequate depth. After exertion the constricting feeling was more pronounced and efforts to inspire became forcible, affecting all the chest musculature.

Two other symptoms occurred with considerable frequency. These were loss of weight and night sweats.

Loss of Weight occurred in 24 cases (61.5%) being found at all ages.

Night Sweats, were present in 4 cases (10%). In two cases loss of weight was present as well. Sputum tests for tubercle bacilli gave negative results in three of these cases. The fourth case unfortunately did not have tests made.

Other symptoms occasionally encountered were, lassitude, vomiting, and vertigo. The first is probably associated with the exertion of coughing and the difficulty of working in the presence of dyspnoea. Sickness is perhaps due to local irritation from swallowed sputum containing coal-dust particles and to the choking sensation evoked by entry into a dense dust cloud. Vertigo is probably due to the alteration in the cerebral circulation brought about by the coughing and difficulty in breathing.

A close survey of all the symptoms displayed was made with a view to discovering what symptom was usually developed first and the approximate time relations in the development of the other symptoms.

Cough with sputum or a frank attack of acute bronchitis was the earliest symptom in the majority of the cases.

Pain in the chest, either pleuritic or as a dull ache, was the symptom next most commonly developed.

Haemoptysis appeared to be next in point of time.

Shortness of breath would seem to be the fourth in the usual order of development of the important

symptoms. Shortness of breath would, therefore, appear not to be an early symptom. If this symptom is present one would expect other symptoms to have preceeded it. This is a general statement to which exceptions occur, as in the case quoted in group I with shortness of breath of 15 years duration as the only symptom.

In the review of the symptoms displayed by members of this group, there is presented,

1. An enumeration of the principal symptoms.
2. An attempt to estimate the incidence and development of these symptoms.

In this latter connection it is noted that cough becomes more general with increase in age of the patient but does not necessarily become more severe.

The presence and amount of the sputum is affected by a similar condition, and blood in the sputum is best seen in the early workers and again between the ages of 50 and 60 years.

Pain in the chest is also more pronounced in the younger workers.

Shortness of breath affects more especially the older workers.

From a study of the men in this group, the main symptoms appear in the order, cough, pain in the chest, haemoptysis, shortness of breath.

TABLE X.

Symptomatology Group II.

No.	AGE.	COUGH	SPUTUM TYPE	SPUTUM BLOOD	SHORTNESS of BREATH.	TIGHTNESS of CHEST.	PAIN in CHEST.	SLEEP.	NIGHT SWEATS	LOSS of WEIGHT.
10	30	Present 5 years	Mucoid	streaks	Present 2 years	Present (Asthma)	Present 5 years	poor	abs.	yes.
11	30	Present	Mucoid	abs.	Present	abs.	Present 5 Years	good	abs.	yes.
12	31	Present 3 years	Muco-purulent	abs.	Present	Present	Present (pleuritic)	poor	Present	yes
13	33½	Present 10 years	White: frothy	small Haemopt.	abs.	abs.	Present	-	abs.	yes
14	34	Present 20 years	Scanty: purulent	small Haemopt.	abs.	abs.	abs.	-	Present	no
15	37	abs.	none	-	abs.	abs.	Present	good	abs.	no
16	37	Present (occas.)	scanty Mucoid	streaks	abs.	abs.	Present slight	-	abs.	no
17	37	Present 11 years	scanty	abs.	abs.	abs.	abs.	good	abs.	yes slight
18	38	abs.	none	-	abs.	abs.	Present frequent	-	abs.	no
19	42 8/12	abs.	none	-	abs	abs	Present	good	abs.	yes

TABLE X. (Contd.)

Symptomatology Group II.

No.	AGE.	COUGH	SPUTUM TYPE	SPUTUM BLOOD	SHORTNESS of BREATH	TIGHTNESS of CHEST	PAIN IN CHEST	SLEEP	NIGHT SWEATS	LOSS of WEIGHT
20	43	Present	Scanty:Mucoid	Haemopt.	abs.	abs.	Present	-	abs.	no.
21	43	Present 10 years	Scanty:Mucoid	Haemopt.	present 3 years	present	abs.	-	abs.	yes
22	43	Present 10 years	Copious:Mucoid or Muco-purulent with coal dust.	abs.	present 10 years	present 10 years asthma	present recent	-	-	-
23	44	Present 2 years	Mucoid or Muco-purulent with coal dust.	abs.	present slight	present at times	present slight	-	abs.	yes
24	45	Present 5 years	Scanty	abs.	present	present	abs.	-	present occas.	no.
25	46	Present recent	Scanty:Mucoid	Streaks	present	abs.	present	poor	present	yes
26	46½	Present 6 years	Scanty:frothy white	abs.	abs.	abs.	present	-	abs.	yes slight
27	48	Present 2 years	Scanty	abs.	present	abs.	abs.	-	abs.	yes
28	50	Present	Copious: Mucoid	Streaks	abs.	abs.	present	-	abs.	yes
29	50	Present slight	Scanty	Streaks (occas.)	present 10 years	abs	present 3 years	-	-	yes

TABLE X. (Contd.)

Symptomatology Group II

No.	AGE.	COUGH	SPUTUM TYPE	SPUTUM BLOOD	SHORTNESS of BREATH	TIGHTNESS of CHEST	PAIN IN CHEST	SLEEP	NIGHT SWEATS	LOSS of WEIGHT
30	50½	present (sev.yrs.)	Mucoid:Muco-purulent:Purulent	Streaks (recurrent)	abs.	present	abs.	-	abs.	yes
31	53	present 15years	Mucoid:Morning mainly. Copious	Haemopt. Mod. amt. single.	present 15years	abs.	present 15years	-	abs.	yes
32	55	present v.slight	scanty	Haemopt. small.oft.	abs.	abs.	present	-	abs.	no
33	55	none	none	-	present 4-5 yrs	-	abs.	-	-	no
34	55	present	scanty	Haemopt. slight recurrent	present slight	present	present 4 years	poor	abs.	yes
35	56	present slight	Fair quantity usually Mucoid	Haemopt. single sl.	present	abs.	present on deep breathing	-	abs.	yes
36	56	present 35years	Frothy Mucoid	abs.	present 20years	present	present (occas.)	poor	abs	no
37	57	present recent	scanty: frothy.	abs.	abs.	present recent	present recent	-	abs.	yes

TABLE X. (Concl.)

Symptomatology Group II.

No.	AGE.	COUGH	SPUTUM TYPE	SPUTUM BLOOD	SHORTNESS of BREATH	TIGHTNESS of CHEST	PAIN IN CHEST	SLEEP	NIGHT SWEATS	Loss of WEIGHT
38	57½	present	Scanty	Haemopt. & streaks	present	abs.	abs.	good	abs.	yes.
39	57 10/12	present slight	Scanty	Streaks	present slight	abs.	present slight	poor	abs.	yes slight
40	59	present	very scanty	abs.	abs.	abs.	abs.	poor	abs.	no
41	59	present (occas.)	none	-	present 2 years	abs.	present (occas.)	good	abs.	no
42	59½	present 12years	Scanty: frothy with coal-dust	abs.	abs.	abs.	abs.	good	abs.	no
43	60	present	Copious	Streaks	present 1 year	present	present	good	abs.	no
44	60	present 3 years	Scanty: frothy or Muco-purulent	abs.	present	abs.	abs.	-	abs.	yes
45	60½	present sev.yrs.	Copious	abs.	abs.	abs.	abs.	-	abs.	no.
46	61¾	present 14 yrs.	Scanty + Coal-dust	abs.	present	present 14 yrs. Asthma	present	poor	abs.	yes slight
47	64	present slight	Scanty: frothy white	Streaks (occas.)	present recent	present	present slight	good	abs.	yes slight
48	65	present sev.yrs.	Scanty: frothy	Streaks	present 2 years	present occas.	abs.	-	abs	yes

PHYSICAL EXAMINATION.

The physical signs in this group are dealt with in the same way as in group I. The detailed results are now given.

WEIGHT AND GENERAL CONDITION.

TABLE XI.

Weight and General Condition.

No	AGE	PRESENT WEIGHT (lbs)	HIGHEST WEIGHT (lbs)	+ GAIN - LOSS (lbs)	± STAN-DARD. (lbs)	GEN. CONDT.
10	30	122	148	-26	-22	-
11	30	138½	168	-29½	-29½	F.G. thin
12	31	126	140	-14	-27	Very fair
13	33½	125	136	-11	-	Poor thin
14	34	143½	144	nil	-36	fair
15	37	155	155	nil	nil	good
16	37	-	-	-	-	excellent.
17	37	129	133	-4	-	fair good
18	38	142	154	-12	-15	thin
19	42 6/12	146½	168	-21½	-26½	fairly good
20	43	146	147	nil	-8	good
21	43	148	164	-16	-20	fair
22	43	122	?	-	-30	poor
23	44	147	161	-14	±12	good
24	45	160	-	-	-2	-
25	46	150	176	-26	-30	very fair
26	46½	137	146	-9	-35	fair.
27	48	153	182	-29	-19	good
28	50	170	188	-18	-	good
29	50	133	136	-3	-40	poor

TABLE XI (Concl.)

Weight and General Condition.

No	AGE	PRESENT WEIGHT (lbs)	HIGHEST WEIGHT (lbs)	+ GAIN - LOSS (lbs)	± STAN-DARD (lbs)	GEN. CONDT.
30	50½	156	-	-	-17	very fair
31	54	141	-	-	-	V. fair
32	55	140	145	-5	-23	fair
33	55	151	151	nil	-11	thin
34	55	124	144	-20	-17	V. fair
35	56	136	161	-25	-	fair
36	56	134	134	nil	-	thin
37	57	143	156	-13	-	-
38	57½	153	168	-15	-	fair
39	57 10/12	140	166	-26	-	-
40	59	136	161	-25	-	fair
41	59	187	188	nil	-	good
42	59½	164	162	+2	-	good
43	60	182	-	-	-	fat
44	60	137	151	-14	-	poor
45	60½	131½	-	-	-	-
46	61 9/12	148	161	-13	-	fair
47	64	216	232	-16	-	big man:fat
48	65	132	158	-26	-	-

"Standard" refers to the standard weight for the age and height as ascertained from published tables. No reference is included under this heading regarding men over 55 years of age, as it was felt that no reliable standard exists.

Out of the 32 cases in which comparison is made, 7 showed no loss of weight (18%). One of the seven cases showed a small gain. In 4 of the cases the loss of weight over a fairly long period was below 10 lbs. In the remaining 21 cases the loss of weight was very definite. The periods over which this loss of weight was calculated, were in all cases fairly long, up to 10 years duration. There was no case of sudden loss of weight.

In 20 cases a comparison of the present weight with the standard weight for the age and height was made. All cases except one revealed a weight below their standard. Twelve of the cases (60%) revealed a loss of 20 lbs. or over below the standard weight and these cases would probably not be included by an Insurance Company as first class lives.

Thus 75% of the members of this group showed a definite loss of weight and practically every member where data were available, showed a marked fall from his standard level.

The general condition of the members of this group, as described in the table, was very largely in accordance with the evidence of their weight chart.

Comparison with the corresponding table under group I. reveals that the general condition of the men in this group, both individually and as a group, was inferior to the condition of the men in group I.

SHAPE OF THE CHEST.

This was investigated in 13 members of this group. The results are appended (Table XII).

The table reveals that in 7 cases there was no change in the Antero-posterior diameter of the chest. In 4 cases the A.P. diameter was increased and in 2 there was a decrease in this diameter, the chest being flat in both cases. Four cases showed the presence of a definite (not slight as in group I) kyphosis. This was Mid-dorsal in three and slightly higher (upper dorsal) in the fourth.

Compared to Group I, the table reveals a tendency in this group towards increasing changes in the shape of the chest Group I reveals some change in 22% of the men, group II in 48%. The alteration may be in the direction of an increase or decrease in the antero-posterior diameter.

TABLE XII.

Shape of the Chest.

No	AGE	ANTERO-POSTr. DIAMETER	LOCAL CHANGES IN SYMMETRY.	KYPHOSIS.
15	37	No change	None	None.
18	38	Incr.	Prominent sternum Slight Pigeon-breast	Mid-Dorsal
22	43	Incr.	Hollowing apices Greater on Left.	Mid-Dorsal
23	44	No change	Hollowing left Apex	None.
29	50	Decr.	Flattening on Left side	Mid-Dorsal
33	55	No change	None	None.

TABLE XII (Contd.)

Shape of the Chest.

No	AGE	ANTERO-POSTr. DIAMETER	LOCAL CHANGES IN SYMMETRY.	KYPHOSIS.
36	56	No change	Sternum prominent	None.
40	59	Decr. Sl.	None	None
41	59	No change	Flattening Right side.	None.
42	59½	No change	None	None.
44	60	Incr. Sl.	None	Sl.Upper Dorsal
46	61 9/12	Incr. Sl.	None	None.
47	64	No change	Sl. Flattening Rt. upper Chest.	None.

CHEST MOVEMENT

This was also investigated in the 13 members whose chest shape has just been dealt with.

TABLE XIII.

Chest Movement.

No	AGE	RESPIRATORY TYPE	EXPANS. AT NIPPLE INS.	EXPANS. CHARACTER.
15	37	Abdomino-Thoracid	1	Lags left side Less left.
18	38	Thoraco-Abdominal	1⅞	Lags left side
22	43	Thoraco-Abdominal	1½	Equal
23	44	Abdomina-Thoracic	1½	Equal
29	50	Abdomino-Thoracic	1⅜	Restricted Left chest.

TABLE XIII (Concl.)

Chest Movement.

No	AGE	RESPIRATORY TYPE	EXPANS. AT NIPPLE INS.	EXPANS. CHARACTER.
33	55	-	$\frac{3}{4}$	Equal
36	56	Thoraco-Abdominal	$1\frac{3}{8}$	Less Rt. side
40	59	Abdomino-Thoracic	$1\frac{1}{4}$	Equal
41	59	Abdomino-Thoracic	$\frac{1}{2}$	V.Sl. Movement.
42	$59\frac{1}{2}$	Abdomino-Thoracic	$\frac{3}{4}$	V.Sl. Movement.
44	60	Abdomino-Thoracic	$1\frac{1}{4}$	Equal
46	$61\frac{9}{12}$	Thoraco-Abd,	$1\frac{1}{2}$	Equal
47	64	-	$\frac{3}{8}$	V.Sl. Movement.

In 7 cases the breathing was more markedly abdominal in type.

In 4 more markedly thoracic.

The expansion at the nipple line during full inspiration is in all cases rather small. The average expansion is almost the same as in groupI. viz:- 1-16 ins compared to 1-19 in Group I. The expansion is slightly unequal in 4 cases, the left sided being affected in three cases and the right side in one.

The Thoraco-Abdominal breathers had a good expansion, generally better than the men of the abdomino-Thoracic type, the average being 1.5 ins to 1.1 ins respectively. It should be noted here that the respiratory type of a patient was noted with the patient at rest, breathing comfortably. It was

noted that the Abdominal element predominated in this group compared to the findings in group I.

Compared to group I the tendency seemed to be towards greater rigidity of the chest, but the findings are not well marked.

PHYSICAL SIGNS IN THE CHEST.

The results of the physical examination of the Chest in this group are now considered. A table showing the principal signs elicited is appended. (Table XIV).

A study of this table reveals the following facts. (1) Seven of the 39 cases (18%) showed no demonstrable physical signs at the time of examination. Two of these cases were aged 37 years and had been working as Coal Trimmers for 12 years. One aged 43 had been Coaltrimming for 20 years and the other 4 for longer periods up to 30 years. It must be noted that all those patients were still engaged in their work and showed symptoms from time to time. Indeed a study of the symptoms displayed by these men reveals symptoms of a severity equal to those evinced by other members of the group, yet no evidence could be elicited on examination. It is also important to note that it is possible for a man of 65 years with over 30 years exposure to coal-dust to remain free from any physical signs in the chest.

(2) All the other 32 members of this group displayed physical signs in a greater or lesser degree. The youngest member of the group aged 30, with 7 years'

working experience, showed a generally diminished air entry with basal crepitations, and in another case, a man of 38 with only 6 years coal-trimming experience showed definite physical signs in the chest.

It is impossible to discuss each case in detail. The physical signs revealed by each member of the group are tabulated and a general discussion and analysis is given. The possible diagnosis on the clinical grounds is appended in the table. This is not meant to be a final diagnosis.

Percussion. The nature of the percussion note was altered in 26 cases (66.6%). In 18 cases the note showed impairment of resonance or actual dullness. The term "impaired" is used to denote a definite loss of resonance not amounting to actual dullness. In this group 16 cases revealed in the lungs areas of impaired note. Only two were found to reveal a dull note on percussion. It was found that the impairment did not follow any definite limitations, but was of a patchy nature. The areas mainly affected were the apices, chiefly the right, and the interscapular regions. In the two instances in which an actual dull note was elicited the apices were involved in both cases. In the 18 cases revealing impaired or dull percussion note, the apices of the lungs were involved in 12 instances, on the right side in 7 cases, on the left side in 3 cases and in one case both apices showed impairment. Out of the 18 cases the interscapular areas were affected in 8 cases.

In several cases more than one area was affected in the same patient. In one case impaired resonance was present over the whole of one lung. No one site appeared primarly to show the change in the percussion note. Different findings were encountered in practically every case. In this group, however, one is able to localise areas in the lungs which reveal alteration in the percussion note, but there would seem to be no characteristic mode of development or progression of such changes. Also it must be noted that marked dullness on percussion is not a frequent finding. In most cases an area of lessened resonance is all that is demonstrable. Such findings, however, would suggest the presence of structural changes in the lung parenchyma and a consequent loss of available air space.

Hyper-resonance of the percussion note was noted in 8 cases in this group, and was a prominent feature in the older men. It was situated basally in 5 of the cases, was confined to one lung in one case, was generalised in both lungs in one case and confined to the anterior margins of the lungs also in one case. The latter was a man of 37 years of age with 12 years' experience as a Coal Trimmer and in addition to the hyper-resonance of the anterior borders showed impaired percussion note in the left interscapular region.

Auscultation. Evidence of physical signs on auscultation was present in 29 cases (74%). Only

3 cases out of the 32 who presented physical signs, failed to reveal abnormal auscultatory phenomena.

The type of breath sounds was altered in one case (2.6%). In this case occasional blowing breath sounds were elicited at the right apex. In all the other cases the breath sounds were vesicular in type. In conjunction with this alteration in the type of breath sound in this case, we find impairment of the percussion note over the corresponding area.

The quality of the breath sounds was altered in an appreciable number of the cases. Thirteen of the cases (33.3%) revealed the presence of diminished air entry into the lungs. In 7 of these cases such diminution was general throughout both lungs. In 5 the apices alone were affected, one on the right side, one on the left and in three both apices were affected. In one case, only the interscapular area was affected. The relation between the auscultatory findings and the signs elicited on percussion must be noted here. We find that generalised diminished air entry, may be associated with a generalised hyper-resonant percussion note, which appears to be a consistent finding. Also we find that generalised diminished air entry may be accompanied by no marked general change in percussion note, but by local patches of impaired note.

In the cases in which the apices alone showed poverty of air entry, changes in the percussion note were not constant. Slight impairment of the note,

or no change at all might be encountered.

Another feature in the auscultatory findings which is of importance is the presence in 13 cases of prolongation of the expiratory sound. It might be thought that such a finding would occur in conjunction with the diminished air entry. Actually in 11 cases out of the 13, no diminished air entry was present and the prolonged expiratory sound formed the principal auscultatory phenomenon. It was usually associated with a hyper-resonant percussion note and in that case was best marked at the bases of the lungs. In a few cases it was found in an area exhibiting impairment of percussion. In one case in this group, it was present as the only abnormality detected on physical examination. This case was one of the younger members of the group.

Accompaniments to the respiratory murmur were present in 18 cases (46%). Crepitations, râles and rhonchi were all found. Crepitations were found in 6 cases and were usually situated basally. Râles were present in 9 cases basal in three, general in three, and limited to one lung (always the right) in three. Rhonchi were found in 3 cases and were general in distribution. Crepitations and râles were found even in the youngest men, but no hard and fast rule regarding the type of accompaniment to be expected, could be enunciated.

The area of superficial cardiac dullness was outlined in 9 cases and was found to be diminished in

4 cases all in men over 40, with more than 14 years experience. In two of these cases other evidence of emphysema was present.

Clubbing of the fingers was present in 7 cases (18%). Two were in young men with 9 and 11 years service, and with very few important physical signs.

Sputum examinations for tubercle baccili were carried out in 25 cases, many repeated, and some having special examinations such as concentration tests and guinea-pig innoculation tests carried out. Negative results were obtained in all cases.

In a review of this section one notes the relative paucity and the indefinite character of the physical signs. Very few of the cases would admit of a definite clinical diagnosis.

The principal physical signs are patchy impairment of resonance with diminution in the air entry and accompaniments. If such physical signs are studied in conjunction with the symptoms displayed by the corresponding cases, great difficulty is experienced in making a diagnosis. The physical signs usually suggest a diagnosis of emphysema with a concomitant bronchitis, but the clinical examination as a whole suggests a more serious underlying cause for the emphysema than a simple bronchitis. In all the cases we have a problem in differential diagnosis. The affection present in the lungs may be due to the occupation the man follows but diseases which might cause similar symptoms and physical signs

are (1) Pulmonary Tuberculosis (2) Bronchiectasis. (3) Parasitic diseases of the lung, (Hydatid disease and actinomycosis) (4) Mediastinal disease (tumours and aneurysm) (5) Enlarged tracheo-bronchial glands. All these conditions must be excluded before ascribing a patient's disability to the conditions of his occupation. Even the least common condition in the above list may be present. Only recently a case has come to the writer's notice in which a Coal Trimmer, who had been admitted to hospital with extensive pulmonary disease diagnosed clinically as silicosis, was found on careful post-mortem examination to be suffering from pulmonary actinomycosis, with concomitant affection of the liver.

The physical signs therefore would appear to be of little help in estimating the exact nature of the disease. One suspects that the extent of the pulmonary damage is greater that the physical signs suggest and it would seem to be difficult to assess a patient's capacity for work from a knowledge of his physical signs alone. A study of the symptomatology is of some additional value and greater help in exactitude is afforded by radiological examination.

TABLE XIV.

Physical Signs in the lungs. Group II.

No.	AGE.	Period Working years	PERCUSSION	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
10	29 10/12	7	-	D.A.E. over both lungs: Creps left base	-	Neg.(1)	-
11	30 2/12	7 approx.	Impaired note both Interscap. Regs.	Breath sounds weak all over: Expir + Rt.Apex:Creps left base	No alteration detected.	Neg.(3)	Emphysema
12	31	8 approx.	Impaired note Rt. Apex and Interscap.	Expir. + throughout	No alteration	Neg.(2)	Emphysema
13	33 5/12	10 approx.	No change	Expir. + both interscap. regs.	V.R. + interscap.regs	Neg.(1)	Tracheo-bronchial adenitis ?
14	34	10 approx	Dull Rt. Apex and Left base	nil def.	No alteration detected	Neg.(1)	none definite
15	37	11	Impaired note Left interscap.reg.: Hyper-resonant Antrly.	nil def.	V.F. and V.R. Sl. diminished left side.	-	none definite
16	37	12	nil def.	nil def.	nil def.	Neg.(1)	none definite
17	37	12 approx	nil def.	nil def.	nil def.	Neg.(4)	none definite
18	38	6	Flat note generally both sides. Definite impairment left interscap and left Supra-spinous areas	Breath sounds faint generally	V.R. and V.F. diminished left interscap area	-	? Pulmonary Fibrosis

TABLE XIV. (Contd.)

Physical Signs in the lungs. Group II.

No.	Age.	PERIOD WORKING YEARS	PERCUSSION	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
19	42	15	Impaired note right Apex.	D.A.E. both inter-scap. Regs.: Creps Rt. base	No alteration detected.	-	?? Pulmonary Tuberculosis
20	43	15 approx.	No changes	Expir. + Rt.Apex Râles left base	No alteration detected	-	? Early Tuberculosis Right Apex.
21	43	20	No changes	No changes	Normal intensity	Neg(3)	none
22	43	14	Markedly resonant over both lungs: Hyper-resonant bases	D.A.E. generally espec. left side. Expir. + both bases. Sibili both sides espec. left.	V.R. + Rt. side (slight)	-	Bronchitis and Emphysema.
23	44	14	Impaired note Rt. Apex and left base. Feeling of resistance Rt.axilla	Expir. + Sibilant Rhonchi bases, & at right apex.	V.R. & V.F. dimin. left side	Neg(1)	? Pulmonary Tuberculosis
24	45	20 approx	No changes	Râles left side	No alteration detected	-	none definite
25	46	19 approx	Impaired note Rt. apex	D.A.E. Rt. apex	No alteration detected	Neg(2)	Fibrosis Rt. apex

TABLE XIV. (Contd.)

Physical Signs in the lungs. Group II.

No.	AGE.	PERIOD WORKING YEARS.	PERCUSSION.	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
26	46 9/12	21 approx	Hyper-resonance left side.	Expir. + both lungs with D.A.E.:Creps right base.	No alteration detected	Neg(6)	Emphysema
27	48	22 approx	No changes	No changes	Normal intensity	Neg(1)	none
28	50	26 approx	Impaired note over right lung.	Râles in the dull area.	V.F. & V.R. dimin. Rt. lung.	Neg(3)	Thickened Pleura Rt.lung
29	50	30	Impaired note right interscap. Reg. Hyper-resonant bases	Expir. + bases Rhonchi left axilla.	No alteration detected.	Neg(1)	Basal Emphysema
30	50½	30 approx	Slight Hyper-resonance.	No changes	No alteration detected	Neg(1)	None definite
31	54	30 approx	Impaired note left interscap Reg.	Expir. + all over occas. fine râle	No definite alteration	Neg(7)	Emphysema
32	55	30 approx	Impaired note left apex.	Fine Creps both bases. Expir. + Rt. & Lt. Apex	V.R. &. V.F. increased both apices	-	some change at apices.
33	55	25	Hyper-resonant both lungs	No changes	No alteration detected	No sputum	Early Emphysema

TABLE XIV. (Contd.)

Physical Signs in the lungs. Group II.

No.	AGE.	PERIOD WORKING YEARS	PERCUSSION.	AUSCULTATION.	VOICE SOUNDS.	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
34	55	30 approx	Impaired note both interscap. Regs. & right apex.	Expir. + Rt. apex. Breath sounds blowing. Occas. Râles.	No alteration detected.	Neg (after conc.)	? Fibrosis Rt. apex.
35	56	30 approx	Impaired note Rt. apex.	Râles and rhonchi right lung	No alteration detected	Neg(2)	? Pulmonary Tuberculosis
36	56	30	Increased sense of resistance. Slight impairment left interscap. region.	Breath sounds faint at apices. Rhonchi in Rt lung only at base	No marked alteration	-	none definite
37	57	30 approx	Hyper-resonant both bases	Expir + all over with Râles espec. basally.	Slight diminution	Neg(2)	Emphysema
38	57½	28 approx	Slight impairment both apices.	D.A.E. all over.	No alteration	Neg(1)	None definite
39	57 10/12	30 approx	No changes	Râles at Rt. base Creps at Lt. base	V.R.+ Rt.Base V.R.- Rt.Base	Neg(3)	Basal Bronchial infection.
40	59	26	Hyper-resonance Bases	Slight.D.A.E. generally.	V.R.& V.F. - no change.	-	None definite.
41	59	24	No changes	No changes	No alteration	No sputum	None

TABLE XIV. (Concl.)

Physical Signs in the lungs. Group II.

No.	AGE.	PERIOD WORKING years	PERCUSSION	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
42	59½	24	Hyper Resonance at base.	Faint breath sounds both apices.	No alteration	-	Emphysema
43	60	-	Nil definite	No definite changes	No alteration.	Neg(3)	none
44	60	28	Dull left apex. Hyper resonance at bases	Faint breath sounds left apex. Expir. + generally.	V.F. & V.R. diminished left side.	-	Fibrosis left apex.
45	60½	35	No definite change	Râles right side.	No alteration	Neg(1)	none definite.
46	61¾	32	Hyper resonance both bases and at Rt.apex	Faint breath sounds at apices.	No alteration	-	Emphysema ?
47	64	39	Impaired note. Rt. & left base: Increase in sense of resistance Rt. upper chest.	Faint Bronchial breath sounds Rt. upper chest. D.A.E. elsewhere.	No alteration	-	Consolidation Rt. upper chest
48	65	-	Nil definite	nil definite	No alteration	Neg(2)	None

D.A.E. = Diminished Air Entry. Expir. + = Prolongation of expiratory sound.

The figure in brackets after the result of the Sputum test indicates the number of examinations made.

EXERCISE TOLERANCE TEST.

This was carried out in 12 cases in this group. The results are tabulated.

From the table it is noted that:-

1. The resting pulse rate is above the average normal in 5 cases compared to 1 case in group I.
2. The average resting pulse rate is 77 beats per minute, compared to 72 in group I.
3. The rise in pulse rate after exercise is not great in any of the cases and is actually less on the average than in group I. (95 compared with 97).
4. The return to the resting level is well within the limits generally allowed, but is slower than in group I. (69 secs. compared to 45 secs.)
5. The resting respiratory rate is much higher than in group I, averaging 21 per min. compared to 15 per min. The rate after exercise increases proportionately and in many instances the increase is large. The time of return to the resting level is again within normal bimits except in one case, but is very much slower than in group I. (Average 75 secs. compared to 40 secs in group I). The respiratory rate returns to normal more slowly than the pulse rate in several cases.
6. The pulse: respiration ratio, at rest and after exercise, remained very similar in this group compared to group I, where the tendency was for the pulse rate to be raised out of proportion to the respiratory rate. It has already been noted that

the pulse rate after exercise is practically identical in the two groups, but in this group the patients require to increase the respiratory rate in order to meet the demand for additional oxygen during exertion. This we assume to be more due to increased damage to the pulmonary tissue, than to increasing age or myocardial changes. It will be noted that the disturbance of both pulse and respiration after exertion is more prolonged than in group I. and again indicates less efficient action by the respiratory mechanism.

TABLE XV.

EXERCISE TOLERANCE TEST.

No.	AGE.	PERIOD WORKING years	PULSE BEFORE EXERCISE	RATE AFTER EXERCISE	TIME of RETURN (Secs.)	RESPIRATORY RATE BEFORE EXERCISE	AFTER EXERCISE	TIME OF RETURN (SECS.)	PULSE : RESTING	RESP. RATIO EXERCISE
15	37	11	64	80	60	20	24	120	3: 1	3: 1
18	38	6	80	88	30	16	18	30	5: 1	5: 1
22	43	14	75	95	-	24	30	45	3: 1	3: 1
23	44	14	80	-	-	27	30	60	3: 1	-
29	50	30	84	120	60	24	30	45	3½: 1	4: 1
33	55	25	78	96	70	18	25	90	4: 1	4: 1
36	56	32	72	84	120	24	36	120	3: 1	3: 1
40	59	26	76	88	60	16	20	16	3½: 1	4: 1
41	59	24	68	84	70	18	18	-	4: 1	4½: 1
42	59½	33	84	108	60	15	18	50	5½: 1	6: 1
44	60	30	90	114	90	27	36	180	3: 1	3: 1
46	61¾	32	69	87	50	15	15	-	4: 1	6: 1

SUMMARY.

The patients in this group are all able to work but have a greater or lesser degree of disability. The age limit is 30 - 65 years and the years engaged in coal trimming vary from 6 - 39 years.

There is no evidence of familial tendency to disease of the chest.

A history of contact with tuberculosis is present in 9 cases (23%).

The previous health of the members of this group, both as children and as adults prior to examination, was not so good as in Group I. The notable illnesses which had affected them in adult life prior to examination were (1) Bronchitis, (2) Pleurisy, (3) Pneumonia, (4) Rheumatic conditions. These illnesses were largely contracted after they began work as Coal Trimmers.

Symptoms were present in practically every case, the principal being, (1) Cough in nearly every case (2) Sputum which was, in all the cases examined, negative for tubercle bacilli. (3) Haemoptysis either as streaking of the sputum or as a frank haemoptysis. (4) Pain in the chest which was a very prevalent symptom, but a slight one. (5) Shortness of breath (6) Tightness of the chest (7) Loss of weight (8) Night sweats.

Cough with sputum, usually mucoid, was the usual initial symptom. Pain in the chest was developed at an early stage and shortness of breath

was a later manifestation.

Physical signs were not invariably present and were found to be of varying severity and not always in keeping with the severity of the symptoms displayed by the same patient.

Seventy-five per cent of the cases showed a loss of weight and there was a general fall of weight below the normal standard.

The shape of the chest was altered in nearly half of the cases examined, either towards an emphysematous type of chest or, less commonly, towards the flat type.

Kyphosis was present in 4 cases only, but was well marked. It was noted that a mid-dorsal kyphosis was found in a patient with a rather flat chest and a definite decrease in the antero-posterior diameter.

The type of respiratory movement showed a tendency to be abdominal rather than thoracic, and the degree of expansion on full inspiration was generally small and rather smaller than in group I. This was taken to indicate a tendency towards an increased rigidity of the chest.

Physical signs in the lungs were present in 82% of the cases. These comprised patchy scattered areas of impairment of the percussion note chiefly affecting the apices and the interscapular regions. The latter area was chiefly affected in the younger patients in this group. A greater incidence of

hyper-resonance of the percussion note was noted in the older men. Six cases showed no alteration in the percussion note but displayed physical.signs on auscultation.

Auscultation revealed a change in the type of breath sounds in only one case. The intensity of the breath sounds was diminished in 33.3% of the men in this group. Accompaniments were present in 46%. There was no predominant type of accompaniment.

A consideration of the value of these physical signs in making an accurate diagnosis has been appended under the appropriate heading.

The result of the exercise tolerance test is discussed in the appropriate section.

In this group symptoms were noted on an average 11.6 years after work had commenced, but there was considerable variation. Two cases had symptoms after 2 year's work and one, who had suffered from chest symptoms previously, was quickly affected after beginning work. It should be noted that the young men in the group appear to have been affected earlier than was the case with the older men. This may, however, be due to inability to remember early slight illnesses in the case of the older workers.

The earliest record of the presence of physical signs is 6 years after work was begun, in a man of 38 years, but they were also present at the age of 30 after 7 years work in two cases, and in two other cases aged 31 and 33 years respectively the same period

had elapsed since they began to work as Coal-Trimmers. On the other hand no definite physical signs were found in the oldest member of this group; aged 65, after nearly 40 years service.

CLINICAL EXAMINATION.

GROUP III

Group III comprises 28 cases. They are all men whose symptoms render them totally unfit to follow their occupation. The age limit is from 44 years to 73 years and the length of employment varies from 20 - 48 years.

Symptomatology and physical signs are presented in the same manner as in the previous two groups.

FAMILY HISTORY.

In group III 4 cases give a family history of chest ailments. Two of them give a history of asthma on the maternal side of the family.

On the other hand there is no definite history of contact with tuberculosis in any of the 28 cases. One case gave a history of having a child who suffered from tuberculous cervical adenitis but no definite proof could be elicited.

PREVIOUS MEDICAL HISTORY.

Records of the illnesses suffered in childhood are necessarily somewhat incomplete.

Thirty-five per cent had suffered from measles, 18% had contracted whooping cough, and 7% had had frequent colds and bronchitis as children.

The percentage number who had suffered from whooping cough is slightly higher in this group than in the two previous groups. The significance of

this is probably slight.

Details of the health of members of this group prior to examination were available in all the cases. The following table gives details of these illnesses and includes the ascertained facts in regard to the family history (Table XVI).

TABLE XVI

Family History and Previous Health.

No	AGE	FAMILY HISTORY RESP. ILLS	T.B.	PREVIOUS HEALTH.
49	44	nil	-	Bronchitis: Influenza Pneumonia after C.T.
50	44	nil	nil	Pleurisy: Double Pneumonia after C.T.
51	47	nil	nil	nil
52	48	nil	nil	Pleurisy: Bronchitis Broncho-pneumonia
53	50	nil	nil	Bronchitis: Rheumatic Pains
54	50	nil	nil	Bronchitis after C.T.
55	53	nil	nil	Influenza.
56	53	nil	nil	Asthma after C.T.
57	54	nil	nil	Bronchitis after C.T.
58	54	nil	nil	Pneumonia before C.T. Frequent colds after C.T.
59	56	nil	nil	Bronchitis. 'Flu.
60	57	nil	nil	Pleurisy after C.T: 'Flu
61	59	nil	nil	nil
62	59	nil	nil	Pleurisy after C.T. Bronchitis Asthma.
63	60	nil	nil	Pneumonia after C.T. Cirrhosis Liver.

TABLE XVI

Family History and Previous Health.

No	AGE	FAMILY HISTORY RESP. ILLS	T.B.	PREVIOUS HEALTH.
64	61	Father and Mother "Bronchitis"	nil	Pneumonia after C.T.
65	62	nil	nil	Bronchitis
66	62	nil	nil	Pneumonia after C.T.
67	62	Mother asthma	nil	Bronchitis after C.T.
68	$62\frac{11}{12}$	nil	nil	Bronchitis Asthma
69	$63\frac{1}{2}$	nil	nil	nil
70	$64\frac{10}{12}$	nil	nil	Bronchitis:Bronchial-Asthma.
71	65	nil	nil	Bronchitis:Pneumonia after C.T.
72	66	Father always had Chest illnesses.	nil	Colds:Bronchitis.
73	67	Mother Asthma	nil	Bronchitis.
74	69	nil	Son?T.B. Cervical Adenitis	Slight recent Bronchitis
75	69	nil	nil	Pleurisy after C.T.
76	73	nil	nil	nil

after C.T. - after beginning Coal-Trimming.

From the table we see that the only notable previous illnesses occurring frequently are:-

1. Bronchitis, present in 15 cases (53.6%)
2. Pneumonia, present in 8 cases (28.6%) all of whom contracted the illness after becoming Coal trimmers except one.
3. Pleurisy, present in 5 cases (18%) all contracted

after beginning work as Coal-Trimmers.

Compared to Group II the only notable change is the smaller incidence of pleurisy as a factor in the previous history.

Table XVII below gives a review of 10 cases showing the earliest period after beginning work at which symptoms developed.

TABLE XVII.

Time of onset and character of Early Sumptoms.

No	YEARS AS COAL-TRIMMER	CHEST INVOLVEMENT.
58	28	Bronchial Asthma 25 years after C.T.
63	42	Pneumonia 27 years after C.T.
64	34	Pneumonia 9 years after C.T.
67	35	Ac.Bronchitis 21years after C.T.
71	43	Ac.Bronchitis 20 years after C.T.
72	45	Bronchitis 32 years after C.T.
73	33	Bronchitis just after C.T.
74	48	Severe colds 20 years after C.T.
75	34	Pleurisy 23 years after C.T.
76	36	Cough and Tightness Chest 24 years after C.T.

The average age at the commencement of work was, in this group, 23 years.

The table reveals that the average time elapsing before symptoms became apparent was 20 years.

The earliest detected symptoms of chest involvement

were (1) Bronchitis 4 cases, (2) Pneumonia 2 cases (3) Pleurisy 1 case, (4) Bronchial Asthma 1 case, (5) Cough with tightness of the Chest 2 cases.

The age of commencement of work in this group is younger than in either of the two previous groups, and the age at commencement of symptoms is slightly older. The greater general age of the men comprising this group makes it possible that earlier signs and symptoms may have been present had records been available. The types of symptom or syndrome comprising the early manifestations of illnesses are very similar to those already noted under the same heading in group II.

The previous health of the men in this group is marked by (1) Mainly healthy childhood. (2) A high incidence of catarrhal infections and also of pneumonia and pleurisy all contracted mainly after beginning work. (3) The later onset of chest involvement as compared to the other two groups.

SYMPTOMATOLOGY.

In the cases discussed under group II, the symptoms commonly found in workers in this occupation are enumerated. In group III cases we have an opportunity of making further study of these symptoms and judging the increase in severity which has brought about complete incapacity.

The chief symptoms are again tabulated for reference and a résumé of the findings is given below (Table XIX).

The symptoms are tabulated under the same headings as those used in group II. It must be stressed, however, that no additional symptom of any material importance was found in this group. The symptomatology was exactly that of group II but of definitely greater severity. One must bear in mind in this connection also that 50% of the members of this group were over 60 years of age and it would be unreasonable to expect ability for full work of such a heavy nature at this age.

Cough was again the most prominent symptom and was present in 96% of the cases (27). Only in 4 cases was this defined as "Slight". In all the others it was a severe symptom. The incidence of this symptom is slightly greater in this group than in group II.

Sputum was present in 26 cases (93%). It was scanty in 12 cases (46%) and copious in 13 cases (50%). One case doubtful.

In 15% the character of the sputum was purulent, in the remainder white, frothy or mucoid. In 19% of the cases coal dust was present in the sputum at times other than immediately after work. One of the oldest members of this series who had actually been away from work for 9 years, still occasionally noted a "black-spit". The incidence and severity of this symptom is seen to be greater than in group II.

Out of the 26 cases showing the presence of sputum 7 or 26.9% noted blood in the sputum. Five cases had sputum which contained at intervals streaks

of blood, one case had suffered from a small haemoptysis, while one had combined both features. The presence of blood in the sputum is a much less common finding in this group than was the case in group II. It is not likely that such a striking symptom could be overlooked even by the oldest worker, and it seems possible that haemoptysis, especially the presence of a true haemorrhage as opposed to streaks of blood in the spit, is a more marked feature in men exposed to continued irritation by fresh contact with the dust from day to day.

Pain in the chest was present in this group in only 46% (13 cases). In 4 cases it was stated to be slight. Pain was not so prominent a feature in this group as in group II and none of the cases gave a history of pain as a long standing symptom. It will be seen from the table that the six oldest members of the group who had been away from work for various periods not exceeding 5 years, did not complain of pain at all. The higher incidence of pain in the younger men has been already noted in group II.

Shortness of breath and Tightness of the chest are again considered separately. Shortness of breath was found in 24 cases 85.7%. It was in most cases, a well marked symptom and one of the most disabling. In direct contradistinction to tightness of the chest it was not present except on exertion or after a severe bout of coughing. Not one of the

men affected appeared to have suffered for a long period from this symptom which is surprising in view of the greater average age and longer working life of most of the members of this group.

Tightness of the chest was found in 16 cases (57.8%). This symptom was a well marked one in the cases in which it occurred but did not appear early in the course of the disease. It was more prominent in the older men, and as in group II was a distressing feature.

Loss of Weight was present in 21 cases (75%).

Night Sweats were present in 4 cases (18%) and in each case was accompanied by loss of weight. Three of the four cases had thorough sputum examinations done for tubercle bacilli. One gave a negative result on 5 separate occasions. A second who was subject to vague rheumatic pains was negative on the one occasion tested. A third case was strongly suspected of having a tuberculous infection but gave a negative sputum test on three occasions, a negative test after concentration of a 24 hours' specimen by the antiformin method, and a negative result on guinea-pig innoculation. The fourth case was not tested. He displayed no suspicious signs of tuberculosis, was 69 years of age and largely overclad.

As in group II an attempt was made to find out the common initial symptoms of disability.

It was found that cough or a frank bronchitis

was the earliest symptom in 32 cases (78.6%).

Shortness of breath was easily the next most prominent symptom.

No other symptom appeared to be present with sufficient constancy to require mention in this connection. Pain, haemoptysis, and loss of weight all appeared as early symptoms but in a small minority of the cases.

This is quite a different picture to that presented in group II. The most probable explanation is that the men in this group are considerably older than the men in group II, and the symptoms they class as early may not really be the initial symptoms of the illness. Thus, the shortness of breath may be simply evidence of a disease process of longer standing.

The symptoms displayed in this group differ but little from those already noted in group II, except in an increase in the incidence and severity of the symptoms. Cough with sputum are the most prominent symptoms, and shortness of breath and tightness of the chest are next in order of appearance. The incidence of pain in the chest appears to be less in this group. Shortness of breath takes some considerable time to develop but is perhaps the most disabling symptom. One would expect it to be more prominent in this group, who are completely unfit for work and of a greater age period.

There is no reason to believe that the facts

noted above contradict the statement of the usual order of development of the symptoms as given under group II. It is believed that the above evidence points to the way in which the disease process developes and gives a clue to the chief cause of permanent disability.

TABLE XIX.

Symptomatology Group III.

No.	AGE.	COUGH	SPUTUM TYPE	SPUTUM BLOOD	SHORTNESS of BREATH	TIGHTNESS of CHEST	PAIN IN CHEST.	SLEEP	NIGHT SWEATS	LOSS OF WEIGHT
49	44	present 8years	Copious	abs.	present	present	abs.	poor	present	yes.
50	44	Slight occas.	Slight: Mucoid	abs.	abs.	-	Slight Lt. chest	-	abs.	abs.
51	47	Slight recent	Scanty	abs.	abs	abs.	abs.	poor	present	yes
52	48	present 6months	Scanty: Mucoid	abs.	present	abs.	present	p -	abs.	yes
53	50	present	Fairly copious: white and frothy.	abs.	present ++	abs.	abs.	-	abs.	yes
54	50	present	Scanty	abs.	present	abs.	abs.	-	abs.	yes
55	53	present 4 years	Scanty. Muco-purulent.	Streaks	present	present	abs.	-	abs.	abs.
56	53	present sev.yrs.	Scanty: Mucoid.	Haemopt. (single)	present	present	present left chest	poor	abs.	yes
57	54	present 6months	Scanty.Mornings only	abs.	present 2 years	abs.	present Lt.side	good	abs.	yes

TABLE XIX. (Contd.)

Symptomaology Group III.

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No.	AGE.	COUGH	SPUTUM TYPE	SPUTUM BLOOD	SHORTNESS of BREATH	TIGHTNESS of CHEST.	PAIN IN CHEST	SLEEP	NIGHT SWEATS	LOSS OF WEIGHT
58	54	present 2 years	Large quantity, frothy	Streaks	present 3 years	present	present slight	poor	abs.	abs.
59	56	present 3months	Copious with Coal Dust. Muco-purulent.	abs.	Present+ 4 months	present	abs.	good	abs.	yes +
60	57	Slight	Scanty	abs.	abs.	abs.	abs.	good	abs.	yes
61	59	present sev.yrs	Morning only: Scanty + coal dust.	abs.	present 2 years	abs.	present slight	-	abs.	yes slight
62	59	Present 3-4 yrs	Scanty: frothy white.	abs.	present 4 years	present	present	poor	abs.	yes.
63	60	present 12years	Copious:Muco-purulent	Streaks frequent.	present	present	present	poor	present	yes
64	61	present 25 years	Slight;Mucoid	Streaks	present	present	present slight	-	abs.	abs.
65	62	present always	Slight:Mucoid	abs.	present ++	abs.	abs.	-	abs.	yes.
66	62	present 4 years	Copious: Muco-purulent.	abs.	present 3 years	present	slight recent	-	abs.	yes
67	62	present 13years	Scanty:Mucoid + coal dust	abs.	present +	present +	present	-	abs	yes

TABLE XIX. (Concl.)

Symptomatology Group III

No.	AGE.	COUGH	SPUTUM TYPE	SPUTUM BLOOD	SHORTNESS of BREATH.	TIGHTNESS of CHEST	PAIN IN CHEST	SLEEP	NIGHT SWEATS	LOSS of Weight
68	62 11/12	present 2 years	Copious: Purulent.	Haemopt. & streaks	present +	abs.	abs.	poor	present	yes +
69	63 1/2	present 3months	Scanty	abs.	present +	abs.	present both sides	good	abs.	yes slight
70	64 10/12	present 5 years	Copious	abs.	present	present	present Rt.side	poor	abs.	yes
71	65	present 27 years	Copious: Muco-purulent and purulent	abs.	present 4 years	present 4 years	abs.	good	abs	yes
72	66	present long time	Profuse: Mixed with coal dust	Streaks.	present	present	abs.	good	abs	yes slight
73	67	present 30 years	Copious: Mucoid & Muco-purulent	abs.	present	present	abs	poor	abs.	yes slight
74	69	present	Copious: Mucoid and coal dust	abs	present	abs.	abs.	poor	present	abs.
75	69	none	none	-	present	present	abs.	fair. good	abs.	abs.
76	73	present V slight	none	-	abs.	present slight	abs.	good	abs.	abs.

PHYSICAL EXAMINATION.

The physical examination is dealt with in the same way as in Groups I and II. Detailed results are given below.

WEIGHT AND GENERAL CONDITION.

TABLE XX.

Weight and General Condition.

No	AGE	Present WEIGHT (lbs)	HIGHEST WEIGHT (lbs)	+ GAIN - LOSS (lbs).	± STAN-DARD.	GENERAL CONDITION.
49	44	130	151	-21	-25	fair
50	44	178	-	-	+4	good
51	47	179	-	-	-	good
52	48	106½	116	-9½	-	poor
53	50	122½	136	-13½	-24	-
54	50	108	144	-36	-	-
55	53	118	130	-12	-	-
56	53	122	166	-44	-36	poor
57	54	113	133	-20	-41	very fair
58	54	162	-	-	-16	poor
59	56	122	134	-12	-36	fair
60	57	131	147	-16	-	fair
61	59	121	135	-14	-	poor
62	59	122	146	-24	-	poor
63	60	224	-	-	-	good
64	61	147	154	-7	-	good
65	62	121½	143	-21½	-	poor
66	62	136½	161	-24½	-	fairly good.
67	62	120	168	-48	-	poor

TABLE XX. (COncl.)

Weight and General Condition.

No	AGE	PRESENT WEIGHT (lbs.)	HIGHEST WEIGHT (lbs.)	+GAIN - Loss (lbs.)	± STAN-DARD.	GENERAL CONDITION.
68	62 11/12	123	182	-59	-	poor
69	63 6/12	124	135	-11	-	fair
70	64 10/12	128	140	-12	-	poor
71	65	148	168	-20	-	good
72	66	163	174	-11	-	good
73	67	126	161	-35	-	V. poor
74	69	167	168	nil	-	good
75	69	150	140	+10	-	good
76	73	144	148	- 4	-	good

"Standard" refers to the standard weight for the age and height as ascertained from the published tables. No reference is made to a standard in men over 55 years of age for reasons given under this heading in group II.

In 4 of the cases tabulated no comparison as to gain or loss of weight is possible owing to insufficient data. Two cases of the 24 remaining men, showed NO loss of weight (8.3%). One of these, practically the oldest member of the group, showed a small gain in weight. The remaining 22 cases (91%) showed a loss of weight. Three showed only a small loss (below 10 lbs.). The loss in the majority of the cases was, however, a heavy one.

Only in 7 cases was a comparison with the

standard weight possible. In 6 cases the present weight was clearly below the standard. In one (the second youngest member of the group) it was very slightly over standard. In five cases out of the six mentioned, the discrepancy between present and standard weights was over 20 pounds.

The general condition (i.e. as to musculative and development) followed very closely the weight chart. Ten were described as of poor physique and development, ten were classed as of good physique and five were in an intermediate category.

SHAPE OF THE CHEST.

This was investigated in 10 members of this group. The results are appended in Table XXI.

TABLE XXI

Shape of the Chest.

No	AGE	ANTERO-POSTr. DIAMETER	LOCAL CHANGES IN SYMMETRY.	KYPHOSIS.
58	54	Incr.	prominent sternum	Slight Mid-Thoracic
63	60	Incr	none	none
64	61	dimin.	Sternum prominent Ribs flattened in front of angles	Mid-Thoracic
67	62	Incr.	Sternum prominent Sulcus at each side Scoliosis convex to Rt.	Lower-Thoracic.
71	65	Incr.	Sternum prominent Harrison's Sulcus	Lower Thoracic
72	66	Incr.	Sternum pushed forward Lower end projects	Lower-Thoracic

TABLE XXI (Contd.)

Shape of the Chest.

No	AGE	ANTERO-POSTr. DIAMETER	LOCAL CHANGES IN SYMMETRY.	KYPHOSIS.
73	67	dimin.	Hollowing apices Indrawn in Respiration.	Lower Thoracic
74	69	Incr.	-	Sl. Mid-Thoracic
75	69	Incr.	None	Sl. Mid-Thoracic
76	73	Incr.	Protruberant Sternum.	None

In this group all the members studied in the table, revealed alteration in the Antero-posterior diameter of the chest. In 8 cases (80%) the diameter was, increased in 2 cases (20%) the diameter was diminished with decided flattening of the chest. A definite kyphosis was present in 8 cases (80%), 4 showing this in the Mid-Thoracic region and 4 in the lower Thoracic region.

The alteration in local symmetry of the chest can be well seen in this group. There is generally a tendency for the sternum to be psuhed forward and to become very prominent.

Compared to the men so considered in the other two groups, there is a much more evident alteration in the shape of the chest notably towards the emphysematous type of chest.

CHEST MOVEMENT.

This was investigated in the same ten men in this group, whose chest shape has just been discussed.

TABLE XXII.

Chest Movement.

No	AGE	RESPIRATORY TYPE	EXPANS. AT NIPPLE. INS.	EXPANSION CHARACTER.
58	54	Abdomino-Thoracic	$\frac{3}{8}$	Both sides equal mainly Vertical.
63	60	Abdomino-Thoracic	$\frac{7}{8}$	Equal.
64	61	Abdomino-Thoracic	1	Equal: quite good
67	62	Abdomino-Thoracic Auxiliary Muscles used	$\frac{1}{4}$	practically undetected.
71	65	Abdomino-Thoracic Auxiliary Muscles used	$\frac{1}{2}$	Equal.
72	66	Abdomino-Thoracic Auxiliary Muscles used	$\frac{1}{2}$	Very slight mainly Vertical.
73	67	Abdomino-Thoracic Auxiliary Muscles used	practically nil	Mainly Vertical.
74	69	Abdomino-Thoracic auxiliary Muscles used	$\frac{1}{4}$	Mainly Vertical.
75	69	-	$\frac{1}{2}$	Equal.
76	73	Abdomin-Thoracic Auxiliary Muscles used	$\frac{1}{2}$	Vertical Mainly.

In 9 cases (90%) the breathing was Abdomino-Thoracic in type, and in 6 of these the respiratory movement was practically entirely abdominal. The expansion in the nipple line during full inspiration was small In no case was the expansion greater than one inch. The average expansion was 0.5 inch approx. compared

to 1.19 inches (Group I) and 1.16 inches (Group II).

Chest movement in the majority of these cases was mainly vertical and in many the accessory respiratory muscles were called into play.

The men in this group reveal a later and more advanced stage of the tendency noted in group II towards loss of expansive power of the lung. The chest in these cases is set in a position of fairly full inspiration and the patients cannot increase the volume of air inspired to any great extent, even by deep breathing.

PHYSICAL SIGNS IN THE CHEST.

The results of the physical examination of the chest in this group are tabulated (Table XXIII). The interpretation of the table is dealt with below Under the heading "Diagnosis possible". The diagnosis suggested by the physical signs is given. This is not intended to be the final diagnosis which could only be definite after X-ray examination.

Only one case in this group (3.5%) revealed no physical signs at the time of examination. This was a man of 59 years with over 30 years' experience as a Coal trimmer. He displayed symptoms of cough with sputum, shortness of breath, pain in the chest, and loss of weight. This patient after a long exposure to the coal dust had symptoms severe enough to incapacitate him, yet revealed no objective signs.

All the other cases displayed physical signs, and the older men, as might be anticipated, appeared

to be more heavily affected.

Percussion. The nature of the percussion note was altered in 15 cases (53%), unaltered in 13 cases (46.5%). It will be noted that alteration of the percussion note is only present in approximately half the cases. It is important to notice that when the note reveals alteration, the change is more definite than in the case of patients in group II. This is especially true of the older men. It is still a patchy alteration, but the areas of dullness are larger, more definite, and more easily localised. Adjacent areas of impairment show a tendency to coalesce to give larger areas. This seemed to be a prominent feature especially at the apices where dullness could be elicited, especially posteriorly, extending over the supra-spinous area and making continuity with an impaired area in the right or left interscapular zone. Another feature frequently noted in the men in this group, was a definite sense of resistance conveyed to the finger during percussion giving the note a flattened tone, but not actually causing loss of resonance.

The areas in the lungs usually revealing impairment were (1) The interscapular regions in 61.5% of the cases, (2) The apices in 38.5%. No distinction could be made as to whether the right or left side was more frequently affected. Dullness at the bases of the lungs, was obtained in only two cases and one case revealed an area of impairment in the axillary region.

The two remaining cases with altered percussion note revealed not impaimment but hyper-resonance. This was marked in one case at the right apex and in the other at both bases. No case displayed a general hyper-resonant note without additional changes. Seven of the cases with impaired percussion note showed areas of hyper-resonance as well.

Compared to the results in group II, there is less involvement of the apices and more change in the interscapular region. There is less general hyper-resonance and more patchy areas of impaired note with adjacent areas of hyper-resonance. In this group, with their longer average period of service there seems to be a tendency for continued action by the dust to result in increased damage to the root areas of the lungs, but all parts of the lungs may be affected. The extent of the areas of impairment is at this atage usually easily appreciated and is thus of more value in diagnosis.

Another important feature revealed by this study is that 50% of the men do not reveal any change in the percussion note. While the foregoing description may be true in a proportion of the cases, it does not apply to all. This may be due to the variable nature of the results of inhalation of the dust or the alteration in the note may be due to extraneous causes and not to dust effects at all. This aspect of the whole subject is better reserved for the general discussion when all the evidence can be considered together.

Auscultation. Evidence of the presence of physical signs on auscultation was found in 27 cases all except the one case already noted.

The type of breath sound was altered in five cases (18%) from the normal vesicular breathing. In 3 cases the breath sounds in the upper chest, at and just below the apices, were medium pitched bronchial in character, while in the two remaining cases the breath sounds were stridulous. In one case this was found at the apex, and in the other best noted at the apex, but audible over the whole of the left lung. In both these cases it is interesting to note that the X-Ray examination revealed gross abnormality in the lung structure which could and probably was producing constriction of a bronchus with some degree of collapse of the portion of the lung supplied.

The quality of the breath sounds showed considerable alteration from a normal state. The most general way in which the sounds were altered, was towards a diminution in the air entry into the lungs. This was present in 15 cases (53.5%). In eight of the 15 cases (53.4%) the change was general over both lungs, in 5 (33.3%) it was best marked on the left side, in 2 (13.3%) it was more prominent in the right lung.

Accompaniments were present in 16 cases (57%). Five cases had râles in the chest at the time of examination.(31%). In two of these the râles were

situated at the left base only, in two they were audible at both bases, in one they were general over both lungs, Five cases showed the presence of rhonchi (31%). All were generalised. Four cases revealed crepitations (25%). In one case they were found only at the left base, in one at both bases, in one at the right apex, and in one all over the left side, but chiefly at the base. Crepitations and rhonchi were associated in one case. Crepitations and râles were found together in one case, the râles being audible at the bases, while the crepitations were found at the apices.

In these cases in which crepitations are audible at the apices, there is usually a strong suspicion of the presence of a tuberculous infection. This suspicion is present when such a finding is made in any patient, but according to Norris and Landis [4] ("Diseases of the Chest and Principles of Physical Diagnosis" 5th Edition p. 553) such signs in a suspected cases of Silicosis are almost certainly due to a complicating tuberculosis. We have not offered any evidence that silicosis is present in the cases under discussion but there is evidence of irritation due to coal-dust, and the two cases in this series with apical accompaniments were carefully considered with this viewpoint in mind.

The description reveals that rhonchi are usually fairly generally situated, râles are more commonly basal but may be generalised, and crepitations are

more commonly situated apically or basally.

Sputum tests were carried out in 18 cases in this series and all gave negative results. One case in whom clinical examination aroused strong suspicion of a tuberculous infection had numerous ordinary tests, a concentration test using antiformin, and a guinea-pig innoculation test carried out, all with negative results.

Clubbing of the fingers was found in 11 cases (39%). It was slight in 4 cases (curving of the nails), definite in 3 cases, and very well marked in 4 cases. The degree of clubbing was usually comparable to the degree of severity of the physical signs and was not markedly dependent on the actual age of the patient.

The remarks on the value of these physical signs in the making of a clinical diagnosis made under group II apply also to the cases in this section. A consideration of signs and symptoms in each case, could give no definite proof that the disease process present in the lungs was due to the nature of the occupation. Many other possible diagnoses must first be excluded. A few of the possible alternative diagnoses with which one is faced have already been indicated under Group II. The only further possibility suggested by certain of the cases in this group is the presence of Carcinoma of the Lung either the type commencing in a bronchus or one that has spread to the lungs from the mediastinum.

It has been thought necessary to give prominence to the difficult nature of the differential diagnosis on clinical grounds. All the cases considered in this paper have been found to be free from such conditions as have been mentioned with one exception. As far as one can be certain all the cases dealt with have no complicating features in the form of the extravenous diseases already noted. The exception (Case No 63) was included in the series when the work was commenced, but was later found to be suffering from a Mediastinal Neoplasm which also involved the Right apical region. He also revealed other interesting X-ray features and was retained in the list as a case of some interest and rarity.

TABLE XXIII.

PHYSICAL SIGNS IN THE LUNGS: GROUP III.

No.	AGE.	PERIOD Working years	PERCUSSION	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAMINATION T.B.	DIAGNOSIS POSSIBLE
49	44	20 approx.	Dull at left apex and both Interscapular areas.	Râles left base	-	Neg. (5)	None definite
50	44	20 approx	No impairment	Breath sounds distant	No alteration noted.	-	? Emphysema
51	47	20 approx	No impairment	Post-tussive Creps.at Rt. apex & in inter scapular Region	No alteration noted	Neg. (1)	? Pulm. T.B. Right lung
52	48	20 approx	No impairment	Post-tussive Creps.at left apex & left base:Expir + Rt apex	V.R. + Rt.apex and left base	Neg.(2) also after Conc.Test and G.P.innoculation test.	? Pulm! T.B. left lung
53	50	28	No impairment	General D.A.E. Right side.	No alteration noted	-	? Fibrosis left lung
54	50	28 approx	Impaired note at right base	Râles left base. Harsh Br. Sds. right side	No alteration noted	-	None definite
55	53	30 approx	No impairment	Rt. lung - D.A.E Lt.lung - striduloous Br. Sds. s and D.A.E.	V.R. + right apex.	Neg. (2)	Not able to diagnose the possibilities clinically

TABLE XXIII. (Continued)

PHYSICAL SIGNS IN THE LUNGS: GROUP III.

No.	AGE.	PERIOD WORKING YEARS	PERCUSSION	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
56	53	34	Slight: impairment right apex.	D.A.E. generally	No alteration noted	Neg(3)	Emphysema
57	54	30 approx	No impairment	General D.A.E.: a few sibilant rhonchi	No alteration noted	Neg(4)	Chr.Bronchitis Emphysema
59	56	28	Hyper-resonance bases Impairment in Inter-scapular regions	D.A.E. left side Rhonchi and post-tussive creps.Rt. base. Sibilant Rhonchi left base	V.R. dimin. generally, espec. left side	-	Bronchitis Emphysema
59	56	35 approx	No marked change.	D.A.E. generally Râles both bases	No alteration noted	Neg(1)	Emphysema
60	57	35 approx	Hyper-resonance Rt. upper chest anteriorly	Expir. + right apex + interscapular area. A few scattered Rhonchi.	No alteration noted	Neg(1)	? Local Emphysema ? Cause
61	59	35 approx	No impairment	No alteration	No alteration noted	Neg(1)	None definite
62	59	35 approx	No impairment	Rt.upper chest Br.Sds.distant cavernous left chest. Br.Sds. have bronchial expiratory sd.	No alteration noted	Neg(4)	Consolidation Rt. and left upper chest

TABLE XXIII. (Contd.)

Physical signs in the lungs. Group III.

No.	AGE.	PERIOD WORKING YEARS	PERCUSSION	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
63	60	42	Stony dull Rt.apex Muffled note inter-scapular areas.Hyper-resonant elsewhere.	Stridulous Br.Sds. Rt.apex.Elsewhere D.A.E. with fine Creps.at Lt.base.	V.R.++Rt.apex V.R. dimin elsewhere	Neg(1)	See notes already given - Mediastinal Neoplasm
64	61	34	Hyper-resonance both bases.Very slight. impaired note.Inter-scap. areas.	Both sides Vesicular not diminished.	V.R. dimin. right apex	-	None definite
65	62	35 approx	No impairment	Expir.+ both apices. A few sibilant rhonchi	No alteration noted.	Neg(3)	None definite.
66	62	35 approx	No impairment	Creps.both apices Râles left base	No alteration noted	Neg(3)	? Pulm. T.B.
67	62 11/12	35	Dull left apex Supra scapular and inter-scapular areas.Dull Rt.apex & both axillae.Increase in sense of resistance	Left lung-D.A.E. generally espec. in dull area. Rt.lung- Bronchial Br. Sds. Rt.apex. Expir+ generally. No accomps.	V.R. + RT.apex V.R. dimin.Lt. base. V.R.+ Rt.base	Neg(1)	Fairly extensive consolidated areas Cause ?
68	62	35 approx	-	Râles all over both lungs.	No alteration noted.	Neg(3)	Bronchitis ?
69	63½	30	Dull Rt. and left apex.	D.A.E. Rt.upper lung Râles basally Rt.& left	No alteration noted.	Neg(6)	? Early Pulm. T.B.

TABLE XXIII. (Contd.)

Physical signs in the lungs. Group III.

No.	Age.	PERIOD WORKING YEARS	PERCUSSION	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
70	64 10/12	35 approx	No definite impairment.	D.A.E. marked in both lungs. Both sides bronchial both apices	No alteration noted.	Neg(1)	None definite Emphysema.
71	65	43	Dull both supra-spinous regions & Rt.interscapular. area. Increased sense of resistance.	D.A.E. generally. Sibilant rhonchi Left lung and at right base.	V.R. dimin. at apices.	-	Emphysema
72	66	45	Impaired note right Interscapular Reg. Hyper-resonance else-where and over left lung.	VesicularBr. Sds. Expir.+ Interscap Regions. Sonorous rhonchi Rt. base & general Lt.side.	V.F. dimin. both lungs. V.R. dimin. right base.	Neg(1)	Emphysema Chr.Bronchitis
73	67	33	Impaired note left base. Hyper-resonance right base.	Faint Br. Sds. left base. Rhonchi generally. Creps. basally.(both)	V.F. & V.R. dimin. left base.	-	Emphysema Left basal Bronchiectasis
74	69	38	Hyper-resonant at both apices. Slight impaired note left interscapular area	Breath sounds faint at bases. Expir.+ generally with Sibilant and sonorous rhonchi.	V.R. & V.F. unchanged	-	Emphysema Bronchitis

TABLE XXIII. (COncl.)

Physical signs in the lungs. Group III.

No.	AGE.	PERIOD WORKING YEARS	PERCUSSION	AUSCULTATION	VOICE SOUNDS	SPUTUM EXAM. T.B.	DIAGNOSIS POSSIBLE
75	69	34	Hyper-resonant basally. Increased resistance sense	Slight D.A.E. left side. No accompaniments	V.R & V.F. slight increase	-	None definite
76	73	36	Hyper-resonant basally. Area of impairment at spine of left scapula	Breath sounds D.A.E. generally Absent at spine of left scapula. No accomps.	V.R. & V.F. dimin. at left scapular spine	-	Emphysema Local Pleural thickening

D.A.E. = diminished air entry. Expir. + = prolonged expiratory murmur.

Br. Sds. = Breath Sounds. V.F. = + Vocal fremitus. V.R. = Vocal resonance.

EXERCISE TOLERANCE TEST.

Unfortunately accufate and complete results for this test were available in only 6 cases. A Table is appended (Table XXIV).

From the table it is to be noted that

(1) The resting pulse rate in the men tested averaged 75 per minute compared to 71 in group I and 77 in group II.

(2) The pulse rate after exercise in the 6 cases who could be tested averaged 95 per minute.

(3) The time taken for return to the resting level is well over the normal time in 2 cases, and the average time is much greater than in groups I or II, being 111 seconds.

(4) The resting respiratory rate is rapid in all the cases, and the average, 22, is above that of group II. After exercise the average rate is 24 which is s slightly less than the average in group II, but the time of return to normal (120 secs.) is very much longer than the corresponding times in either group I or group II.

(5) The pulse respiration ratio before and after exercise was again noted and in 4 cases showed a tendency for the ratio after exercise to rise. The change is small and no conclusive or helpful inferences can be drawn.

It is to be noted that in all the three groups the pulse rates before and after exercise are approximately the same. The differences between the groups

exist in (1) The rate of respiration. (2) The time required for both pulse and respiratory rate to return to the resting level after exercise. This time becomes progressively longer in each group. One cannot however lose sight of the fact that the older men who are mainly grouped in the third group, would be almost expected to show such a state of affairs, on account of their age.

TABLE XXIV.

EXERCISE-TOLERANCE TEST

No.	AGE.	PERIOD WORKING YEARS	PULSE RATE BEFORE EXERCISE	PULSE RATE AFTER EXERCISE	TIME OF RETURN (secs.)	RESPIRATORY RATE BEFORE EXERCISE	RESPIRATORY RATE AFTER EXERCISE	TIME OF RETURN (secs.)	PULSE : RESP. RATIO RESTING	PULSE : RESP. RATIO EXERCISE
58	54	28	84	108	130	18	24	150	5: 1	4½: 1
63	60	42	60	-	-	22	-	-	3: 1	-
64	61	34	81	100	30	20	20	-	4: 1	5: 1
67	62	35	72	90	145	24	27	150	3: 1	3: 1
71	65	43	72	96	240	21	24	105	3½: 1	4: 1
72	66	45	60	84	105	24	30	75	2½: 1	3: 1
73	67	33	90	-	-	25	-	-	4: 1	-
74	69	48	80	90	20	24	20	-	3: 1	4½: 1
75	69	34	78	-	-	19	-	-	4: 1	-
76	73	36	82	-	-	20	-	-	4: 1	-

SUMMARY.

The subjects in this group are all unfit to carry on their occupation. The age limit of the group is 44-73 years and the years employed in the occupation vary from 20-45.

In two cases only is there a familial tendency towards disease of the chest.

There is no history of contact with a sufferer from tuberculosis in any of the members of this group.

As children all the subjects were relatively healthy and in adult life the same illnesses as in group II appeared to have been prevalent in this group also. This group showed a slightly higher incidence of bronchitis in the previous health than did group II.

The symptomatology displayed by this group is very similar to that of group II. No new symptom is adumbrated. The symptoms appeared to be of definitely greater severity. Shortness of breath is a very prominent symptom in this group - much more so than in group II. This was concluded to be evidence of a disease process of longer standing i.e. that shortness of breath is a symptom which usually takes a long time to develop. Its severity may determine ability or non-ability to continue at work.

The physical signs were also very similar to those in group II, but were more definite, though

still equivocal as far as diagnosis was concerned. Loss of weight was a more common feature. There was a marked tendency for the shape of the chest to be altered towards that shape usually associated with the presence of emphysema, but a minority of the cases showed a flattened chest. Alteration was however present in all the cases examined compared to only 50% of the cases examined in group II. In practically every case examined the type of respiration was abdominal, and there was in most of the cases bery little thoracic movement on respiration, indicating an inability to expand on the part of the lungs. In group II this was only noted in 64% of the cases. Physical signs in the chest were present in 96% of the cases.

Alteration in the percussion note was found in only half the cases but in these cases the extent of the impaired areas was greater than that found in group II and the sign was more easily elicited. The dull area frequently involved the apices and inter-scapular zones. A peculiar sense of resistance somewhat like that experienced by the finger on percussion over a chest containing fluid, was noted in several cases. Areas of hyper-resonance of the percussion note were found in about one-third of the cases. All the cases except one revealed abnormal physical signs on auscultation. The type of breath sound was altered in 5 cases. The intensity of the breath sounds was diminished in 53.5% of the cases. Accompaniments were present in 57% of the cases and no type of accompaniment was predominant. The importance of apical crepitations is stressed.

The value of these physical signs for the purpose of making an accurate clinical diagnosis is discussed under the appropriate heading and the differential diagnosis from Pulmonary Neoplasm is added to the list already given under group II.

A note is made on the results of the exercise-tolerance test and their significance is pointed out.

In this group, symptoms were noted on the average 20 years after work as Coal Trimmers had commenced. There was again a large variation in the exposure times before symptoms became prominent. The men in this group had commenced work at an earlier average age than the men in either of the other two groups, and were exposed to the dust for a much longer time before showing symptoms or signs. There is no reliable evidence in this group regarding the earliest time after beginning work at which physical signs appeared.

The foregoing pages present a detailed account of the actual clinical findings in this group of cases all of whom are employed as Coal Trimmers.

We have already pointed out that a clinical examination has not revealed any symptoms or physical signs which can be attributed solely to the effects of this particular occupation on the workers. The findings disclosed are common to many forms of pulmonary disease and without a knowledge of the occupation the men follow, one would not necessarily attribute their symptoms to the effects of inhalation

of coal dust. In this connection it has been necessary to attempt to show that other ailments which might cause a similar train of symptoms and physical signs are actually absent in the cases reviewed. With this in view the previous health of the men has been stressed and in cases where serious pulmonary illness has been disclosed, the relation of this illness to the time of beginning coal-trimming has been noted. The relationship of the symptoms and physical signs to a possible tuberculous infection has also been mentioned and efforts made to exclude the presence of the latter infection.

It is now necessary to turn to the radiological appearances found in men engaged in this occupation, to obtain further information as to the effects, if any, of coal-dust on the lungs of these patients. Here again it will be necessary to exclude X-ray appearances produced by previous or coincident disease.

A full discussion and summation of the evidence collected, is given in the Discussion at the end of this paper, after the radiological findings have been presented.

SECTION B.

RADIOLOGICAL EXAMINATION.

GENERAL DESCRIPTION

INTRODUCTION.

In this section the X-ray films of workers in this occupation are studied in detail, the appearances found are noted and an attempt is made to assign to a definite cause the abnormal appearances found in the films. The grouping used in the Clinical Section is retained but a certain amount of rearrangement has been made in order to correlate similar changes in the X-ray films and bring out more clearly contrasting pictures.

A general survey of the 44 radiograms available, revealed that practically all showed abnormal appearances. This allowed the films to be grouped into two classes. (1) Those which showed no abnormality. (2) Those showing abnormal appearances. In the second group while the changes in all the cases revealed points of similarity, there were marked differences between the films. The differences were mainly to be found in the extent and degree of alteration present and not in the type of alteration. It was found possible to subdivide this latter group into three sub-groups according to the appearances of the X-ray plates, and a description of each subgroup and its characteristic features is given in this section.

A general description of the radiographic appearances in each of the three clinical groups is first given. This is done to show the general type of appearance encountered and the variations in the appearances of the X-ray films of men with approximately similar working capacities.

Thereafter the available films are regrouped into the three subgroups already mentioned and a detailed study of each group is made, in which clinical findings and radiological appearances are correlated.

Lastly in three cases, two or more X-rays were available, taken at intervals while the patient was under observation. These are described and the changes found are noted.

Before proceeding with the details of the radiological examination it is necessary to explain one point in the terminology. It was found that all the films displayed an appearance which could best be described by the term "mottled." The character of this mottling showed some variation and three main types were detected. These are:-

(1) Faint Mottling:- This was usually best marked in the Hilar areas and seemed to spread thence outwards into the general lung field. The appearance could be likened to that of a honeycomb. The walls of the "cells" were clearly outlined and the "cell space" not encroached on. The cell walls are of varying thickness and a little indefinite in

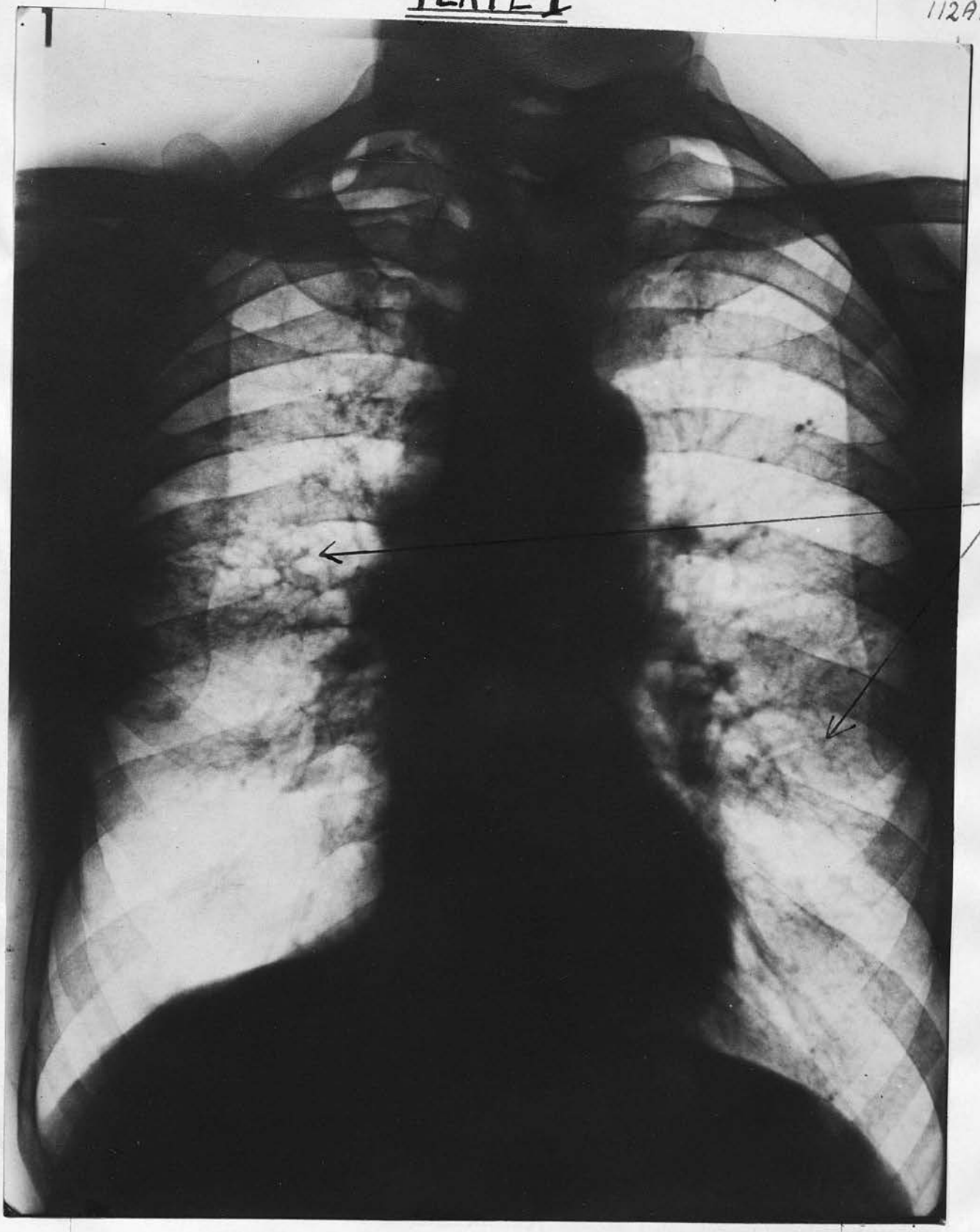
contour with an occasional beaded appearance best marked near the hilum (Plate I).

(2) Fine Mottling:- In this the honeycomb arrangement is still visible. The "cells" are much smaller and the walls much more indefinite and much thicker. The tendency towards beading is much more definite, some of the beaded areas being almost large enough to be called nodules. The "cell spaces" tend to be encroached on. This type is best seen near the hilum and basally (Plate II).

(3) Woolly Mottling:- This is best marked basally. The honeycomb element is still noticeable but the "cells" are much larger very irregular in shape with very thick badly defined walls with great individual variation in thickness of the walls. The beaded areas are very large with woolly indefinite edges (Plate III).

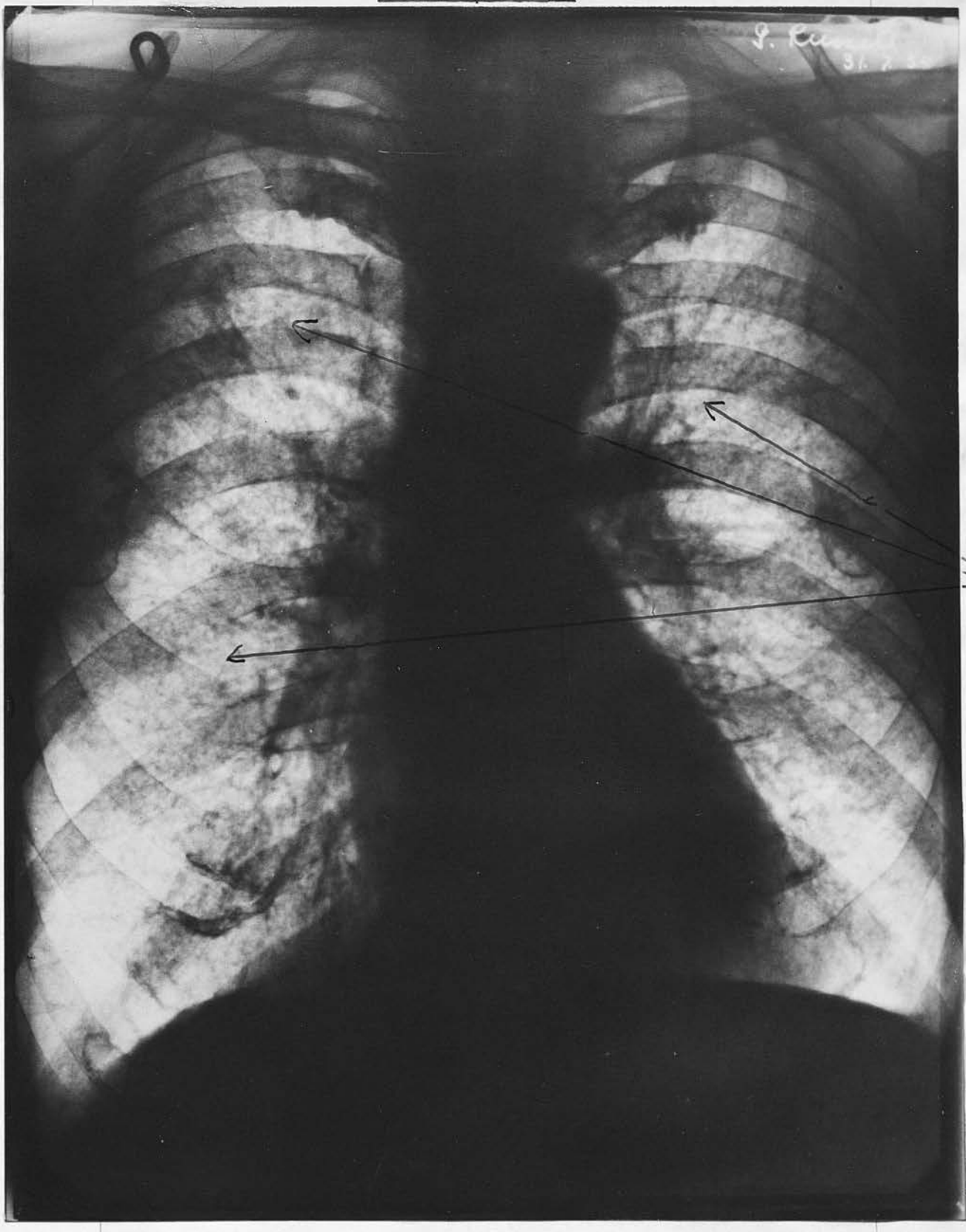
X-ray plates exemplifying these appearances are, inserted in the pages immediately following.

PLATE I



A. _____ AREAS of FAINT MOTTLING.

PLATE II



A. _____ AREAS OF FINE MOTTLING

GROUP I.

In the Clinical group I nine cases were included, only two X-rays are however available - No 1 and No. 6.

No I. was a young worker aged 27 with approx. 7 years service. The X-ray picture showed no alteration in the position of the ribs and no mediastinal enlargement. There was a slight increase in the extent of the root shadows and increase in the extent and density of the trunk shadows especially on the right side. The lung fields displayed a very early faint mottling situated only in the right upper lobe. The appearance in the upper lobe was different to that obtaining elsewhere in the lung fields. The outline of the diaphragm was regular.

No 6. was a man of 50 years with 25 years service. The ribs were somewhat horizontally placed on the left side. There was no alteration in the Mediastinal shadow. There was an increase in both the root and trunk shadows best seen on the left side. The lung fields showed the "fine" type of mottling especially marked on the right side near the hilum and towards the base and on the left side in the mid-zone. The diaghragmatic outline was regular. There was no suggestion of nodulation.

The above pictures illustrate at this early stage at least one feature which will be discussed at greater length elsewhere, namely the discrepancy

between the years spent in coaltrimming and the resultant X-ray picture. Neither of these cases revealed any disabling symptom and there was no evidence of any complicating disease which might have caused the changes, observed in the radiograms. Also Case No I. reveals that, despite the absence of changes in the general lung fields, hilar shadows are increased at this early period beyond the limits usually found in a young man otherwise healthy.

In both instances the right side appeared to have been rather more affected than the left. In No I. the very slight degree of mottling was on the right side and the hilar shadows were more pronounced here. In the second film No 6, the changes were more advanced on the right side and mottling on the left side was confined to the mid-zone adjacent to the hilum.

GROUP II.

The number of X-rays available in this group was 24. The ages of the men whose X-ray films are described range from 30 years to 65 years.

Out of the 24 cases some alteration in the rib positions and widening of the interspaces was present in 12 cases (50 per cent). Three cases showed the changes generally on both sides. Four cases showed the alteration especially on the left side. Five cases displayed this feature principally at the bases on each side. This alteration is usually found in cases in which there is a considerable

degree of emphysematous change in the lungs and speaks of the definite presence of this change in a considerable proportion of the men in this group.

Mediastinal broadening was noted in 10 cases (41.7 per cent). Five showed a generalised widening of the mediastinal shadow, and five revealed the broadening only at the upper part. In three of the latter this was due to broadening of the aortic arch. In one case only was the mediastinum actually displaced from its normal central position. The alteration in the mediastinum was best marked in the older members of this group.

Hilar and root shadows showed an increase in extent or density or both in 79 per cent of the cases. In 4 cases this was best seen on the left side, in I case best seen on the right side, and in the remaining 14 cases the sides appeared equally affected. In only two cases in this group was there evidence in the X-ray of an old tuberculous infection. In one case a calcified gland was noted at the left hilum and in another a small calcified focus in the second right intercostal space. In general terms hilar changes were rather more marked in the older men with a longer period of service.

The examination of the lung fields revealed the changes detailed below.

In no case was the appearance normal. The condition of the lungs as revealed by X-ray examination varied from one case (No 14) which showed very faint

mottling especially at the hilar regions on both sides to another (No 38) in which the fields were in great part opaque due to the density of the mottling with superimposed dense aggregated masses.

Mottling of one or other of the types previously described was present in all the cases at some part of the field but was frequently associated with other more advanced changes.

Nine cases in this group (37.5 per cent) showed mottling only. This was of the "faint" type in 5 and "fine" in 4 cases. The mottling was best marked on the right side in 4 cases and on the left in 5 cases. Seven of the nine cases showed a considerable degree of peribronchial thickening. This always began at the hilum and extended outwards into the lung fields usually either towards the apex or towards the base. In two cases the condition was very marked and the thickened bands radiated outwards to all parts of the lung like spokes from the hub of a wheel. There were no nodules or aggregated masses in these nine cases. Basal emphysema was present in 4 cases, and early diaphragmatic adhesions were encountered in two cases, one affecting both sides, and one on the left side only.

Nine cases (37.5 per cent) showed mottling with nodules or larger aggregated masses which appeared to be formed by the coalescence of separate nodules. The mottling was "fine" in 3 cases and of the "woolly" type in 6 cases. It was constantly more

dense near the hilum on the right side, but on the left side was best seen towards the base. Three of the cases showed peribronchial thickening, The nodules varied in size from a large pin head to a split pea. Basal Emphysema was found in two cases. Two cases showed localised pleural thickening. Diaphragmatic adhesions were present in five cases, two of which revealed a marked degree of the condition with peaking of the affected side.

Six cases (25 per cent) showed dense mottling with occasional large discrete nodules and aggregations of nodules, together with large masses, circular or pear shaped, with an outline clearly defined at some parts of the circumference and rather indefinite and fluffy elsewhere. The mottling was "fine" in 4 cases and "woolly" in two cases. The "fine" type of mottling displayed in these cases was very dense and in two cases practically confluent forming a film or haze over the whole field. One case revealed basal emphysema. Four cases showed the presence of diaphragmatic adhesions two of which were extensive.

A summary of the general changes found in X-ray films of members of this group reveals (1) Some widening of the rib interspaces in 50 per cent of the cases, most constantly seen near the bases. (2) An increase in the breadth of the mediastinal shadow in 41.7 per cent of the cases, best marked in the older members of the series, but only one case in

which there was actual displacement of the mediastinum was noted. (3) An increase in the density or extent or both of the hilar shadow in 79 per cent of the cases, again best marked in the older members of the group. (4) Changes in the lung fields in all cases either (a) Mottling (b) Mottling with the presence of nodules or (c) Mottling with nodules and large opaque shadows. (5) Increased thickening of a peribronchial distribution best seen in the early group with mottling only, and perhaps rather more marked basally than elsewhere.

GROUP III.

The number of X-rays available in this group was 18. The ages of the men whose X-ray plates are presented range between 44 and 66 years. Seven of the members of this group are aged 60 or over and the group includes a number of men with very long service as coal-trimmers. Five of the seven men over 60 years of age had an average period of service of 36 years.

In the 18 cases, 8 or 44 per cent, showed alteration in the position of the ribs with widening of the interspaces. Only one case showed a general elevation of ribs and widening of the interspaces. Six revealed bilateral widening at the bases and one basally, chiefly on the right side.

Ten cases (55 per cent) showed marked broadening of the mediastinal shadow and in addition two others

displayed a notable enlargement of the aortic shadow. In two cases the whole mediastinum was definitely displaced to the left side. In both these cases there was advanced fibrosis on the left side.

In 16 cases (88 per cent) there was an increase in density and extent of the root shadows. In 13 of these cases the change was noted on both sides, in 3, on one side only. This increase was very definite in all the 16 cases and a more striking feature than in group II. In three cases calcified glands were found at the hilum, two on the left side and one on the right. As far as this change was concerned, no distinction could be drawn between the various members of the group as regards age and length of service. It was impossible to make distinction regarding the extent of this change. One case (No 72) with 45 years' service had no marked hilar increase.

The lung fields presented changes of a somewhat similar nature to those found and already described in groups II. Again the variety of the picture must be stressed. One case with 34 years' service, and now unfit to follow his occupation, showed an entirely negative film. Two cases revealed mottling only. In both cases this was "woolly" in type with a very few pin head nodules. The mottling in both cases was general but was best marked in the right and left upper lobes in one, and in the right and and left lower lobes in the other. Both showed some

degree of emphysema, one basally and the other generally over the right side. The latter also revealed a diaphragmatic adhesion on the right side.

Four cases showed mottling and the presence of nodules. The mottling in all cases being of the "fine" type but very dense. The nodules were numerous and mainly small, and in one case only well marked in the zone adjacent to the hilum. Two of these cases revealed basal emphysema, and none of the four showed any alteration in the contour of the diaphragm.

Eleven cases showed the presence of mottling with nodules and in addition large aggregated masses. In all these cases except one, the large aggregations occupied the greater part of the lung field and the areas of mottling were found surrounding the masses. The exception mentioned showed no aggregations but a very dense fibrosis on the left side with a cavity formation in the upper part of the lower zone. Such an appearance gave rise to considerable doubt as to the causative condition. A thorough search was made for evidence of a tuberculous infection but examination of the sputum by ordinary methods and by concentration methods with antiformin gave negative results as did also a guinea-pig innoculation test. This man's previous illnesses included a broncho-pneumonia which may have been at least partly responsible for the condition.

The type of mottling found was "fine" in 4 cases,

a combination of "fine" and "woolly" mottling in 3 cases, "woolly" in 3 and "faint" in one.

Eight of these cases showed large aggregated masses in the right lung fields, half of which were situated in the mid-zone. The left lung fields revealed seven such masses, three of which were in the mid-zone. The distribution of these masses was very largely symmetrical in the two lungs. The appearance of these large aggregated massed was as described under group II but the masses were larger and better formed. In one of these a very large mass, about the size of a small pear, lay outside the right hilum and was united to the root shadows by thin dense bands. This mass appeared to have been formed by the coalescence of two smaller, almost circular shadows with very well defined edges.

Other smaller aggregations often had woolly indistinct edges and appeared to have been formed by the coalescence of adjacent nodules in a lung showing the "woolly" type of mottling. Such masses were usually best seen away from the hilum usually in the upper zone but occasionally in the lower. The central parts of such aggregations were uniformly dense, but the outer edges shaded somewhat indefinitely into the surrounding mottling.

Another feature noted in two of the cases was the tendency for heavy mottling to become confluent, creating an opaque film over a part of the lung field.

In one case the mottling was of the "fine" type and in the second of the "woolly" type.

In this latter group of eleven cases three distinct types of X-ray appearances have been noted. (1) Mottling of some type, with circumscribed masses. These masses may or may not be strictly limited and are present in the majority of the cases. (2) Mottling with fibrosis, by which is meant absence of aggregation but the presence of definite fibrous bands. (3) Confluence of the mottling as described above. Two of these three types may be found in association.

In this latter group ten of the eleven cases revealed alteration in the contour of the diaphragm. Seven showed adhesions on both sides, three of which had marked changes with peaking. The peaking was found in the right side in two cases and on the left in one. The remainder showed adhesions on the right side only.

Emphysema was also diagnosed in 8 cases, being basal in 7 cases and found in the right upper lobe in one case. This was thought to be a compensatory condition due to surrounding fibrosis.

CONCLUSIONS FROM FOREGOING SUMMARY.

The foregoing pages describe the X-ray appearances found in the three original clinical groups. From the details presented several points of interest arise and may be noted here.

The first important fact is that all the X-rays examined could be grouped into three distinct classes; one class exhibiting mottling only, a second, mottling with the presence of nodules, and the third mottling, nodules, and the presence of large aggregated masses.

A second striking feature is that, although there is a tendency for men who are unable to work (i.e. group III cases) to have the more severe X-ray picture, this is by no means an invariable rule. In group I only two X-rays are available and no general conclusion can be derived from this number. Both are almost symptomless and have negative films, or at any rate films showing very slight alteration from normal. In group II. we find that men with moderately severe symptoms may present radiological pictures which can be assigned to either the first or second class described above, and although symptoms are more severe, are able to work with a degree of fibrosis compatible with inclusion in the third class. Out of the 24 films available in group II the proportion in the three classes are 9 : 9 : 6. In group III we find that all the men are unfit for work, yet one film reveals an entirely negative result, two show an appearance of the first class, four of the

second class and eleven of the third class. This bears out the statement that the tendency is towards the more severe X-ray picture in those unable for work, but men may be able to carry out their work with advanced pulmonary changes as evinced by X-ray examination. Also in certain cases a less severe degree of pulmonary damage may be accompanied by complete incapacity for work.

Thirdly, some facts regarding the length of service required to produce radiological changes may be adduced.

In group I, minimal signs could be demonstrated after 8 years' work in one case, but in the second, after 25 years' work, signs were little if any more definite. In group II a definite early change was noted in a man of 30 years after 7 years' work, but also in a man of 60 years with a very much longer working period (approx. 30 years). A definite change of the second degree was noted in a man of 43 years with approx 15 years' service but was also seen in a man of 65 with double the length of service. Changes of the third degree were present in a man of 30 (7 years' service) still working, and the next youngest patient to reveal this type of X-ray appearance was a man of 43 years with 20 years' service. In group III one man aged 53 showed a negative film after 34 years' service. Two showed changes of the first degree after 20 years' service. Four showed second degree changes after 28, 30, 43

and 45 years' service respectively. Eleven showed third degree X-ray appearances after experience varying from approx. 20 - 40 years.

Evidently one can conclude from the above facts that about 7 years work is sufficient to cause pulmonary damage severe enough to reveal its presence by early X-ray changes and may be long enough to cause the extensive alterations of the third degree. Generally, however, a second degree picture is not obtained until after 15 years' work and a third degree picture a little later. On the other hand a slight degree of fibrosis may be present and may not develop, a man working on to 60-65 years of age without developing beyond the first or second degree.

Obviously mere length of exposure to the dust is not the only factor in determining the degree of damage sustained by the lung. If such were the case one would expect a gradual development depending on the length of service, and the process would be a fairly uniform one. In other sections an attempt will be made to define some other factors which may be responsible for this irregularity in development of the X-ray appearances.

Fourthly, after considering all the data already given, and the general impression gained by viewing and reviewing all the plates, one could not definitely say that any one side was affected more than the other. In general terms the mid-zone of each field was most markedly affected and early nodulation and

aggregation was first noted here. Following these changes, the upper areas appeared to be next affected. Basally the changes were not so definite and a very large percentage showed emphysema at the bases.

THE TYPES OF RADIOGRAPHIC APPEARANCES

In the previous section mention has been made that the X-ray appearances found in the men under discussion, who are all engaged or have been engaged in coal trimming, could be divided broadly into three groups. Each of these three groups had distinguishing characteristics, and it is now intended to present details of the X-ray appearances in each. group.

Out of a total number of 44 X-rays, two are entirely negative and have been excluded from this survey. Of the remaining 42, twelve were found to show an appearance consistent with inclusion under the first group showing mottling of the lung fields only. Thirteen revealed characteristics of the second group (mottling and the presence of nodules) while seventeen were placed in the third category (mottling, nodules, and large aggregated masses).

In the following tables the X-ray details are set out along with the symptoms and physical signs exhibited by the corresponding patients, and a note is added regarding the results of sputum tests for tubercle bacilli. This is done in view of the fact that X-ray appearances of great similarity may be found in cases of pulmonary tuberculosis. As will be discussed later, the symptomatology and physical signs evinced by the cases under discussion, are in the main, equivocal, and repeated sputum examinations are perhaps the simplest and best way of excluding a

tuberculous infection as the cause of the clinical findings and radiological appearances.

TABLE XXV.

TYPE I. : SYMPTOMS, PHYSICAL SIGNS, AND RADIOLOGICAL APPEARANCES.

No.	AGE.	PERIOD WORKING YEARS	PRINCIPAL SYMPTOMS	PHYSICAL SIGNS	APPEARANCES OF LUNG FIELDS IN X RAY	ROOT AND TRUNK SHADOWS	APPEARANCE OF DIAPHRAGM	SPUTUM TESTS T.B.
6	50	25	Dyspnoea 15 years	Sl.basal-hyper-resonance. D.A.E. left apex	Fine mottling espec. at mid-zones right and left.	Both incr.	regular	No report
10	30	7	Cough:pain chest: dyspnoea	D.A.E. gen. Creps right base	Faint mottling espec. upper & mid zones Rt. side, & Mid-zone left side Emphysema	Incr. in Trunk	regular	Neg. (1)
12	31	8 approx	Cough: dyspnoea: Pleuritic pain	Imp. P.N.Rt. apex & right Interscap region. Expir. + all over. Clubbing of Fingers.	Faint mottling espec. upper & mid zones Rt. & Lt.: Basal emphysema	Both incr.	One adhesion each side	Neg. (2)
14	34	10 approx	Cough: Single. Sl. haemoptysis	Imp. P.N. Rt apex & Rt. base	Very faint mottling espec. Mid zone Rt. Sl. basal emphysema	Both incr.	regular	Neg. (1)
16	37	12	Sl. chest pain.	nil	Fine mottling general Rt. & left	Both incr.	regular	Neg. (1)
17	37	12 approx	Cough	nil	Very fine mottling at hila & upper lobes. General obscurity over upper lobes	Incr. in Trunk	Small adhesion left side	Neg. (3)

TABLE XXV. (Concl.)

TYPE I.: SYMPTOMS, PHYSICAL SIGNS AND RADIOLOGICAL APPEARANCES.

No.	AGE	PERIOD WORKING years	PRINCIPAL SYMPTOMS	PHYSICAL SIGNS	APPEARANCES OF LUNG FIELDS IN X RAY	ROOT AND TRUNK SHADOWS	APPEARANCE OF DIAPHRAGM	SPUTUM TEST T.B.
30	50½	30 approx	Cough: Blood in spit.	General Hyper-resonance.	Faint mottling espec. upper zones Rt.& Lt. Few small basal Nodules Basal Emphysema.	Both incr.	Regular	Neg. (3)
37	57	30 approx	Cough:Tight chest: Pain chest.	Hyper-resonance basally: Roles: Expir.+.	Fine mottling Espec. Mid and basal zones Rt. Side, Mid-left side.	Both incr.	Regular	Neg. (2)
39	57 10/12	30 approx	Cough:haemopt. dyspnoea.	Râles & Creps generally.	Dense fine mottling general Rt. & left.	No incr. in either	Regular	Neg.(3)
45	60½	35	Cough: sputum.	Râles Rt.side	Faint mottling espec. Upper zone (Rt.) & at base (left).	Both incr.	Regular	Neg. (2)
49	44	20 approx	Cough: dyspnoea. Tight chest.	Imp.P.N. left apex & Rt & Lt Interscap regs: Râles Lt. base. Clubbing Fingers	Early woolly mottling: Pin head nodules Rt. hilum:: Calcified Gland left hilum	Both incr.	Regular	Neg. (5)
50	44	20 approx	Sl.cough: pain.	D.A.E. generally	Early woolly mottling espec. lower zones Rt and Lt.: A few early nodules: Thickened pleura Rt. base.	Incr. in Trunk	Regular	No report

D.A.E. = diminished air entry. Imp. P.N. = Impaired percussion note. Expir.+ = Prolonged expiratory sound.

The figures after the result of the Sputum Test indicate the number of examinations made.

TYPE I.

A review of Table XXV reveals in convenient form the following salient points.

(1) The age limit varies between 30 and 60 years.

(2) The symptomatology is very similar in all the cases. It is impossible to give a conception of the severity of the symptoms in tabular form, but a general review, in which the length of time a symptom had been present and its effect in causing incapacity for work was considered, revealed that the symptoms were insufficient to incapacitate the patient in 10 cases. In 2 cases they were severe enough to make work impossible. Ten cases (88 per cent) revealed cough as the most prominent symptom and three cases (25 per cent) noted the presence of blood in the sputum. This latter symptom is said to indicate a late stage of pneumoconiosis with the possibility of a super added tubercular infection (Norris and Landis[4] "Diseases of the Chest" 5th Edit. pp. 546 et seq.) but is found here in men displaying an early X-ray picture of this condition and in whom there was no suspicion of primary or superadded tuberculosis. Shortness of breath was present in 5 cases in this group (41 per cent).

(3) The physical signs in this group were minimal, and would hardly give a clue to a serious underlying condition. In two instances there were no demonstrable physical signs. In only five cases (41 per cent) were accompaniments present at the

time of examination. In two cases the physical signs were more advanced, with dullness at one or other apex and in the interscapular regions and clubbing of the fingers. The other physical signs noted were occasionalyhyper-resonance of the percussion note usually basally with generalised or local areas of diminished air entry into the lungs. (4) The radiological picture presented an increase in the root shadows in 8 cases (66.6 per cent) with peribronchial thickening in 11 cases. Mottling of the lung fields was present in all the cases, being of the "faint" type in 5, "fine" in 5, and of the "woolly" type in two. Generally the mottling is best seen in the zone adjacent to the hilum and then usually affects the upper lobes. No nodules were present except in two cases where a few minute nodules were recognised. Four of the cases had radiological evidence of emphysema at the bases of the lungs. Two cases showed diaphragmatic adhesions both of a minor degree. Plate IV gives a fairly representative conception of the radiological appearances noted.

It should be noted that two of the men whose X-ray films reveal the early appearances already described are unfit to continue their occupation. Their age is 44 years and their period of service approximately 20 years. There are five other members in this class, whose working experience is considerably greater, yet they are able to continue at work and do not reveal such marked X-ray evidence of pulmonary fibrosis. The two disabled men reveal

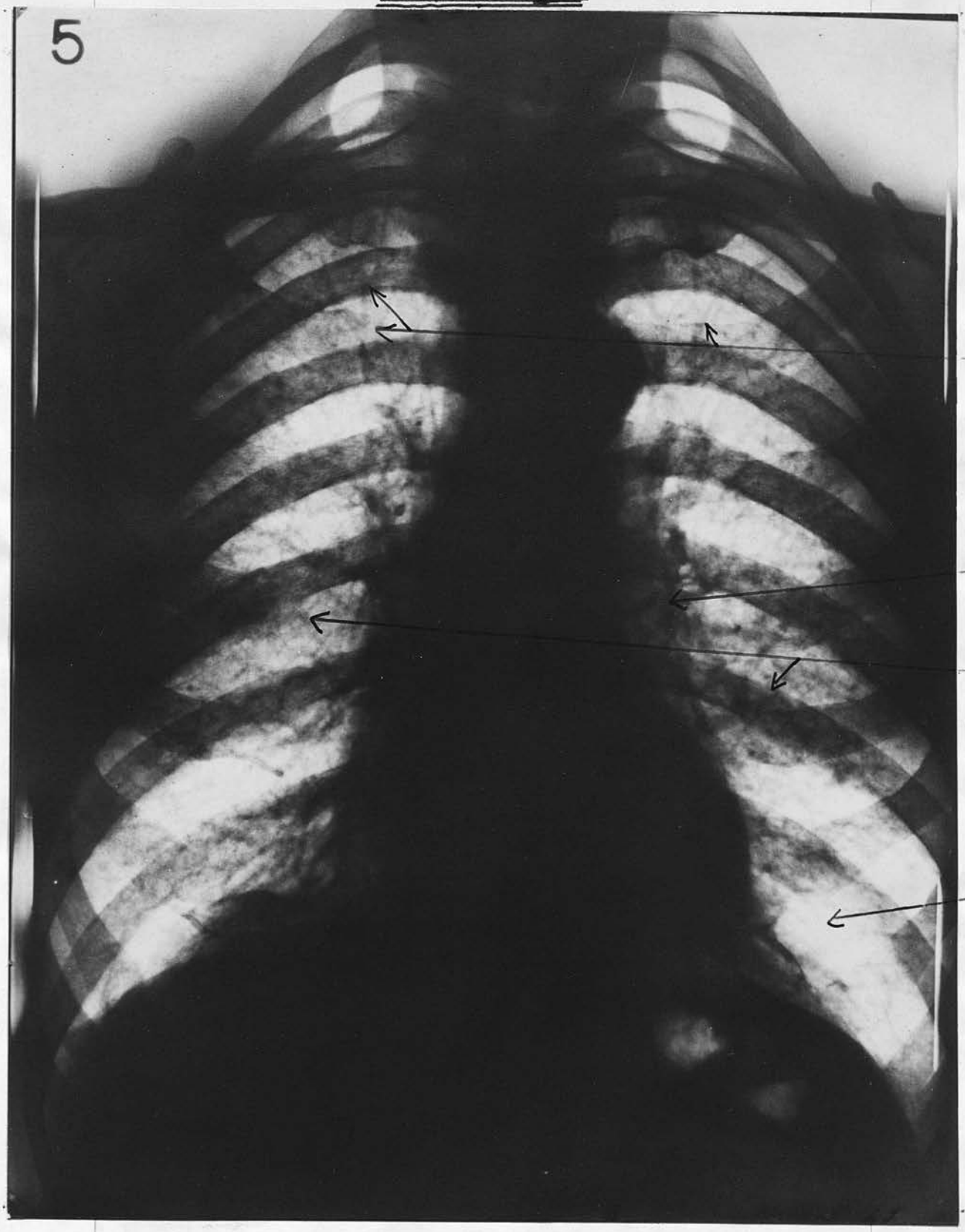
the most advanced X-ray films in this group.

Also, while the youngest member of the group aged 30 has quite well marked symptoms and physical signs, two other members with distinctly longer periods of service show extremely slight symptoms and no physical signs, but have a much more marked degree of pulmonary damage as evinced by radiological examination.

Again, the oldest member of this group, with 35 years' service, and displaying symptoms and signs of a chronic bronchitis reveals a radiological picture of much less severity than the other men.

The above details are noted to draw attention to the lack of uniformity in the development both of clinical and radiological signs in these cases. General rules may be formulated, but each case must be given individual consideration. It is impossible to predict the probable X-ray findings from a knowledge of the length of service in the occupation or even from a knowledge of the clinical findings present in the case, for a patient with well marked clinical signs may present only slight radiological changes and the opposite condition may also hold good.

PLATE IV



A. _____ Increase in density and extent of the root shadows.

B. _____ Fine mottling in hilar areas.

C. _____ Basal emphysema.

D _____ Faint increase in peribronchial shadows.

TABLE XXVI.

TYPE II.: SYMPTOMS, PHYSICAL SIGNS AND RADIOLOGICAL APPEARANCES

No.	AGE.	PERIOD WORKING YEARS	PRINCIPAL SYMPTOMS	PHYSICAL SIGNS	APPEARANCES OF LUNG FIELDS IN X RAY.	ROOT AND TRUNK SHADOWS	APPEARANCE of DIAPHRAGM	SPUTUM TESTS T.B.
19	42 2/12	15	Pain chest: Loss of Weight.	Imp. P.N. Rt. apex. D.A.E. Interscap. regions. Creps right base.	Fine mottling espec. mid & lower zone Rt. side & lower zone leftside. Nodules Rt. lower zone. Basal Emphysema Lt. side.	Both Incr.	one adh. (Rt. side)	None done
24	45	20 approx	Cough: dyspnoea	Râles left base.	Dense fine mottling mid-zone Rt. side & mid & upper zones Lt. Pin head nodules all over. Emphysema - Rt. upper lobe & Lt.base.	Both incr.	Adhesions both sides	Neg. (1)
25	46	19 approx	Dyspnoea: pain chest	Imp. P.N. Rt. apex. D.A.E. left apex.	Woolly mottling mid-zone Rt. side & mid & upper left. Occas. small nodule	No incr.	Regular	Neg. (2)
26	46½	21 approx	Cough: pain chest.	Hyper-resonant P.N. left side. D.A.E.generally Creps Rt.base	Woolly mottling mid-zones Rt. & left. Basal Emphysema.	Incr. in Root.	Regular	Neg. (3)
27	48	22 approx	Cough: dyspnoea.	Nil	Dense fine mottling upper & mid zones Rt. & left. Nodules mid zone. Basal Emphys.	Both incr. very marked.	Regular	Neg. (1)

TABLE XXVI. (Contd.)

TYPE II.: SYMPTOMS, PHYSICAL SIGNS AND RADIOLOGICAL APPEARANCES.

No.	AGE.	PERIOD WORKING YEARS	PRINCIPAL SYMPTOMS	PHYSICAL SIGNS	APPEARANCES OF LUNG FIELDS IN X RAY.	ROOT AND TRUNK SHADOWS	APPEARANCE OF DIAPHRAGM	SPUTUM TESTS T.B.
32	55	30 approx	Cough: haemopt: Pain in chest.	Imp.P.N. left apex: Creps at bases.	Woolly mottling at mid & lower zones Rt. side & upper Lt side. Nodules basally.	Incr. root.	Two adhesions Rt. side.	Not done
35	56	30 approx	Cough: haemopt: dyspnoea	Imp.P.N. Rt. apex. Râles & Rhonchi generally.	Woolly mottling (gen.) Nodules (gen.) Basal Emphysema.	Incr. Root.	Peaking of diaph.both sides	Neg. (2)
43	60	-	Cough: tight chest: dyspnoea.	Nil	Woolly mottling espec. Rt. & left bases. Nodules.	Incr. Root.	Peaking of diaphragm both sides	Neg. (3)
48	65	-	Cough: dyspnoea	Nil	Fine mottling Rt. side. Woolly mottling left side espec upper & mid zones. Aggregated nodules. Basal Emphysema	Incr. Root.	Regular	Neg. (2)
54	50	28 approx	Cough. Shortness of breath.	Imp.P.N. Rt. base. Râles left base. Slight Clubbing of Fingers.	Dense fine mottling. Generally on right side, upper & mid on left side. Many small nodules. larger at hilum.	Marked Incr.on both sides	Regular	Not Tested

TABLE XXVI. (Concl.)

TYPE II.: SYMPTOMS SIGNS AND RADIOLOGICAL APPEARANCES

No.	AGE.	PERIOD WORKING YEARS	PRINCIPAL SYMPTOMS	PHYSICAL SIGNS	APPEARANCES OF LUNG FIELD IN X RAY	ROOT AND TRUNK SHADOWS	APPEAR. of DIAPHRAGM	SPUTUM TESTS T.B.
69	63½	30	Cough: Shortness of breath: Pain chest.	Imp.P.N. both apices. D.A.E. Rt. upper lobe: Râles both bases.	Dense fine mottling espec. mid & lower lobes Rt. & left. Nodules	Incr. Root	Regular	Neg.(4)
71	65	43	Cough: Shortness of breath: Tight chest.	Dull in supra spinous & Inter-scapular regs. D.A.E. generally. Sibilant Rhonchi basally.	Dense fine mottling generally. Pin head nodules	Incr. Root & Trunk	Regular	Not Tested.
72	66	45	Cough: Streaks of blood in Sputum: dyspnoea: Tight chest	Imp.P.N. right Interscapular Reg. Hyper R. generally Rhonchi generally.	Dense fine mottling left. Woolly mott-ling Rt. side. Nodules pin head to split pea.	Sl. incr. in Trunk.	Regular	Neg.(1)

Imp. P. N. = Impairment of percussion note

Hyper. R. = Hyper resonance of percussion note

D. A. E. = Diminished air entry

Expir. + = Prolongation of the expiratory sound.

TYPE II.

The foregoing table (No XXVI) reveals the following outstanding features regarding the men whose radiographic appearances fall into this type.

(1) The age limit of members of this group varies from 43 years to 66 years.

(2) As in group I cases (table XXV) the symptoms are very similar in all the cases and no new symptom is found in this group. In nine cases the symptoms were not severe enough to incapacitate the patient, in four incapacity was found. In the nine cases still able for work, symptoms did not seem to be more severe than those encountered in the type I cases, but in the four incapacitated men, the severity of the symptoms was much greater. Eleven of the group (85 per cent) showed cough as the most prominent symptom, but in only one case was the duration over ten years. Three cases (23 per cent) had noted at one time or another, the presence of blood in the sputum. Ten cases (77 per cent) showed dyspnoea as a prominent symptom.

(3) Physical signs also resembled those noted in the type I cases, but were rather more definite. Despite that fact 3 cases (23 per cent) showed no demonstrable physical signs at the time of examination. Diminished air entry was found in 5 cases sometimes generalised at other time localised. Accompaniments, râles or rhonchi or crepitations, were found in 9 cases (69 per cent). The accompaniments were

usually found at the lung bases but in three cases râles and rhonchi were audible throughout both lung fields. Impairment of the percussion note was more definitely noted in this group. The parts of the lung most frequently affected were. (1) The apices, in 75 per cent of the cases showing this physical sign; (2) The interscapular region. The impairment of the percussion note was best noted and more advanced on the right side in the members of this group.

Clubbing of the fingers was present in only one case.

(4) The general X-ray appearances may be summarised as follows:- Except in one case, where there was no increase in extent or density of either the root or trunk shadows, the root shadows were increased in extent or density or both in eleven cases (84.5 per cent) and the trunk shadows in six cases (46 per cent) The increase was very well marked in four cases. Mottling was present in all the cases. It was of the "fine" variety in six cases and "woolly" in six and was of a mixed type in one. On the right side the mottling was seen best in the mid-zone and then towards the lower zones. On the left side the mid-zone was again the most affected area and the next most prominent change was noted in the upper zone. Nodules, varying in size from a large pin head to a split pea were visible in all the plates examined. The smaller nodules were usually visible all over the

field, and were more numerous on the right side. The larger nodules were more definitely at or near the hilum in the mid-zone and again towards the base. Emphysema was present in six cases, usually situated basally.

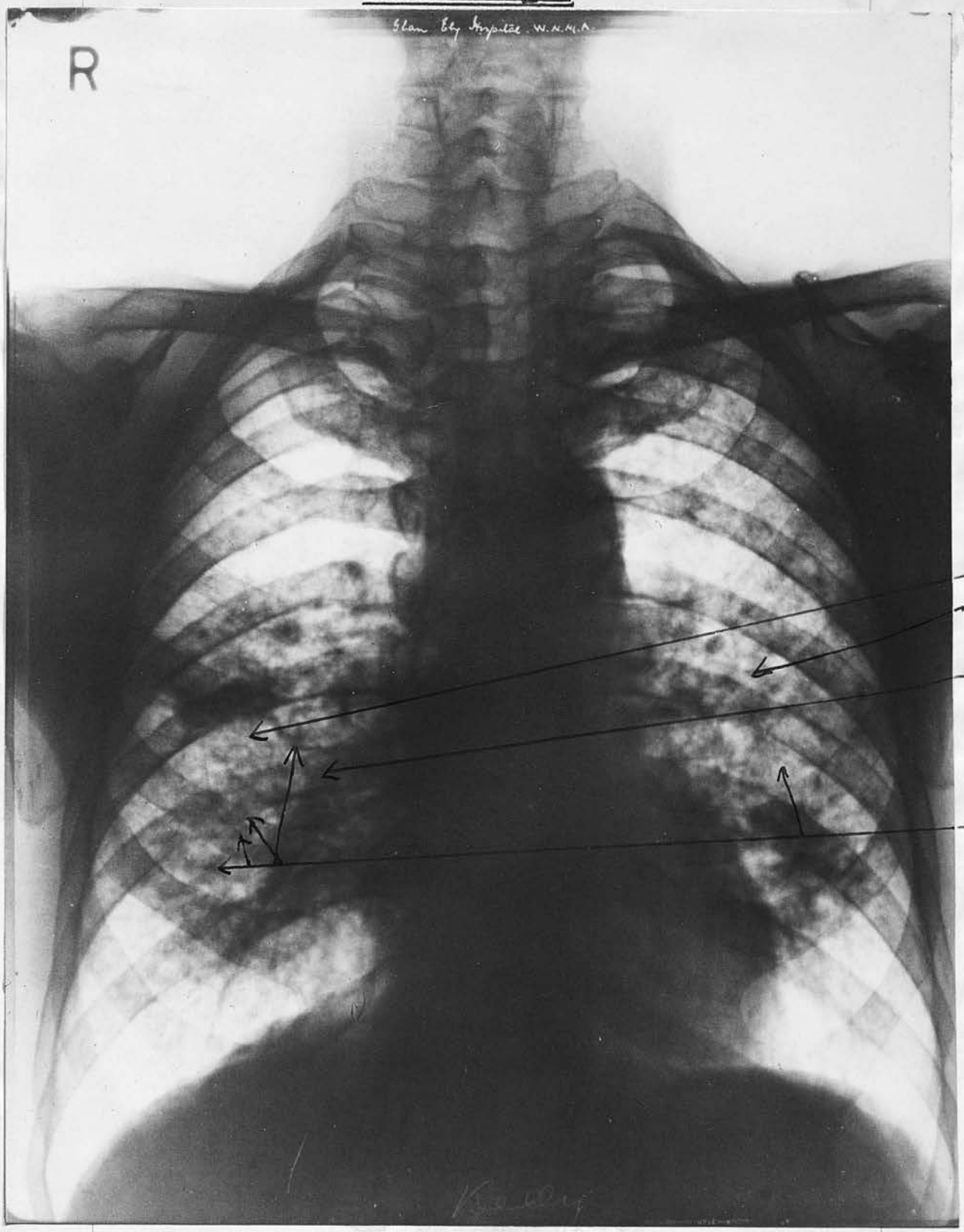
Diaphragmatic adhesions were present in five cases (38 per cent.) In four of the cases both sides were affected and in two the alteration in contour was very marked and the leaves of the diaphragm were peaked. (Plate V).

Sputum tests were available in nine cases and all gave negative results. No case in this group was believed to suffer from a coincident tuberculous infection in the lung, but one case had a previous history of tuberculous epididymitis.

It is noted that the ages of the men in this group revealing complete incapacity for work, average 61 years and their period of service averages 36½ years. The men at work despite symptoms are, on the average, 51 years of age and have an average service period of 22½ years. While the symptoms are more severe in the four incapacitated men than in the nine who are still fit for work, the radiological appearances could not be said to be more marked. This might suggest that at least in certain cases the condition of fibrosis advances to a certain degree and then remains stationary although accompanied by increased severity in the symptomatology which eventually produces complete inability for work.

PLATE V

Glass Slide Hospital W.N.M.A.



A. _____ INCREASE IN ROOT SHADOWS.

B _____ FINE MOTTLING.

C. _____ EARLY WOOLLY MOTTLING.

D. _____ NODULES OF VARYING SIZE AND DENSITY

TABLE XXVII.

TYPE III.: SYMPTOMS, PHYSICAL SIGNS AND RADIOLOGICAL APPEARANCES.

No.	AGE.	PERIOD WORKING YEARS	PRINCIPAL SYMPTOMS	PHYSICAL SIGNS	APPEARANCES OF LUNG FIELDS IN X RAY	ROOT AND TRUNK SHADOWS	APPEAR. OF DIAPHRAGM	SPUTUM TESTS T.B.
11	30	7 approx	Pain chest: Dyspnoea: Slight sputum	Sl. Imp.P.N. generally: Creps: D.A.E.	Dense fine mottling, causing film over both upper fields: Opacities Aggregation of Nodules. Basal emphysema.	Not incr.	Adhesions on both sides	Neg.(6)
21	43	20	Cough: Haemopt.: Short. breath: Pain chest.	Nil def.	Large dense opacities at hila: Aggregation of nodules: Fine mottling at apices: Basal emphysema	Incr. Trunk	Adhesions on right side	Neg.(3)
28	50	26 approx	Dyspnoea: Pain in chest: Blood in sputum.	Imp.P.N. Rt. side. Râles Rt. side: Clubbing of fingers.	Opacities, mid & lower zones, Rt. side: Mid & upper zones left side. Fine mottling bases: Emphysema left base.	Marked incr. in both.	Peaking, right. Adhesions on left.	Neg.(3)
31	54	30 approx	Cough: dyspnoea: Haemopt: Pain in chest.	Imp.P.N. Interscap. Reg. Creps at bases.	Dense aggregated masses at upper & lower zones both sds. Woolly mottling mid zones & at bases	Incr. root	regular	Neg.(2)
34	55	30 approx	Cough: Haemopt.: Pain chest.	Imp.P.N. both Interscap Regs: Rales.	Cricket-ball like masses both mid zones Calcified pleura: Woolly mottling mid & upper zones Rt. & Lt. Basal emphysema.	incr. root	Adhesions both sides	Neg. after concentration.

TABLE XXVII. (Contd.)

TYPE III.: SYMPTOMS, PHYSICAL SIGNS AND RADIOLOGICAL APPEARANCES.

No.	AGE.	PERIOD WORKING YEARS	PRINCIPAL SYMPTOMS	PHYSICAL SIGNS	APPEARANCES OF LUNG FIELDS IN X RAY	ROOT AND TRUNK SHADOWS	APPEAR. OF DIAPHRAGM	SPUTUM TESTS T.B.
38	57½	28 approx	Cough: Haemopt.: Dyspnoea.	Imp.P.N. both apices: D.A.E. generally.	Much opacity + dense masses at mid & adjacent zones both sides. Basal Emphysema.	Both incr.	Regular. both sides	Neg.(2)
51	48	28 approx	Slight cough	Post-Tussive Creps Rt apex & Interscap Region.	Fine + woolly mottling general; Nodules basally: Aggregated mass at Rt Hilum: Emphysema Rt upper lobe.	Both incr.	Adhesions on right side.	Neg.(1)
52	47	20 approx	Cough: Dyspnoea.	Post-Tussive Creps left apex & Lt. base. Expir + Rt. Apex: Finger clubbing.	Very dense fine mottling mid & upper zones Rt. & Lt. sides. Small nodules & dense fibrosis left side with small cavity below left hilum: Emphysema right base.	Both incr	Adhesions both sides.	Neg.(1) & after conc. & Guinea-pig innoculation
53	50	28	Cough: Dyspnoea ++	D.A.E. (generally) espec. Rt. side.	Confluent dense fine mottling upper zone left. Woolly at bases: Mass at Rt. Hilum.	Incr. Root.	Peaking Right. Adhesion lt.side	Not tested.

TABLE XXVII. (Contd.)

TYPE III.: SYMPTOMS, PHYSICAL SIGNS AND RADIOLOGICAL APPEARANCES

No.	AGE.	PERIOD WORKING YEARS.	PRINCIPAL SYMPTOMS.	PHYSICAL SIGNS.	APPEARANCES OF LUNG FIELDS IN X RAY.	ROOT AND TRUNK SHADOWS	APPEAR. OF DIAPHRAGM	SPUTUM TESTS T.B.
55	53	30 approx	Cough: Haemopt: dyspnoea: Tight chest.	D.A.E. Rt. lung. Stridulous Breath sounds left anteriorly. Clubbing fingers	Very little faint mottling upper zone left. Masses in upper & lower zones Rt. side. Some aggregated nodules left side. Basal Emphysema Right.	Incr. Root	Adhesions on both sides.	Neg.(2)
59	56	35 approx	Cough: dyspnoea: Tight chest.	D.A.E.generally Râles basally. Clubbing +.	Fine & woolly mottling upper & mid zones both sides. Aggregated nodules left side. Masses Lt. & Rt. side. Basal Emphysema.	Incr. Root	Adhesions on right side.	Neg.(1)
61	59	35 approx	Cough: dyspnoea: pain.	Nil definite	Dense fine mottling mid & upper zones Rt. side, mid & lower zones left side. Aggregated masses Rt. base & left Hilum	Both incr.	Adhesion on right side.	Neg.(1)
62	59	35 approx	Cough: dyspnoea: Tight chest: Pain chest.	Rt.Upper lobe Breath sounds cavernous. Lt. Broncho-Vesicular.	Dense fine mottling Rt. upper zone. Woolly mottling Lt. side. Large aggregated nodules and opaque masses.	Incr Root.	Peaking Right side Adhesion left side	Neg.(4)

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TABLE XXVII. (Concl.)

TYPE III.: SYMPTOMS, PHYSICAL SIGNS AND RADIOLOGICAL APPEARANCES.

No.	AGE.	PERIOD WORKING YEARS	PRINCIPAL SYMPTOMS	PHYSICAL SIGNS.	APPEARANCES OF LUNG FIELDS IN X RAY.	ROOT AND TRUNK SHADOWS.	APPEAR OF DIAPHRAGM	SPUTUM TESTS T.B.
63	60	42	Cough: dyspnoea Blood in sputum: Tight chest: Pain in chest.	Imp.P.N. Rt.apex & interscap. Regs. Hyper-Res.elsewhere D.A.E.generally, Creps left base. Stridulous Breath sounds right apex. Clubbing +.	Complete opacity upper quarter Rt. field. Aggregations below. Woolly mottling left side espec. upper zone. Basal Emphysema.	Incr. Root.	Regular	Neg.(1)
66	62	35 approx	Cough: dyspnoea: Tight chest: Pain slight.	Creps at apices. Râles left base.	Woolly mottling: Nodules Rt.side. Dense sheet of opacity Lt.side.	Both incr.	Adhesions both sides	Neg.(3)
68	62	35 approx	Cough: haemopt. dyspnoea: Loss of weight.	Râles all over.	Woolly mottling. many small nodules. Tendency to aggreg. into sheet of uniform density in upper zones Rt & Lt Basal Emphysema.	Incr. Root.	Adhesions both sides. Peaking on left side ulceration	Neg(3) & after conc. & Guinea-pig innoculation
70	64	35 approx	Cough: Tight Chest: dyspnoea: Pain chest.	D.A.E. generally Bronchial Breath sounds at apices	Scattered fine mottling upper Rt. & upper & lower zones left side. Aggregated nodules and dense opacities Basal Emphysema.	Both incr.	Adhesions on both sides	Neg(1)

Imp. P. N. = Impairment of the percussion note. Hyper R. = Hyper; resonance of the percussion note

D.A.E. = diminished air entry. Expir. + = prolongation of expiratory murmur.

The figures in brackets after the result of the sputum test indicate the number of examinations made.

TYPE III.

The table reveals the following salient points.

(1) The age limit is between 30 and 65 years but only three cases are under 50 years of age.

(2) The symptomatology displayed is very similar to that found in types I and II but is more severe. The symptoms seem to be more highly developed. In six cases symptoms were of insufficient severity to cause inability for work, and in eleven cases the men were disabled.

A study of the symptoms displayed by this section shows that, while the symptoms displayed by the workers and non-workers are identical in character, the severity is greater in those unable to work. In the six cases still at work only one had severe symptoms, while in the eleven who were unfit for work, eight displayed severe symptoms. Fifteen (88 per cent) had cough as the most prominent symptom. Eight (48 per cent) had blood-stained sputum. Fifteen (88 per cent) were short of breath on exertion and pain in the chest was also a more prominent symptom being present in ten cases.

(3) Physical signs were not more generally found than in type II and were absent in two cases (12 per cent).

Accompaniments to the respiratory sound were present in ten cases (59 per cent) at the time of examination and in three of the cases crepitations were elicited at the apices. Diminution of the air entry was found in six cases. Impairment of the

percussion note was present in six cases only (35 per cent). Two revealed this lesion apically, two in the interscapular region, one had a generally impaired note and in one the impairment was limited to the right side. Finger clubbing was present in five cases.

(4) The radiological appearances can be summarised as follows:-

Increase in the root shadows was present in fifteen cases (84 per cent) and increase in the trunk shadows in eight cases (47 per cent).

The picture presented of the lung fields is very complicated. Mottling is again present in all the cases, but other factors are present here which give added difficulty to description. These factors are (1) aggregation of the nodules noted in the type II cases to form larger nodules. (2) The presence of large masses, either singly or numerous, in the lung fields (Plate VI). (3) Very greatly increased density of the mottling forming a film over part of the lung field. In view of these facts it is impossible to say at which point mottling is best marked, as it can only be seen when not hidden by the large masses of fibrous tissue. The type of mottling is "fine" in eight cases, "woolly" in five cases, and mixed in four cases and is always best seen in the upper zones. The aggregated masses are also best seen in the upper half of the lung fields. They present a more difficult problem in description. They may be present as a result of fusion of a large

number of adjacent aggregated nodules, or the distinction from a neoplasm may be difficult. As a rule these masses are most often present in the mid-zone adjacent to the hilum, but may be found in the upper or lower zones of the lung fields. The edges are frequently poorly defined and may appear continuous with the surrounding dense mottling or aggregated nodules. In some cases however the edges are quite sharply defined and regular and not definitely associated with adjacent mottling, though frequently attached to the hilar shadows by dense parallel bands. Such masses were seen in eleven cases (65 per cent) of the members of this group. Usually the distribution was symmetrical in the two lung fields, but the larger masses were more ffequently found on the right side. As many as four separate and distinct areas could be seen in one field. The size of the masses varied from that of a half-crown up to that of a small pear. The latter occurred in the right lung, was single, adjacent to the hilum, and attached to it by fibrous bands.

In five of the cases the density of the mottling caused complete opacity of part of the lung fields; this had to be distinguished from the appearance caused by a considerable degree of pleural thickening. The dense mottling was present alone in three cases, and in conjunction with the opaque masses described, in two. In all cases the mottling affected the upper, or middle and upper zones of the lung.

In one case, the left lung showed a typical X-ray

picture of pulmonary fibrosis, with dense adhesions throughout to the heart and diaphragm, displacement of the mediastinum, and also a cavity just below the hilar region. This case had received special attention in order to exclude the presence of a tuberculous infection. No evidence of the presence of tubercle was found. The previous medical history stated that he had suffered from Broncho-pneumonia during adult life.

Eleven cases (65 per cent) showed emphysema at one or both bases, and one case revealed an emphysematous area in the right upper lobe, amid a great deal of surrounding opacity.

Fourteen cases (82 per cent) showed diaphragmatic adhesions. In eleven instances both sides were affected. In three cases only the right side was affected. In three cases the adhesions were extensive, leading to peaking of the diaphragm, and all occurred on the right side.

Sputum tests were carried out in 16 cases, all with negative results. The varied radiological appearances presented by the men in this group made it more difficult to exclude, by X-ray only, a possible tuberculous infection. Any doubtful case had further tests applied to the sputum - concentration with antiformin and guinea-pig innoculation. Two cases Nos 53 and 63 showed appearances very similar to those in the other men at some part of the lung field, but also certain dense shadows very suggestive of Neoplasm. Case No 53 was thought not to have a

Neoplasm, but further investigation of Case 63 revealed a Mediastinal Neoplasm involving the right apex of the lung, from which he has since died.

PLATE VI

A. _____ FOUR LARGE. AGGREGATED MASSES N.B. 1. POSITION 2. CHARACTER OF EDGES 3. CONTINUITY WITH ADJACENT MOTTLING.

B. _____ DENSE FINE MOTTLING

C. _____ DENSE DIAPHRAGMATIC ADHESION_PEAKING. N.B. 1. CONTINUITY WITH AGGREGATED MASS.

D _____ BASAL EMPHYSEMA. E _____ COMPENSATORY EMPHYSEMA.

THE THREE TYPES OF RADIOGRAPH AND THE THREE STAGES OF THE DISEASE.

The foregoing tables and commentaries present the features found in films which reveal points of similarity and which can be grouped together as having common appearances. It is useful at this point to correlate the facts which emerge from such a consideration.

It is obvious that the three types of X-ray previously described represent three stages of severity of lung damage. This damage we believe to be due to the nature of the occupation these men follow, for reasons which will be given later. It is convenient to give a definition of each stage, as evinced by the findings already detailed:-

Stage I:- The radiological appearances suggest early pulmonary damage, and may be found in men whose length of service as Coal Trimmers varies considerably (from 7 - 35 years). The appearances can be found seven years after commencing work or not till a much longer period of time has elapsed.

The symptoms of which the patient complains are usually cough, varying from a continual throat clearing to a severe cough, and shortness of breath. Cough is usually the earliest disability. A patient at this stage may have slight occasional streaks of blood in the sputum, but this is not common and sputum itself is not a marked feature at this period. It would appear that blood stained sputum can be, and is, produced by exposure to coal dust and need not necessarily be due to superadded tuberculous infection.

Physical signs are usually ill-defined. There may be none, or impaired percussion note may be present with occasional râles or crepitations, usually basally. Early signs of basal emphysema with hyper-resonant percussion note and diminished air entry with râles, are also found. Finger clubbing may be present even at this stage but is unusual.

X-ray examination reveals increase in the extent and occasionally in the density of the root shadows, with peribronchial thickening. There is mottling in the lung fields of one or other of the types already described. Usually it is the "faint" or the "fine" type. The mottling is seen best in the zone adjacent to the hilum, and then seems to spread to the upper zone. Early basal emphysema is visible. Alteration in the contour of the diaphragm is uncommon but may occur in minimal form.

A patient revealing this stage of fibrosis on X-ray examination may have full capacity for work, but is usually handicapped by certain disabling symptoms. In an exceptional case, symptoms may cause complete incapacity even when radiological examination reveals an appearance as described above.

Stage II:- The appearances which characterise this stage may be found in men whose length of service as Coal-trimmers varies from 15 years to 45 years. It appears to be present in men with a longer period of service than the men in stage I.

The symptoms displayed are those found in stage I

but of rather greater severity. Breathlessness becomes a more prominent symptom, and cough is almost universal. Pain in the chest is not a marked feature but a slight haemoptysis or a blood stained sputum is again occasionally found. Again we find that the presence of sputum with the cough is not a marked feature.

Physical signs may be absent entirely. They are similar to those found in stage I but are usually more definite. Impairment or actual dullness of the percussion note is more definitely noted and is frequently at or near the apices. The right side appeared more often affected. Rales and rhonchi and crepitations are found in nearly seventy-five per cent of the cases, and a diminution of the air entry is more often encountered. Emphysema, usually basally, is found. Finger clubbing may be found but is unusual at this stage.

The radiological appearances reveal increased root shadows and peribronchial thickening. The latter does not appear to be so well marked as in stage I. Mottling is present and is either "fine" or "woolly" in type and is usually distributed symmetrically and is fairly generalised. Small nodules varying in size from a pin-head to a split pea are present and are more or less evenly distributed but in early cases are best seen in the mid-zone near the hilum.

Basal emphysema is more marked than in stage I and areas of emphysematous appearance are found in

other parts of the lung fields.

Diaphragmatic adhesions are fairly common and may be very marked with peaking of the leaves of the diaphragm.

Patients are usually able to continue at work, but symptoms of sufficient severity to cause complete incapacity for work may be present.

Stage III. The age incidence in this stage ranges from 30 years to 65 years. It may be found after a working life of only 7 years or after a much longer period up to 42 years. The average working life of the men exhibiting the appearances of this stage is 29 years.

The symptoms are usually severe. Cough is very marked. The presence of sputum is not universal and the amount is slight except in the older patients. Shortness of breath is very marked and blood is present in the sputum in nearly half the cases. Pain in the chest is also a more prominent feature at this stage.

Physical signs are little if any more definite than in the previous stage, but localised areas of impaired percussion note occasionally amounting to actual dullness are found and râles, rhonchi and crepitations with areas of diminished air entry are present. Finger clugging is very much more marked at this stage.

The X-ray picture reveals increase in the root and trunk shadows and the lung fields show in all cases a great deal of fibrosis. In addition to mottling of the "fine" or "woolly" type, there may be

present, (a) aggregation of nodules (b) large masses of dense fibrosis with rather clearly defined edges. (c) increase in the density and extent of the mottling to form a film over a section of the lung field.

Emphysema, usually basal, but occasionally complementary and situated elsewhere is common, and diaphragmatic adhesions are practically always present.

Capacity for work is usually absent but a patient exhibiting the advanced changes described may yet be able to continue in employment.

It was noted in the commentary on the general X-ray appearances, that the incidence of pulmonary fibrosis did not correspond exactly with the length of time the subjects had been exposed to the effects of the coal-dust. In this connection one fact must be kept in mind, namely that all the older workmen, in addition to having actually worked for a greater number of years, have also worked for a longer number of hours, This is due, in part to the system of working, and also to better trade conditions in earlier years.

This same factor is further emphasised in the tabular review already given. A general survey reveals that the average age of patients in stage I is 44.3 years and their average working experience is 20 years. In stage II the average age is 54.4 years and the average working experience is 27 years. In stage III the figures are 53.6 years and 29 years. This reveals that there is a general relationship between the extent of the disease and the period of

of occupation as far as Stages I and II are concerned, but not as regards stage III. This has already been noted.

In stage I patients, one case only was over 60 years of age and four were over 50 years of age. In stage II, five patients were 60 years of age and over and three were 50 years and over. In stage III, four patients were over 60 years and nine were over 50 years. These facts in conjunction with those already noted would suggest that a first stage picture may be seen over the age of 60 after nearly forty years work and is not unusual over 50 years of age. A second stage film is quite common over the age of 60 years and not so commonly seen over 50 years, being most commonly found between the ages of 40 and 50. The third stage appearances are not so common over 60 years of age but are very frequent between the ages of 50 and 60 years. It would appear, therefore, that it is between the ages of 50 and 60 years that the third stage appearances in radiograms are most frequently found and it would seem that some other factor or factors, apart from length of exposure to the dust, operate in certain cases to bring about a much more extensive degree of fibrosis. A similar factor seems to be present in the case of the young patient of 30 years, showing a third stage radiogram, and to a lesser extent to dictate why patients with widely differing exposure times should show identical stages of disease. What this factor is, the present section cannot reveal, but a more

detailed survey of all the available evidence is given in the discussion at the end of this section and its great importance from an economical view point is stressed.

DEVELOPMENT OF THE RADIOGRAPHIC APPEARANCES.

In the series of radiograms available it has been impossible to trace precisely the gradual increase in severity of the radiographic changes. To do this, a series of films at definite time intervals would be required in the case of each patient. The general tendencies have however been noted and in this section we propose briefly to consider three cases in whom more than one X-ray examination had been made and to note the changes that have taken place.

All the cases considered belong to men in Group II. i.e. those able to continue work despite the presence of symptoms.

Case No. 26. aged 46½ years.

Plate I. Nov. 1926. showed increased root shadows, woolly mottling on both sides, best marked in the mid-zones on each side. Basal emphysema present. No alteration in the contour of the diaphragm. This would be classified as a second stage film.

Plate 2. Feb. 1928. Fifteen months later, radiograms revealed that the increase in root shadows is not more extensive, but the shadow is of greater density. The extent and density of the mottling is increased very markedly on the right side in the mid-zone. The nodules present have a more definite edge than those seen in Plate I. Coarse mottling is seen in the mid-zones. The mottling towards the apex is finer. A few nodules have aggregated near the right hilum.

On the whole the mottling is more dense on the left side. Basal emphysema is not more marked. There is slight tagging of the left leaf of the diaphragm.

Plate 3. Feb. 1932. Four years later, there is no change except that basal emphysema is better marked. There is no evidence of any extension of the early aggregation at the right hilum noted in plate II.

During these six years the patient continued at work.

Case No 31. aged 54 years.

Plate I. 1925. showed an increase in the density of the root shadows especially on the right side. Both lung fields show large aggregated masses. There are three on each side, one in the right middle and upper zone, and two in the right lower zone, and a similar distribution on the left side. There is mottling of the "woolly" type occupying the lung areas between these masses. Basal emphysema is present. The contour of the diaphragm is regular. This appearance is consistent with a third stage film.

Plate 2. 1929. This film showed that the Mediastinal shadow was broadened. There was no change in the hilar shadows. The details in the lung fields had altered as follows.

(1) Increased density in all the aggregated masses.

(2) The edges of all the masses are more sharply defined.

(3) On the right side the two lower masses have fused and a band of fibrosis has extended to the base and has caused marked deformity of the outline of the right leaf of the diaphragm.

(4) Some degree of compensatory emphysema is now found in the upper part of the lung fields.

(5) The basal emphysema is more marked.

The patient was obliged to give up work at this time, four years after the third stage appearances were noted.

Plate 3. 1934. showed no appreciable change from the appearances described under Plate II.

Case No 39. aet $57\frac{10}{12}$.

Plate I. 1926. This reveals no increase in extent or density of the root or trunk shadows. There is mottling of the "woolly" type throughout both lung fields. There is very little emphysema at the bases or elsewhere. The appearance is consistent with a first stage film.

Plate 2. 1928. Showed no increase in the root or trunk shadows. Some slight increase in the mottling was present more marked on the left side; No increase in the basal emphysema. The condition is not in any way more marked than that depicted in the film taken two years previously. The patient continued at work during the period.

These three cases again illustrate the impossibility of judging what the X-ray appearances will be, by a knowledge of the length of time the subject has been engaged in Coal-trimming. The man with the longest service shows least changes in the radiograms in this short series.

Case No 26 shows that development from a fairly

early second stage appearance to a well marked second stage may occur in a short period - as little as fifteen months. In the early film the nodules are small with rather indefinite edges, in the second one they are larger but the edges have become much more clear-cut and defined and a tendency towards aggregation is noted. All the changes are more advanced in the hilar area. There is, in the second plate, slight evidence of diaphragmatic adhesion, which is suggestive of an increase in the fibrotic process. Four years later; after continuing at work for that period, there is no evidence of any change in the radiological appearances, though previously definite changes had been observed in a much shorter time. This seems to point that development of the disease may proceed up to a certain stage and then be arrested.

Case No 31 illustrates a similar point. A well marked third stage picture is seen in the first plate and the patient is still able for work. A second plate taken four years later revealed increased density of the aggregated masses, with more clear definition of their edges and a new band of fibrosis extending to the base on the right side. The third plate, taken 5 years after the second, shows no increase whatever in the degree of fibrosis. The patient was forced to relinquish work at the time of the second X-ray.

Case No 39. shows a very early first stage

picture at the age of 58 years, with no increase whatever after 2 years' further work - another case of apparent arrest of the process at a certain stage.

The question still remains, why do the changes described in this and other sections show such lack of uniformity? In the first two cases described above, the only change noted in the character of the fibrosis at what might be termed the end stage, was that nodules and masses, instead of showing indefinite irregular edges, had quite well defined edges as though a limit of spread had been reached and this limit could not be trespassed. One significant feature in all the plates was the absence of any suspicion of "infiltration". Many of the points raised in the preceding sections are discussed in the section immediately following.

DISCUSSION OF THE RESULTS.

The foregoing pages present a detailed account of the results of an extensive examination of the chest, both clinical and radiological, in men occupied as Coal trimmers. These results must now be correlated and discussed, so that a complete picture of the usual clinical findings in men engaged in this occupation may be presented.

REVIEW OF THE LITERATURE.

The harmful effect of the inhalation of dust has been recognised from very early times. Georgius Agricola,[1] in his work "De re metallica", wrote "This dryness (in mines) causes the workman even greater harm, for the dust ---------- penetrates into the windpipe and lungs and produces difficulty in breathing and the disease which the Greeks call Asthma. If the dust has corrosive qualities it eats away the lungs and implants consumption." From this early reference to the subject until the present time great advances in our knowledge of the harmful efffects of dust inhalation have been made. Bernardino Ramazzini[2] in a book published in the year 1700 added more precise knowledge to the store already gathered especially in the case of stone - hewers and cutters, and with the gradual increase in the number of industries in which dust was evolved, further knowledge regarding the dangers of the various types of dust and means for overcoming these dangers

became a vital necessity in order to safeguard the health of the workers.

At the beginning of the twentieth century the position of the Medical world is summarised by Goldberg[3] ("Occupational Diseases" p. 58) as follows:- "Medical opinion up to beginning of the twentieth century continued to hold as a broad truth that the inhalation of any kind of dust predisposed to diseases of the lungs of which pulmonary tuberculosis was the chief". Since then researches by various workers, among them Sir Thomas Oliver, A.L.Collis, Professor Haldane and Professor S. Lyle Cummins, have carried our knowledge to a much greater state of precision.

It is generally recognised that the major effect of inhaled dust falls upon the respiratory tract and the term Pneumoconiosis, first given by Zenker, is used to describe pulmonary affections which develop as the result of the inhalation of inorganic dust (Norris and Landis[4] "Diseases of the Chest and Principles of Physical Diagnosis" 5th Edition p. 546). Any inorganic dust may cause pneumoconiosis but the capacity for causing damage varies with the different types of dust. The most dangerous is silica dust.[4] (Norris and Landis op cit. p. 547). One would note here that the term silicosis cannot be substituted for pneumoconiosis. The definition of silicosis given by the International Congress on Silicosis at Johannesburg in 1930 was "A pathological condition of the lungs due to the inhalation of silicon dioxide". Silicosis is

therefore the name given to a pulmonary condition produced by a specific dust, namely silica, while pneumoconiosis is a generic term used to describe a type of pulmonary condition which may be produced by any inorganic dust. Research on the question of silicosis has even reached the point at which quantitative estimations have been made. It has been stated that 10,000,000 particles of dust containing 35% of free silica, per cubic foot of air inspired, may be tolerated without great injury to the lung. It has also been shown that the damage to the lung is caused by the small particles of dust with a diameter of a red blood corpuscle or less. According to Norris and Landis[4] Op. Cit. p. 549, "The ultimate expression of the inhalation of inorganic dust is the presence of fibroid changes in the lungs. The amount of the fibrosis will depend partly on the character of the dust and partly on the exposure."

The term 'silicosis', according to many authorities, should be restricted to the effects of dust that is nearly pure silica. The effects of such a dust are characterised by "The severity of the damage produced, the brief time in which such damage may be caused and finally by the high incidence of tuberculosis which accompanies it" (Norris and Landis[4] Op cit p. 547) Many dusts, however, contain other elements in addition to the silica content and one such, coal dust, is the important factor in the subject under discussion.

LITERATURE DEALING WITH COAL DUST.

Coal dust is very largely pure carbon with a very small silica content. The silica content has been variously stated. Edwards [5] ("Radiographic Diagnosis in Diseases of the Lungs" British Medical Journal. September 14th 1935) states that coal carries 2 to 4 per cent of free silica. Professor S. Lyle Cummins allows the author to state that in this area in South Wales the total silica present in the coal is small and probably less than 1 per cent. As this is a figure for the total silica, some may exist in the form of silicates as well as Silicon dioxide.

Statements in the literature in direct reference to the occupation of Coal trimming are very few, but the occupation of Coal mining, in which men are exposed to a much smaller volume of dust but in which the possibility of working in rock containing a high percentage of silica is present, is frequently referred to. The consensus of opinion in the literature rejects the view that Coal dust in itself is liable to be harmful. In repairers and borers and in all workers in mines who encounter stone dust, Silico-Anthracosis may and does frequently occur. In a paper on "The need for Dust Prevention Methods in the Coal Industry" read to the South Wales Institute of Engineers, [6] Professor Lyle Cummins quotes Haldane as saying that "There seem at any rate no real grounds for thinking that coal dust when inhaled in moderation causes any injury to the lungs."

Norris and Landis[4] (Op.Cit. p. 547) state that Carbon dust of itself may bring about a mild degree of fibrosis of the lungs. A more comprehensive statement on the subject has recently been made by Professor Lyle Cummins[7] (British Medical Journal, August 1935). He gives a simple classification of the effects of inhaled dusts and makes special reference to the occupation of coal-trimming. It is necessary to give this classification in detail as further reference will be made to it later especially to that part dealing with Coal-trimmers.

CLASSIFICATION OF THE PNEUMOCONIOSES.

(Prof. S. Lyle Cummins.)

Type I. - Dust retention and accumulation determined by the operation of a chemically active dust inhaled into the lungs; resulting in a nodular fibrosis and in X-ray films, bilateral symmetrical mottling.

Examples:- Silicosis: asbestosis

Type II - Retention and accumulation of an inert dust, determined by lymphatic blockage through previous or simultaneous inhalation of a chemically active dust; resulting in nodular and diffuse fibrosis, dust accumulations, and in X-ray films bilateral symmetrical mottling and irregular diffuse shadows.

Examples:- silico-anthracosis:silico-siderosis

Type III- Accumulation of an inert dust through excess of entry over elimination; resulting in block anthracotic but usually well aerated lungs without much fibrosis and in X-ray films, nil or partial

small mottling.

Examples: The Anthracosis of coal-trimmers and screeners

Type IV - Localised dust retention in areas of obstructed lymph flow due to old tuberculous foci or other lesions; resulting in extensive sharply localised accumulations of dust in fibratic,"india-rubber like", areas of non-symmetrical distribution and, in X-ray films, "Cricket-ball" or "pseudo-neoplams-like" shadows.

Examples:- The fibrotic aggregations of inert dust occasionally present in individual cases in all types of pneumonoconiosis, but especially frequent in Silico-anthracotic persons, in coal-trimmers, and in screeners.

This paper further states the "Sinkers", "borers" and "hard-heading" workers, (in mines) breathing in much stone dust and relatively little coal dust are liable to exhibit advanced silicosis after a relatively short period of work --------- at the other extreme are the coal trimmers with little or no risk of silicosis, though it is possible that they may prove to suffer, to some extent, from a form of diffuse lung fibrosis of "foreign body" type, from excess of anthracotic accumulation."

The foregoing pages give a brief résumé of the literature on the subject and the views which appear current. With this as a background the lessons learned from the present investigations into pulmonary conditions in Coal trimmers may now be considered and independent conclusions drawn from the facts presented.

THE SYMPTOMATOLOGY IN GENERAL.

The symptoms displayed by workers in this occupation may first be considered. The symptomatology is not a very varied one, but it is important to realise the nature and significance of the early symptoms for much future suffering can be avoided if a change of occupation is practicable at an early stage.

The period of exposure to the dust necessary to cause symptoms is not constant. Instances of this can be seen from the facts already given, Men of over 50 years of age with nearly 30 years service as Coal-trimmers being free from symptoms while men of 30 years of age with only a few years service may exhibit symptoms of sufficient severity to cause disablement. The longest time noted before symptoms were developed was 32 years. The average period of exposure prior to the onset of symptoms was 15 years. The usual age of the patient at the time of onset was approx. 40 years. One interesting point in this connection was that patients in the third group, which comprises mainly the older men, had commenced work, on an average at an earlier age but did not develop symptoms until 20 years had elapsed since they began work. This is even more incomprehensible, when it is remembered that these men have worked longer hours than the men in the other groups. The average exposure of 15 years is in accord with that noted by other workers (Norris and Landis [4] "Diseases of the Chest and Principles of Physical Diagnosis"

page 551).

It has been noted that the early symptoms are important as a warning of future trouble; but it must be confessed that the early symptoms and signs are by no means distinctive. The usual mode of onset appears to be the gradual, even insidious, development of a cough, while another mode of onset is an attack of acute bronchitis characterised by the usual symptoms and signs, but very persistent, especially if the patient attempts to continue work, and liable to be rapidly followed by a second and even a third attack. Many of the men confess that their chest trouble arose after a cold which they tried to "work off". The cough seems to be at first an irritant throat cough and later becomes more persistent, due to irritation or infection of the bronchi, with the presence of sputum. In a few cases an attack of pneumonia seems to be the starting point of a breakdown in health and even less commonly a dry pleurisy. An attack of spasmodic dyspnoea resembling an asthmatic attack may adumbrate the underlying condition, or gradual onset of shortness of breath determine the beginning of the illness. It can be stated that any acute chest illness in a coal-trimmer may be the beginning of a train of symptoms which will finally lead to complete disability, but this is by no means an invariable rule. These considerations should, however, lead to additional care in the convalescence from such an illness, and adquate time should be allowed for recovery. Relapses and second attacks must be guarded against as deterioration may be more rapid thereafter.

SYMPTOMATOLOGY IN DETAIL.

The actual symptoms displayed have been already discussed. They include, cough, the presence of sputum, pain in the chest, haemoptysis, shortness of breath, tightness of the chest, loss of weight, night sweats and certain other less common complaints, lassitude giddiness, headache and vomiting.

It is impossible to say that there is any definite order of appearance of the symptoms. Practically every case exhibits a different order of development of the symptoms. Cough is almost always the initial symptom and is a very persistent one. It is always present in the older men even in those who have actually given up their work. It begins as an irritative throat cough, only present after exposure to the dust cloud, gradually becomes more persistent and finally, when established, is evidence of bronchial and pulmonary damage which is naturally aggravated by further exposure to the dust.

The presence of sputum is another well marked symptom. It is more frequently present in the older men and is more copious in such cases. In character, it is usually frothy or mucoid and a purulent or muco-purulent sputum is not common and is evidence of fairly advanced secondary changes due to an infective element superimposed on the irritative. The sputum very frequently contains coal particles. These are always present after completing a "shift" and in those men with a lengthy experience of the work, they are found at times other than immediately after work.

One case in this series occasionally noted coal dust particles in the sputum nine years after he had ceased work. The fact that the usual character of the sputum is the mucoid or frothy type suggests an irritative effect on the bronchi rather than an infection by micro-organisms, though this latter condition eventually supervenes in a certain percentage of the cases. The 15 to 20 per cent who show a purulent sputum are suffering from an infective element superimposed on a mechanical irritation. The above figure refers to the cases whose sputum is constantly purulent or muco-purulent. In many others recurrent attacks of acute bronchitis will give rise to this type of sputum, which again becomes mucoid when the infection is overcome. This is amply evidenced by the experience of treating such patients throughout an attack. Similar conclusions in the case of Coal Miners are arrived at by Prof. Lyle Cummins [6] in his paper "The need for Dust-Prevention Methods in the Coal Industry", read to the South Wales Institute of Engineers in December 1931.

It was found that in men actively engaged in work, pain in the chest was a very common symptom. In the older men who were unable to work, it was much less prevalent. In the former group it seemed to develop in point of time after the cough was noted. (Pain here refers to a constant chest pain and not to the transient acute pain of an attack of pleurisy). The pain is practically always aching or dragging in character any very seldom pleuritic or

stabbing. The site of the pain is usually substemal or localised to the front of the chest, and in the writer's experience is more often experienced on the left side. It is of less frequent occurrence in those men who have ceased work and is probably due as much to the inhalation of the dust as to the effect of the dust when inhaled. The inhalation of the dust leads to persistent cough, which pulls on the attachments of the intercostal muscles and the diaphragm, and also causes irritation of the Trachea and bronchi. In the older men with radiographic evidence of fibrosis, the presence of adhesions will account for some of the pain. Taken throughout it is a very prominent symptom and one which causes infinite discomfort and defies most remedies.

The next symptom of import is <u>haemoptysis</u>. It is present in about one-third of the cases and is a more frequent occurrence in the men who continue at work despite having symptoms. It is more often met with during the development of the symptoms, but it would appear probable that certain cases in which symptoms develop readily are more prone to suffer from haemoptysis. A study of the whole subject reveals more and more strikingly, that, given identical conditions, no two men react alike. This fact applies not only to the presence or absence of blood in the sputum but to all other manifestations of the effects of coal dust. In some measure we may take the presence of blood in the sputum as an indicator of activity or spread of the pathological

conditions in the lungs and in all cases sputum tests are necessary to exclude tuberculous infection and, as far as possible, prove the aetiological relationship of coal dust to this symptom. From the results of the investigation already detailed, it is unquestionable that coal dust, when inhaled for a sufficient period of time in sufficiently high concentration, can and does cause haemoptysis without the necessity of postulating the existence of a superadded tubercular infection. In no case in this series was there any proof of such secondary infection.

The blood is more commonly revealed as a streaking of the sputum. A frank haemoptysis is less common and is very uncommon in the older cases. Such an haemoptysis is usually small but may be recurrent. The amount of blood lost is never sufficient to give alarm and the men seem to look on it as an event which may be expected. The cause of such an haemopytsis cannot be proved in a purely clinical surgey. It may, and does in some early cases, come from the pharynx due to the chronic inflammatory changes caused by the dust. More frequently it may be bronchial in origin and the same factor may be at work. In the case of a small haemoptysis it is almost certain that a pulmonary vessel is involved due to obstruction to the veins in an area of fibrosis. Norris and Landis[4] (Op.Cit. p. 550) point out that such an alteration in the circulation of the lung can occur through the presence of the fibrous tissue.

The fourth outstanding symptom is shortness of breath, with which may be considered tightness of the chest. The distinction made between these two symptoms has already been discussed and they will now be considered together.

It has been pointed out that shortness of breath is best marked in the men with a relatively long period of service. It is maintained that in this type of worker shortness of breath is not common as an initial symptom. If it is present in any case, that case will usually be found to have some other symptom of even longer duration. It is a very common symptom in those who have been forced to give up work, so common indeed that it is here considered as the most important disabling factor. The length of time necessary in this occupation before shortness of breath developed varies considerably and again the factor of individual susceptibility comes into play. (Edwards, 5) Radiographic Diagnosis in Diseases of the Lungs", British Medical Journal Sept. 14th 1935 p. 495). Several of the men in this series show shortness of breath after 6 to 8 years' work, and others only after 20 to 25 years' work. If the radiograms of the men showing shortness of breath are studied, it is seen that while men in the first and second stage of the disease may show shortness of breath, it is almost universal in the men in the third stage. In general one may say that shortness of breath is a manifestation of the disease at a more advanced stage than that at which the other

symptoms just described, are found. It must be remembered, however, that shortness of breath may be caused by conditions apart from the effects of the coal dust. Some of these may be responsible in whole or in part for this symptom both in the younger and the older men. Cardiac failure in the latter and asthma in the former may be cited as examples.

Tightness of the Chest is a symptom which does not necessarily accompany the shortness of breath. It may be found alone. It is more marked in the older men and is probably related to the diminished expansion of the lung.

The four symptoms described above are the outstanding features in the symptomatology of this disease. Several additional symptoms may be noted and some of these are referred to as constitutional symptoms (Norris and Landis [4] Op.Cit. page 552). These included loss of weight, night sweats, lassitude headache, giddiness and vomiting. All these appeared to be related to the general ill-effects of the dust on the lungs, with the resultant secondary bacterial infection and alteration in the circulatory effiency and also to the effects of swallowed dust and sputum. In all the cases in this series there was no striking degree of cyanosis present. Cyanosis was only seen in one or two cases and then only in very slight degree. These cases were amongst the older men who had been obliged to relinquish work.

THE PHYSICAL SIGNS.

From the survey of the symptomatology exhibited

by workers in this occupation we pass to consider the physical signs elicited in an examination of the chest. The evidence on which this survey is built has been fully explained in the appropriate sections and the factors under consideration sufficiently emphasised.

The general physique of the men is usually good. This would be expected in an occupation calling for a marked degree of physical strength. Despite the fact that loss of weight is a very constant finding and that most of the men are slightly, and in many cases grossly, below standard weight, the muscular development is surprisingly good. Very few possess excess adipose tissue and many show well developed musculature of good tone, with loose unsupported skin covering. The men who exhibit marked symptoms, however, evince, by their hollowed temples, pale faces with slight cyanosis of the ears, thickened oedematous conjunctivae, prominent neck musculature and finger clubbing, that some organic damage has occurred which has had widespread results.

Inspection of the chest reveals little in the healthy coal trimmer, but even thus early, with no other evidence of disease, slight mid thoracic kyphosis may be present. This is considered to be due to the attitude adopted at work. When symptoms have become a notable feature we begin to find a alteration in the chape of the chest. The antero-posterior diameter may be slightly increased and certain local changes in symmetry occur, notably

slight prominence of the sternum, with slight flattening of one or other side of the chest. With further advance in the severity of the symptoms practically every case shows a change in the antero-posterior diameter of the chest, usually towards an increase, and even more marked alterations in local symmetry occur, with occasional evidence of alteration in the shape of the chest wall from disease within the thorax.

The expansion of the Chest during a full inspiration is somewhat small, even in the healthy workers and decreases with length of service. In men totally incapacitated it averages less than half an inch and in some cases no expansion can be detected, movement being entirely vertical. Throughout a series of cases it was noted that a thoracic type of respiration was not uncommonly found in the younger men but was not noted in the older members of this series.

Physical signs in the Chest can usually be detected. These may be present within a short time of commencing work or may be delayed up to 30 years. With increasing age and length of service physical signs become more prevalent but in a few cases symptoms of sufficient severity to incapacitate a patient may be accompanied by no definite physical signs. The physical signs in the majority of cases are not indicative of any definite pathological condition. A knowledge of the patient's occupation may help to explain the cause of the abnormal signs

detected, but without such knowledge a positive diagnosis of damage due to coal-dust cannot be made.

The actual findings in an examination of the chest are often scanty even in men with long service as Coal-trimmers. The percussion note is frequently impaired in scattered areas which can usually be delineated with a fair degree of accuracy, although estimation of the character of the note is difficult for two reasons. One is that in these cases, a peculiar flattening of the note throughout the lung is quite usual. The description "muffled resonance" is the best descriptive temm that can be applied to it. It is thought to be due to the fibrosis of the alveolar walls. The other reason is well expressed by Norris and Landis [4] (Op. Cit. page 553). "As the process is bilateral and of nearly equal distribution one lacks a basis for comparison".

The parts of the lung in which impairment of the percussion note is most frequently found are the interscapular area and near the apices. The impairment at the apices is an important finding. It is quite a definite occurrence and by many authorities is acknowledged as a sign of a complicating tuberculous infection (Norris and Landis [4] Op. Cit. page 553). As far as the results of this investigation are concerned, it has been shown that impairment of the percussion note at the apices of the lungs can occur as a manifestation of effects due to the inhalation of the coal-dust. Impairment of the percussion note in the interscapular area is a natural result of the

greater damage to the lymphatics, with consequent fibrosis in the mid-zones of the lungs. The increased damage in this zone is due to the number of dust cells travelling in the lymph channels to glands at the bifurcation of the bronchi and vessels. Fibrosis in this area of the lung is produced after the channels by which these cells usually reach the glands mentioned have been blocked. (Norris and Landis [4] Op.Cit. page 550 and Crocket [8] "Physical and Radiological Examination of the Lungs" pages 221 and 222).

Many cases show no alteration in the percussion note but may display abnormal physical signs on auscultatory examination. These abnormalities may be (1) alteration in the character of the breath sounds (2) diminished intensity of breath sounds, and (3) the presence of accompaniments. Alteration in the character of the breath sounds is unusual and means gross alteration in the structure of the lung either by the coal dust, as in a massive fibrosis causing partial obstruction to a bronchus with resultant stridulous breath sounds, or by some extraneous cause such as tuberculosis or new growth. Alteration in the character of the breath sounds does not always accompany impairment of the percussion note. Usually associated with an area of impaired percussion note one finds diminution of the air entry. Alteration in the character of the breath sounds is considered by the writer to be of considerable significance in deciding whether or not

extraneous disease is present. In general, alterations in lung structure due to effects of inhaled coal dust, do not cause changes in the character of the breath sounds. The usual auscultatory findings are (1) diminution of the air entry either local or general and (2) the presence of accompaniments, which may be râles or rhonci (Bronchial Catarrh) or crepitations (Alveolar Catarrh). Crepitations are not solely confined to the older workmen as might be expected if there was orderly progress in the effects of the inhalation of the dust. Crepitations may be found in men with only a few years working experience. No type of adventitious sound is constant or pathognomonic. Rough pleural sounds, clicks and rubs may be present but were not conspicuously noted in this series of cases.

The foregoing pages present a picture of the outstanding symptoms and physical signs encountered in workers in this occupation. Little mention has been made of the Family History and the Previous Medical History of these men.

In certain cases the Family History may be of some importance especially in cases of illness which is known to exhibit an hereditary tendency such as asthma, or in cases where close contact predisposes to infection as in the case of tuberculosis. It is possible that exposure to dust may of itself predisposed to the development of dyspnoea of a spasmodic nature, but this result is even more probable in a man who has a predisposition to Asthma.

It need only be stated that in this series of cases there was not an unduly high proportion of men with such a family history and it appears unlikely that an hereditary predisposition of this nature plays any important part in the causation of symptoms. In a man with such hereditary tendencies, however, one might expect symptoms to develop earlier or more extensively.

In the case of Tuberculosis a family history is of importance. A case occurring in a family makes a contact history of considerable importance from two view points, (1) The obvious risk of infection, (2) If mild infection does occur lymphatic damage is caused in the lung and this leads to greater ease in the development of fibrosis due to inhaled coal dust. It is noteworthy that in the series of cases presented, a contact history of tuberculosis occurred in eight cases, most of them affecting men who were able to carry on with their work. It was probable that in these eight cases no tubercular infection was present.

The question of a tuberculous family history leads to another important question, namely, the possibility of many of the symptoms and signs displayed by these workers being actually caused by tubercular infection.

It has been pointed out that no definite diagnosis can be made in these cases on the symptoms and physical signs alone. Such symptoms and signs might give rise to many alternative diagnoses which have already been suggested and need not be

recapitulated here. X-ray evidence is of course of great assistance in making an accurate diagnosis, but on purely clinical grounds the findings may be highly equivocal. Outstanding in the list of alternative diagnoses is Pulmonary Tuberculosis. In practically every case this must be excluded and the problem is often very difficult even with radiological help. The difficulty is enhanced by the fact that coal dust appears to exert an inhibitory action on tubercular lesions as has been shown by Prof. Lyle Cummins and Dr. Weatherall [9] and which is commented on by various other workers. This inhibitory action is explained by the former workers as being due to the power of coal-dust to adsorb the active principle of tuberculin in vitro and they state that it appears probable that a similar adsorption may occur in vivo in men working in coal dust. (Prof. Lyle Cummins "British Medical Journal" August 17th, 1935). The scrutiny of the evidence regarding the presence of tuberculosis in this series of cases has been very strict. X-ray plates have been carefully studied for suspicious signs with particular regard to (1) The distribution of the lesions, (2) the character of the lesions noted in the lung, (3) The general condition of the patient as compared to the radiological appearances in the lungs. Many present X-ray evidence of advanced pulmonary disease without corresponding physical signs, a condition which is very unlikely to be tubercular. (4) The sputum tests (5) The temperature reaction of the

patients, a continued temperature being suspicious of a superadded tubercular infection.

In the present series, two cases showed X-ray appearances which were considered suspicious of a superadded tuberculous infection, but no confirmatory evidence was forthcoming.

Sputum tests were only available in 45 out of the 76 cases but were done in all the doubtful cases and frequently repeated. In certain cases further tests by the antiformin concentration method and by guinea pig innoculation tests were carried out. In every instance negative results were obtained.

It may be said that in the whole series, two cases showed signs suggestive of tuberculous infection but in no case was there positive proof of such infection. It is felt that sputum tests at present form the only absolute proof of the presence of tuberculosis, in men engaged in this occupation, but its absence cannot be proved. The writer recalls the case of a coal-trimmer not included in this series, who had been thoroughly investigated because of a suspicion of tuberculous infection. He was pronounced as suffering from Silico-anthracosis but free from tuberculosis. He continued at work with increasing difficulty, increasing breathlessness, and increasing physical signs in the lungs, and a slight occasional swinging temperature. Eighteen months after the original investigation he died with abundant tubercle bacilli in the sputum and a cavity at the right apex. This case illustrates very

clearly the practical difficulties encountered in making a diagnosis and the fact that opem tuberculosis was practically a terminal event.

In dealing with men in this occupation, tuberculous infection must always be kept in mind. It is admittedly difficult to exclude absolutely but it is felt that the cases here presented represent solely the effects of the inhalation of coal dust.

The Previous Medical History of men employed as coal trimmers affords one striking feature. This is the high incidence of respiratory disease such as Bronchitis, Pleurisy and Pneumonia. Bronchitis was present in 42 per cent of the men in this series and was in every case first noted after they began work as coal trimmers. It has already been pointed out that the bronchitis is in a large proportion of the cases mechanical rather than infective in origin. The infective element is deemed to follow after the Mechanical damage and to be much more resistant to treatment. Prof. Lyle Cummins [6] in his paper "The Need for Dust Prevention Methods in the Coal Industry" Dec. 17th 1931. points out a similar feature in coal miners, when he says "Infection of the walls of the (bronchial) tubes may be secondary to an abnormal pullulation of germs normally present in smaller numbers in the respiratory tract due to the loss of muscular and elastic efficiency of the bronchial tubes through fibrosis induced by dust; i.e. a result not a cause. The bronchitic of coal miners is mechanical rather than bacterial." The peculiar

liability of a lung damaged by dust inhalation to invasion by all the disease producing organisms (mentioned by Crocket [8] "Physical and Radiological Examination of the Lungs" page 221) can largely be explained by this hypothesis of initial mechanical damage followed by infection.

Pleurisy was present in the previous Medical History in 25 per cent of the men in this series, and in 84 per cent of that number occurred after the patient had begun coal-trimming. The pleurisy in all cases was of the dry variety. No case gave a history compatible with the presence of an effusion. In no case was the pleurisy traumatic in origin and again the question arises, was the pleurisy invariably infective in origin or was it due to the involvement of the pleura in a fibrotic process? Details obtainable are insufficient to prove this point, but personal experience of these cases reveals certain factors which lead one to believe that a mechanical origin is frequently present. These factors are (1) There is often a sensation of pain and dragging before any acute pain arises. (2) The pain is usually less acute than one is accustomed to find in the ordinary cases (3) Rise of temperature is very little marked and general symptoms less obvious (4) Recovery is more rapid but a slight dragging sensation is very persistent. As in any other dry pleurisy the question of a tuberculous origin must again arise, but the after history of all the cases who suffered from this ailment appears perfectly satisfactory.

In the 20 per cent of the men who had suffered from pleurisy before beginning work as coal trimmers the theory of a fibrotic origin must, of course, be discarded.

Pneumonia was found in 23.7 per cent of the series and two-thirds (66.6 per cent) had suffered from it after they began coal-trimming. In a few cases there had been recurrent attacks, one man having had three attacks. Evidently a lung damaged by the inhalation of coal dust is very susceptible to infection by the pneumococcus. It is of interest to note that the only case of pneumonia in a coal trimmer which the writer has personally supervised took a normal course until the crisis, but complete resolution was very markedly prolonged, taking about three months to become complete. Despite this delay in resulution the man stated that he felt fit and desired to resume work long before physical signs had disappeared from the lung.

It is important to note that no other conditions appeared in the previous medical history with such noteworthy frequency as did the pulmonary affections. These appear to be of marked importance in men engaged in this occupation.

The symptoms and physical signs, together with relevant details in the family history and previous medical history, have now been considered. The results of this clinical examination are of considerable importance but are, in many respects, inconclusive. They fail to reveal the actual cause

of the symptoms displayed. Even with a knowledge of the nature of the occupation the examiner cannot be sure that his findings are the result of an occupational hazard. He has many alternative diagnoses to exclude. He cannot estimate the extent of the disease, nor correlate accurately the clinical findings with a sequence of pathological events. It is to a study of X-ray plates of the lungs that he must turn to obtain more detailed information regarding the features noted above "X-rays", states Crocket [8] (Op.Cit. p. 225) ..... "Are not only the easiest, but the most reliable method, of studying the effect of the inhalation of dust."

RADIOLOGICAL APPEARANCES.

In describing the radiological appearances, very full descriptions have been given and the relevant conclusions have been drawn. These findings must now be discussed.

It is evident from the facts elicited from a study of the radiograms that Coal trimmers are liable to develop pulmonary fibrosis. The nature of the occupation suggests that this fibrosis is due to the inhalation of coal dust and an exhaustive review of the clinical findings has failed to reveal any other cause for the presence of the fibrous tissue in the lungs. In the course of the study of the radiological appearances, it was found that the degree of fibrosis varied enormously from case to case, but the available X-rays could be classified into

three groups. A description of the characteristics of these has already been given and it is unnecessary to repeat the details of this description. (See section on Radiology - The types of Radiographic Appearances). The three groups depict distinct stages in the severity of the effects of the inhalation of the coal-dust as is evident from the increase of the severity of the lung damage depicted in each successive group. We may consider that the appearance described in the first group or stage is an early degree of lung damage, group II a later stage and group III the final result of long continued inhalation of the dust.

RADIOLOGICAL APPEARANCES IN SILCOTIC LUNGS CONTRASTED WITH X-RAY FINDINGS IN COAL TRIMMERS.

Workers on the subject of silicosis, when interpreting the X-ray appearances have been accustomed to divide them into three stages. This arbitrary classification is very widely recognised and workers in different countries do not differ greatly, if at all, in their interpretation of the three stages. Thus Norris and Landis,[4] two American workers in their book "Diseases of the Chest, Principles of Physical Diagnosis" pp. 559 et seq., give a detailed description of the salient features in these three stages; their description differs in no material aspect from that given by Crocket[8] in his "Physical and Radiological Examination of the Lung" pp 223 et seq. For the sake of convenience the description of the three stages given by the

former authorities is appended.

RADIOGRAPHIC APPEARANCES IN SILICOSIS (NORRIS AND LANDIS).

"The first stage is characterised by an increase in the hilar shadows and thickening of the usually prominent trunk shadows and an undue prominence of the finer linear markings ..... The descending trunk shadows seem to be more marked on the right side than on the left and this may be due to the interference of the heart shadow. Abnormality of the diaphragmatic excursion occurs in all the stages even the first."

"The second stage is characterised by a more or less uniform mottling throughout the lung structure due to deposition of dust in the lymph spaces, cells, and fibrous tissue interspaces, with the addition of a certain amount of localised fibrosis. This stage comprises what has usually been regarded as the typical case of pneumoconiosis. Its onset seems to depend largely upon the character of the dust inhaled. It occurs early in those exposed to Silica; comparatively early in Coal Miners ..... The distribution of the mottling was found by us to appear invariably first on the right side on a level with the hilum shadow. It certainly becomes quite perceptible on the right side before it appears on the left..... In the advanced stages the two sides seem to be equally involved. The distribution is more or less symmetrical but naturally not uniform throughout the lung. From this starting point it

gradually spreads to the bases and apices but it is never so marked at the extreme apex or base as around the mid portion of the lung. The appearance of the mottling depends more or less on the character of the dust. In those exposed to Silica the spots are very dense and sharply circumscribed and can be seen when very small. In the less irritating forms of dust the spots are not so sharply defined."

"The third stage is characterised by the appearance of diffuse fibrosis and all that term implies. While there is no sharp dividing line between the second and third stages it would appear in some instances that the mottled appearance in the second stage becomes more and more conglomerate and finally passes over into the appearance of dense fibrosis. In some instances a general haze seems to spread over a certain portion of the lung, The greatest density is in the subapical region although this is not the area of most intense mottling in the second stage. Dense fibrous bands can be seen extending in various directions and frequently to the diaphragm causing marked retraction. In this stage the mottling has become extremely coarse and sometimes is no longer to be recognised as such. The heart and blood vessels are frequently dragged out of place and bronchiectatic cavities are quite common."

If one now compares the description of the three stages given above with the description of the three types of appearance found radiologically in men working as coal trimmers (Section on Radiology

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Types of Radiographic Appearances pp127-) many points of similarity can be found.

The description of stage I in the coal-trimmer is almost identical with that given by Norris and Landis quoted above. The condition in the coal-trimmer takes longer to develop and is never quite so marked but the actual changes are very similar. Even diaphragmatic adhesion was observed in this stage.

In stage II we find in both cases the presence of nodules tending to be symmetrical in distribution. In the coal trimmers the nodules are not nearly so definite in outline. They are not so distinct and are more difficult to distinguish from the adjacent mottling. The typical "snow storm" effect often seen in a well marked cases of silicosis is <u>not</u> frequently observed in the coal trimmer. X-rays of this type do not closely resemble the corresponding second stage film in silicosis. They are manifestly a more advanced stage of fibrosis than are the first stage appearances and more closely resemble the second stage appearances.of a true silicosis than anything else, without actually showing the definite sharply defined picture seen in the case of silicosis. Again a longer period of exposure to the dust is necessary to produce the picture.

The third stage appearances in the coal trimmer show the same general type of appearance as that found in the worker exposed to high concentrations of silica-containing dust. We find the aggregated masses. The presence of films over a portion of the

lung fields and also, but much less commonly, the presence of fibrous bands. Here again the condition may be extensive but is never so marked as in the case of silicosis. The nodules are smaller and less well defined and merge into surrounding areas which display only early or first stage appearances. In addition to the factors already noted there are present in many of the films of the coal-trimmers, large well defined masses, usually multiple and frequently symmetrical, which are not mentioned by Norris and Landis as being characteristic of third stage X-ray appearances in silicosis. They are however referred to by Crocket [8] (Op.Cit. p. 225) in his description of the third stage picture and would appear to be frequently present in cases of silicosis. Diaphragmatic adhesions are very commonly found in this stage in the coal trimmer but are not so universally found as in the case of men exposed to dust containing much silica. There is very little evidence of the extensive degree of fibrosis which causes displacement of organs.

THE CAUSAL FACTORS OF THE RADIOLOGICAL APPEARANCES IN COAL-TRIMMERS.

It will be evident from the foregoing comparison that radiological findings in the coal trimmer show a very marked similarity in the type of radiogram displayed, to the findings in men suffering from silicosis, but the degree of fibrosis in the lungs is much less and the men do not suffer the same degree of disablement.

In the early part of this discussion, a classification of the pneumoconiosis by Prof. Lyle Cummins was given in detail (See section on "Literature dealing with Coal Dust" pp. 164-166). In this classification it is stated that in coal trimmers the pulmonary findings are "black, anthracotic, but usually well aerated lungs, without much fibrosis and in X-ray films - nil or partial small mottling," and the findings in coal trimmers are placed under type III in which there is excess of entry of an inert dust over elimination. In a further group (type IV), are placed the cases with large fibrotic areas or pseudo-neoplasm-like shadows. These latter are believed to be due to localised dust retention in areas of obstructed lymph flow due to old tuberculous foci or other lesion, and manifestly could occur in cases of undoubted silicosis by the action of the silica in damaging the lymphatic flow and leading to retention of dust. It is evident that this classification imputes only a mild degree of fibrosis to the action of the coal-dust and explains the localised dust accumulations as being due to obstructed lymphatic flow caused by previous damage to the lymphatic system by an old tubercular infection previous pneumonic infection or other damaging factors.

It is evident that there is some factor present in the cases in this series, either in the lungs themselves or in the environment of the cases which brings about the marked degree of fibrosis depicted in the radiographs. If this factor is to be found in the lungs we must look for an infective origin

either tuberculous or pneumonic, if it is present in the external conditions to which these men are exposed, the obvious cause is the extremely dense dust cloud. It is unlikely from the outset, that all cases could be suffering from infective pulmonary disease of sufficient severity to cause the appearances already noted, but it is possible that all of them may have had some previous infective disease which so damaged the lymphatic circulation that removal of the dust particles became impossible and fibrosis resulted. It is necessary to review the evidence obtained on this theory at the present juncture.

Damage to the lymphatic circulation by tuberculous infection could be brought about by a tuberculous adenitis of the hilar lymphatic glands or by a frank tuberculous infection of the lung parenchyma. In regard to the question of a previous tuberculous adenitis, this was thought to be present in only four cases in the present series. The diagnosis was made from the presence of calcified hilar glands. One of the four cases displayed a completely negative X-ray as far as fibrosis was concerned, two showed a first stage film and one a second stage. It can be seen therefore, that even in these cases where there is a very strong suggestion of the presence of previous tuberculous infection, the fibrotic process may assume similar characters to those found in other cases and does not assume unusual proportions. In addition it shows that proof of a previous

tuberculous infection is lacking in 90 per cent of the X-rays examined in this series, and evidence of infection by sputum examinations is absent in a higher percentage.

In regard to the question of a previous pneumonic process and its possible relation to the radiological picture, it has been possible to trace ten cases in this series who have had pneumonia either before or after beginning work as coal trimmers. Of these ten cases, five showed a film of the third stage, three of the second stage, and two a late first stage. This would appear to show that a previous attack of pneumonia does tend to bring about a more severe degree of fibrosis, but many men develop as serious a fibrotic lesion who have never had pneumonia. It may be a predisposing factor towards the marked development of fibrosis but does not seem to be an essential factor in this development.

In regard to the presence of Bronchial catarrh, this ailment is very general in these workers and is in many cases severe. It is doubtful however if this could cause sufficient lymphatic damage to bring about the results noted, and this theory would still fail to explain the incidence in young workers of advanced or third stage appearances.

It can be seen from the foregoing statements that in this series of cases we have been unable to find evidence that infective conditions are essential to the production of fibrotic lesions in

X-ray films of the lungs of coal trimmers. Such conditions we believe, may facilitate and quicken the development of fibrosis but this fibrosis can and does occur in the absence of such pulmonary infections. We are therefore driven to the conclusion that LONG CONTINUED inhalation of coal dust can produce a degree of fibrosis easily recognisable in X-ray films and that varying degrees of severity in the condition are found. We believe that the inhalation of the dust initially causes some degree of lymphatic damage with blocking of the channels and a resultant fibrosis and that accumulation of coal dust particles occurs in those areas in which the drainage is obstructed. The degree of fibrosis is not nearly so marked as in the case of dust containing a high percentage of silica and the nodules are less definite because of the lesser degree of obstruction and fibrosis. It is a point of considerable importance, whether the very scanty percentage of silica in the coal dust of this area can be harmful. It may be that the small amount of silica present in the dust is compensated by the increased amount of dust per unit volume of air inspired. Whatever the ultimate cause of the fibrosis found in these workers, we consider that there is evidence to show that inhalation of coal dust may cause a definite and recognisable degree of fibrotic change.

THE DEVELOPMENT OF THE X-RAY CHANGES IN COAL TRIMMERS.

We have endeavoured to show that men working as coal-trimmers do develop some degree of pulmonary fibrosis. We may now discuss the development of the condition in these workers.

The process is one of fibrosis. The fibrotic nature is obvious in the advanced cases showing displacement of organs, but as these are uncommon in the case of coal-trimmers recognition of fibrosis by clinical means is often difficult. Radiological examination is the only way of recognising the early degrees of the condition and in order to fully understand and interpret the X-ray appearances, some conception of the pathology of the condition is necessary. The following brief resume of the current view on the pathology is largely derived from Norris and Landis[4] "Diseases of the Chest", already referred to on several occasions.

RESUME OF THE PATHOLOGY OF PNEUMOCONIOSIS.

It is the finer dust particles which are harmful. These particles which cause damage usually have a diameter of 0.5 to 5 micromillimetres. These cause irritation of the alveolar cells with swelling and a catarrhal process accompanied by proliferation of cells called "dust cells". The "Dust-cells" are derived from the walls of the capillaries and lymphatics which have a close relationship with the alveolar epithelium and are phagocytic. They take up the dust particles and convey them away from the alveoli in the pulmonary lymphatic channels. Some of

the cells are arrested at the proximal ends of the lymphatic channels along the alveolar ducts, others reach the bifurcation of the bronchioles or of the bronchi and vessels and many reach the tracheo-bronchial glands. Arrest of the cells leads to an area of fibrous tissue formation with lymphatic blockage, the degree depending on the silica content of the dust. Increase in the degree of lymphatic damage leads to more and more fibrosis with corresponding increase in the clinical and radiological signs, and also to a holding up and accumulation of "dust cells" containing coal dust particles.

With this pathological conception before us the development of the changes found in the X-rays of this series of cases can now be discussed.

The earliest radiological change noted is enlargement of the hilar and trunk shadows. Increase in the extent and density of the root and trunk shadows are usually found associated in the X-rays of this series, indicating that there has been primary damage to the tracheo-bronchial glands by the cells reaching them from the alveoli. This is turn has led to some delay in the circulation in the lymphatic channels leading to these glands with increased difficulty in the transferrence of the "dust cells" and a consequent slight degree of fibrosis. In a few instances trunk shadows alone show increase and this may indicate that blockage has occurred at one of the other points noted, the bifurcation of the bronchioles or bronchi.

The next development in the X-ray picture is the presence of mottling. This is first noted in the zone adjacent to the hilum and usually best seen on the right side. It extended next to the subapical region and is at first very delicate and appears to be due to blockage of the outlet of the smaller lymphatic channels by earlier changes in the peribronchial and perivascular channels. It is an appearance of this nature which is included in the so-called first stage. The mottling never appears so marked at the bases of the lungs. Such delicate changes cannot be detected except by X-ray examination. Symptomatology and Physical signs at this stage reveal only some slight bronchitis indicated by cough which is usually only occasional and by a few scattered rales. In a few cases crepitations may be audible and are usually basal and may possibly indicate some slight degree of alveolar catarrh which is the starting point of the whole sequence of events. This stage displays no remarkable symptom unless some slight streaking of blood in the sputum is present.

In the introduction to the section of this thesis dealing with radiology, it is mentioned that the types of mottling found, can be grouped into three classes which were termed "faint", "fine" and "woolly". Mottling may be present alone as sole evidence of the fibrotic process without the formation of nodules and the mottling may be of either of the three types. One finds however, that the very earliest change is mottling of the "faint" type, the

presence of "fine" mottling suggests a more advanced process and "woolly" mottling evidence of still more advanced fibrosis. The mottling in itself is probably due to a fibrosis of the inter lobular septa and from the description of the three types one can follow the manner in which the mottling develops. Progressive thickening of the septa occurs, with decrease in the area of lung field visible in the X-ray, and enlargement of the pulmonary lymph nodes takes place giving rise to the beaded appearance noted in the "fine" type of mottling. There is a tendency for the larger beaded areas to aggregate and form nodules. The presence of nodules in the X-ray film together with mottling is considered as an advance in the severity of the condition to the second stage. In the early or first stage, no marked distinction regarding the side primarily affected can be elicited, but the middle and upper zones of the lungs show the changes most clearly. Despite the fact that it is the upper zones which seem to be most heavily affected and even at this early stage in the condition, slight irregulatity in the outline of the diaphragm may occur and not necessarily in cases showing the most advanced types of mottling. This slight interference with the regularity of the contour of the diaphragm reveals the presence of some adhesions between the two layers of the pleura in this area, and as the pulmonic pleura in this area has its lymph drainage to the glands in the hilum of the lung, the adhesions can occur if

appear that the infrequency with which this feature occurs in the early stages is due to the fact that it is the upper zones of the lung fields which are primarly affected by the fibrotic process.

The transference from the appearances just described to the second stage proper, is gradual. The nature of the change has already been suggested. The mottling is either of the "fine" or "woolly" type and small nodules are present varying in size from the head of a large pin to the size of a pea. These appear to be a development of the beading already noted. In the cases showing the "woolly" type of mottling, the nodules are larger and more irregular and show that their formation is due to the aggregation of two or more smaller nodules. The small nodules are not of great density and moreover usually reveal a uniform density throughout. The larger nodules show greater density in the centre with a gradual lessening of opacity towards the periphery. In many cases the edges are somewhat indefinite and have small tentacles stretched out as though to embrace the neighbouring nodules. The distribution of the pathological appearances is more uniform at this stage, but is perhaps more advanced on the right side. The earliest nodules are again found in the mid-zone and towards the apex, though not actually reaching it, but in this stage there is also well marked invasion of the basal portion of the lungs. Associated with this there is found a greater degree of diaphragmatic involvement in this

stage and actual peaking of the diaphragm may occur. In this particular, the findings in this series differ from those usually described, in which first stage films are stated to be quite free from diaphragmatic involvement and second stage films to show only slight irregularities in contour without peaking (Crocket[8] "Physical and Radiological Examination of the Lung" p. 224). One must further note that the root and trunk shadows show no further enlargement compared to that seen in the first stage, which appears to show that after the main lymph channels are obstructed the most marked and most progressive damage falls upon the pulmonary tissue drained by the small efferent channels.

The development of the process has now been traced to the second stage. As is pointed out below this may be the end of the process. A man may work as a coal-trimmer for forty years and not develop any further degree of fibrosis; on the other hand further advance in the fibrotic process may occur and the third stage be developed.

The outstanding feature in this stage is the presence in the X-ray film of areas of dense fibrosis of very considerable size. In these cases mottling is still visible but is largely hidden and certainly overshadowed in importance by the large dense masses. It is to be noted that such masses may be associated with the "fine" type of mottling as well as with the more advanced or "woolly" type. The origin of such dense shadows is at least debatable. There is X-ray

evidence in this series of cases that the smaller nodules described in the second stage appearances, aggregate with adjacent nodules to form larger masses. This was one method of formation definitely seen in several of the cases under discussion. Norris and Landis [4] (Op.Cit. p. 560) make an almost similar statement when they say ".....It would appear in some instances that the mottled appearance in the second stage becomes more and more conglomerate and finally passes over into the appearance of dense fibrosis." This process would appear to be a natural outcome of the process already active in the second stage. The areas of fibrosis may be found near the hilum or in the upper and lower zones away from the hilum.

In other cases we find large masses, usually present in both lungs, of very circumscribed appearance. Their outline is quite regular and they appear to attain a certain size and then remain stationary, although two such masses may unite giving a very large neoplasm like shadow. Such shadows are usually, but not always, situated close to the hilum and in some cases may be united to the hilar shadow by dense bands. They are occasionally found in the upper zone and only very rarely in the basal portion of the lung. Such masses are referred to by Crocket [8] (Op.Cit. p. 225) and are included by Prof. Lyle Cummins in Type IV of his classification. The latter makes a note that such masses are occasionally present in all types of pneumoconiosis but are

specially frequent in cases of Silico-anthracosis and in coal-trimmers.

Two other appearances were noted at this stage. One is a very great spread in the extent of the mottling resulting in a film or haze over a part of the lung field. This type of appearance is mentioned by Norris and Landis [4] (Op.Cit. p. 560) and this appearance was seen in five cases in the present series. The second was the presence in one case only, of a different type of fibrosis. This case revealed a fibrosis such as that seen after pneumonia with delayed resolution or empyema. It is believed that this type of fibrosis is <u>not</u> due to coal-dust inhalation and a study of this man's previous health reveals that he had suffered from a severe broncho-pneumonia which may prob ably account for the appearances noted.

Finally we note that involvement of the diaphragm is very frequent in this stage and alteration of the contour is well marked in over 80 per cent of the cases.

An endeavour has been made to describe the development of the fibrosis found in X-rays of the lungs in coal-trimmers from its origin to its final stage. It must be emphasised however, that no proof has been supplied that such a developmental sequence will take place. Proof could only be obtained by a sequence of films in the same worker at certain definite intervals. In the limited number of cases available in this series, in which two or more plates

at known intervals had been taken, we have seen that a recognisable increase in the fibrotic process does occur. In one case an early second stage film became a well marked second stage film in 15 months, but then remained stationary for four years with no further signs of increase despite continuity of work; in another an early third stage film became a well marked one in four years.

TIME OF ONSET, AND TIME REQUIRED TO DEVELOP THE RADIOLOGICAL PICTURE.

One of the most striking features of the whole enquiry is the variation in the time of onset and the time necessary to develop the condition. It is unnecessary to reproduce the evidence for this statement, which has already been fully given but certain of the facts elicited may be repeated:-

1. The earliest working life to exhibit a first stage picture, was a man of 30 years with six years' experience as a coal trimmer, and a further case exhibits this stage after seven years' experience. The oldest case to exhibit this stage was aged 66½ years and had had 35 years' experience (approx.)

2. The earliest detected second stage picture was in a man of 42 years after nearly 20 years' experience. The oldest case to reveal a second stage film was 66 years with 40 years' experience.

3. The earliest third stage film was found in a young man of 30 years with approximately 7 years' experience. The oldest case to reveal this stage was aged 65 years with over 40 years' service.

4. The average age of the patients with second and third stage films was approximately the same.
5. The third stage appearances are most frequently found in men between 50 and 60 years of age.
6. One case, after 34 years' work as a coal trimmer, revealed a completely negative film.

From these facts one realises the immense individual variation in the time required to develop the radiological appearances. One can only make a general statement on this point. It seems that definite early signs of pulmonary damage due to coal dust inhalation may occur after about 6 - 8 years' work. It may not develop further and after 35 years' work may still remain an early stage. On the other hand no abnormality at all may be found after over 30 years' work. It is usually the case however that men with over 20 years' experience have developed an X-ray picture compatible with a "second stage" degree of fibrosis:

The earliest second stage picture is usually found after 20 years' experience in the work, and the majority of the men between the ages of 40 and 50 display this stage. Here again many do not develop any further increase in the degree of fibrosis. As in the case quoted above development from an early to a definite second stage film may be rapid and no further increase in the degree of fibrosis may occur or if it does, then development may be slow. The appearances in the X-ray film can offer no explanation why increase in the degree of fibrosis does not occur.

A third stage film may be found after 8 years' work, but the usual time of onset is between the ages of 50 and 60. It has been already pointed out that the average ages of the men displaying second and third stage films is approximately equal, but on the other hand the common period for a second stage film is between 40 and 50 years of age. It would seem that the third stage appearances are usually found a decade later than the second stage and the fact that the average ages in the two groups are equal probably only means that men in the second stage being less incapacitated are able to continue at work for a longer period without seeking medical advice and examination.

We have seen therefore that the time of onset and the development of pulmonary fibrosis in coal trimmers is a variable occurrence. It may not occur at all. It may occur only in a mild degree. It may progress to a fairly advanced stage and remain stationary. In certain cases it developes to the third stage and leaves evidence in X-ray films of each of the earlier stages. It may advance rapidly and reach the more advanced stages in a very brief number of years.

We have seen that unless a special X-ray examination is made at certain definite intervals and a series of films thus made available, it would be impossible to give any accurate estimation of the number of years exposure to the dust requisite to produce the various stages and in view of the variations in development noted above such an estimation would not be extremely helpful.

POSSIBLE EXPLANATIONS FOR VARIATIONS IN THE X-RAY APPEARANCES.

It has already been noted that men working under identical conditions for an approximately equal period of time, may display widely different radiographic appearances. Some attempt is now made to explain this finding.

It must first be noted that in the X-rays of the younger men displaying early pulmonary fibrosis, it is impossible to say whether a more advanced stage will develop or not. In the cases of the men who have already had considerable exposure to the dust, comparisons can be drawn. From the relevant tables we see that there are 13 men over 50 years of age, who display third stage appearances, but there are 8 men over 50 years of age who display only second stage appearances and 5 over 50 years with only a first stage film. The conditions of work and the exposure times in these cases are quite comparable and the fact that all cases do not develop uniformly suggests either that certain cases display greater resistance to the effects of the dust or that the more heavily affected cases reveal a greater susceptibility to its effects. Edwards [5] ("Radiographic Diagnosis in Diseases of the Lung", British Medical Journal. Sept 14th 1935 p. 495) states:-

"Individual susceptibility may play a part in the development of silicosis; some men after forty and fifty years of mining in sandstone are frequently unaffected, while others will show changes after 6

or 8 years. With a high silica content in the dust the onset of the disease is more rapid and in lungs with damaged lymphatic circulation, whether due to tuberculosis or chronic bronchitis, the condition developes more rapidly". The writer here speaks of "individual susceptibility" by which he means that certain cases are more liable than others to develop pulmonary fibrosis, and he is also referring to silicosis. It would appear that a similar feature occurs in the pulmonary fibrosis due to coal dust. This explanation would cover all those cases which reveal various stages of development and also the rarer cases in which advanced or very advanced radiological appearances are found in young men with brief coal trimming experience.

Again we have noted that obstruction or damage to the lymphatic system of the lung is produced by the action of the dust and that this process is an important factor in the production of the fibrosis. It is possible that a study of the previous conditions in the lung which might have led to lymphatic damage, will explain some of the variations in the radiology of the condition.

Two factors may be considered, (1) Actual damage to the lymphatic channels with complete or partial obstruction of these channels. (2) Alteration in the rate of flow through these channels. The first may be caused by (a) Trauma, (b) Infection of a non-tuberculous nature, (c) Neoplasm, (d) tuberculous

infection, the second by alterations in the circulation (a) Cardiac in origin (b) haemopoietic in origin.

In considering the first factor it is convenient to discuss first the previous incidence of infective chest illnesses of a non-tuberculous nature.

In the men displaying first stage appearances, five were of 50 years of age or over. Of this number three had no previous history of any serious respiratory illness and the remaining two had not suffered from serious ailments, one having had a traumatic pleurisy, the other frequent attacks of bronchitis.

In the men displaying X-rays of second stage severity, eight were 50 years of age or over. Of that number only two were free from a history of serious respiratory illnesses. Of the remaining six, four had suffered from pneumonia and two from severe recurrent attacks of bronchitis.

In the men displaying third stage films, thirteen were 50 years of age or over and of these four had not had any serious respiratory illnesses. Of the remaining nine, four had suffered from pneumonia two having had more than one attack, three suffered from bronchitis with asthma which is a very potent source of lymphatic damage owing to the resultant emphysema and two had suffered from frequent attacks of bronchitis.

It would appear that the men in the second stage displayed a more marked degree of previous ill health than the men in the first stage and the

third stage cases were even more affected in this way. In general then the effect of damaging chest infections does seem to play some part in determining the degree of fibrosis found on X-ray examination; it cannot however be regarded as a large part. In a workman with a previous history of frequent severe chest infections one would expect to find a more advanced degree of fibrosis than in one of the same experience with a good previous medical history. On the other hand, if one compares the X-rays of the cases with good previous medical histories with those who have had fairly severe previous ill health in any of the stages, there is often very little difference in the degree of fibrosis displayed. This factor does explain in some cases why more advanced fibrosis is present and especially is this true in considering the transition from first to second stage appearances.

The possibility of trauma and neoplasm acting as factors affecting the degree of fibrosis found on X-ray examination, is not one likely to occur in a sufficient number of cases to enable any conclusions to be made.

The question of the presence of tuberculous infection has already been dealt with, and this series of cases has failed to reveal any positive evidence that it has an effect in determining the stage to which fibrosis shall advance. The difficulty is to get absolute proof of the presence of superadded tuberculous infection. It is obvious that if

present it will greatly modify the lymphatic circulation. One may interpolate here the view of Mavrogordato[10] quoted by Crocket ("Physical and Radiological Examination of the Lung" p. 226) that the massive areas in the radiograms of the third stage always indicate superimposed tuberculosis. He (Mavrogordato) believes that "Foci of tuberculosis form between agglomerated masses of the pseudo tubercles (nodules) and alveolitis and fibrosis follow and a dense mass results in which the silicotic nodules are incorporated." One must also bear in mind the power of coal dust to adsorb toxins and minimise symptoms, an attribute which enhances the difficulty of proving the presence of tuberculous infection.

The second factor mentioned above refers to the circulatory system. It is believed that any evidence of circulatory insufficiency as denoted by a persistently quickened pulse rate or evidence of disease of the heart itself would lead to impairment in the lymphatic circulation and be a contributory factor in producing fibrosis. A deficiency in the haemoglobin content of the blood would also lead to circulatory impairment and might be considered in this connection. The difficulty in drawing conclusions on this point is that in many cases the circulatory symptoms may be due to the actual disease processes in the lungs i.e. an effect, not a contributory cause. It must be confessed that no definite results were obtained from this line of approach in the present series of cases. Many of

the older men displayed symptoms referable to the circulatory system, but few displayed symptoms of cardiac failure. Only one or two had oedema of the ankles, for instance, and the difficulties in interpretation of these symptoms noted above, was experienced. One fact of significance was noted. When the average pulse rate of the men under 50 years of age was compared with the average pulse rate of the men over 50 years, it was found that the two rates were practically identical. In stage one cases the rates were:- below 50 years 86 per min, above 50 years 85 per min. In stage two the rates were:- below 50 years 77, above 50, 79. In stage three the figures were 93 in both instances. The fact that the younger men revealed an average pulse rate equal to that of the older men who had endured a much longer exposure to the dust, appears to show that quickened cardiac action is present before sufficient pulmonary damage has occurred to bring abour cardiac embarrasment. Otherwise there is no evidence in the present series that circulatory disease may enhance the effect of inhalation of coal dust in causing fibrosis, but it is considered that a further study of this particular feature might prove of interest.

RELATIONSHIP OF THE CLINICAL FINDINGS TO THE RADIOGRAPHIC APPEARANCES.

It is necessary to refer to the relationship between the symptoms and physical signs displayed by these workers and the corresponding radiological picture.

In general terms the more severe the symptoms and the more definite the physical signs, the further advanced one would expect the disease to be. This is borne out by the fact that of the men in stage one, only 16.6 per cent. displayed symptoms which rendered them unfit for work. In stage two 30.7 per cent. were unfit. In stage three, 64.7 per cent were rendered incapable of work. Here again one is brought face to face with the variable nature of the effects of this condition. While as a general rule the above facts hold good, one may find men whose symptoms are sufficiently severe to cause complete incapacity for work displaying radiographic evidence of an early stage of the disease; and on the other hand men whose X-ray film betokens advanced disease are still able to do their work efficiently enough to retain their positions. It is also noted that in some cases who are unable to work the symptoms evinced are slight compared to those symptoms present in men who are still at work. Evidently individual susceptibility plays some part in this connection also.

The most notable feature in the relationship

between the symptomatology and radiology of this condition is the gradual increase in the shortness of breath with advance in the degree of pulmonary damage displayed in radiograms. This is a perfectly understandable feature. There is also in the most advanced stage, an increase in the number of cases which show the presence of blood in the sputum. There is a well marked increase in the severity of the symptoms between men in the first stage and men in the third stage, but the cases in stage two, who remain capable of work, do not show any great increase in severity of the symptoms over those in the first stage. Every case, whatever the stage, displayed certain symptoms, but in many cases one could not deduce the severity of the X-ray picture from a consideration of these symptoms.

Physical signs are no more helpful in determining the degree of fibrosis present. They are of course quite definite in advanced cases but in intermediate cases are equivocal. They do, however, substantiate one fact determined more accurately by radiology, namely that it is the mid and upper zones of the lung on which the brunt of the fibrotic process falls. One notes that even with a mild degree of fibrosis, finger clubbing can be detected but this is of greater frequency and severity in the advanced cases.

In one case in this series, symptoms and certain physical signs were detected and were of sufficient severity to prevent work, yet this man displayed no

evidence of fibrosis on X-ray examination after 34 years' work. One can give no explanation for this case, which forms the antithesis of the other cases mentioned, in which radiology betrays disease more advanced than the clinical findings would lead one to expect.

We may conclude that the clinical findings offer very little help in determining accurately the extent of the condition present. Their importance lies in the fact that on their severity the fate of the w worker ultimately depends. If even an extensive fibrotic process is unaccompanied by symptoms of commensurate severity, a man may be able to continue at work; on the other hand less extensive disease in a man whose susceptibility to the dust is great and whose powers of resistance to a secondary infection of the lung are low, will cause partial or complete incapacity. It is probable that the power of resistance to secondary bacterial infection is of great importance in determining whether or not a man will be able to carry on with his work under existing conditions for a reasonable length of time. This power of resistance must vary in every case, as it does in all walks of life, and would appear to be an important factor in the pathology of this condition, bringing with it other considerations regarding the heredity of the family, their social position, the hygiene of their surroundings and their economic status.

We may conclude this summary of the clinical and radiological relationships by quoting Norris and Landis [4] ("Diseases of the Chest, Principles of Physical Diagnosis" p. 553). "The type of dust, the length and intensity of the exposure, offer more certain means of predicting the X-ray picture than anything else". In view of the results of this investigation one is bound to lay stress on the intensity of the exposure.

CONCLUSION.

We have now completed a detailed survey of the pulmonary conditions found in coal trimmers who are exposed to the hazard of the inhalation of coal dust in large quantities.

In the study of the symptomatology and in the results of the clinical examination we find that they display symptoms and physical signs comparable to those found in workers in other occupations involving the inhalation of dust containing silica. We have seen that such symptoms and signs may develop with remarkable rapidity and that X-ray evidence of advanced disease may quickly become available. As a rule however the changes in the lungs in coal trimmers develop much more slowly than do the changes in men exposed to dust containing a larger amount of silica. We believe that a period of ten years is usually required to produce an early stage of pulmonary fibrosis, the intermediate stage develops about ten years later, after twenty years' service, and the final stage is usually found after twenty-five to thirty years' work.

From the study of the evidence presented in this thesis we believe that the inhalation of coal dust can produce a definite degree of pulmonary fibrosis which resembles that produced by the inhalation of dust containing much silica. The principal differences observed in the nature of the fibrosis due to coal dust compared to that due to dust

containing a high percentage of silica are: 1 The condition takes a much longer time to develop. 2. The typical second stage picture in silicosis with its "snow-storm" appearance in X-rays, is not often seen in coal trimmers. Nodules are present in the case of the coal trimmers but are neither so definite nor so numerous, and the second stage picture in these workers ahows rather a marked increase in the extent of the mottling with ill-defined nodular shadows. 3. Not every man subjected to the inhalation of coal dust develops radiological evidence of fibrosis. 4. Advanced pulmonary changes in the coal-trimmer may not prevent continuation of his work. It is suggested that the cause of the fibrosis in the coal-trimmer is largely due to the excessive amount of dust which is inhaled. This acts to a certain extent in a mechanical manner but it is believed that the small amount of silica found in the dust may contribute to the production of the final picture.

The difficulties experienced in making a diagnosis on purely clinical grounds have been pointed out and the very difficult question of the relationship of tuberculous infection to this condition has been fully dealt with and the means at our disposal for excluding this possibility have been commented on.

The difficult and controversial question of compensation for disability has not been raised. This occupation has not so for been included in the list of industrial diseases for which compensation is liable. We believe that there is insufficient

evidence to show that the small percentage of silica in the coal dust is harmful, but as already stated it may play a part in the causation of the fibrosis. Despite this fact, cases occur in which the inhalation of coal dust does definitely produce disability. This is uncommon in the young men but becomes increasingly more common as the length of service increases. We are led to the conclusion that the damage to the lungs produced by the inhalation of the coal dust is even of sufficient severity to bring about a fatal issue in a proportion of the cases. In the cases which we have had the opportunity of attending, this fatal termination was due to a congestive cardiac failure. It would therefore appear that the claim by the men that this is a dangerous occupation is not entirely without justification on purely medical grounds.

SUMMARY.

1. The symptomatology and physical signs displayed by a series of 76 cases working as coal trimmers are presented and discussed.

The radiological appearances in 44 available X-rays are presented and suitable comment is made.

2. The onset of symptoms is usually insidious, but may develop rapidly. A persistent cough or repeated attacks of acute bronchitis are the usual signs of onset, but symptoms may first appear after pneumonia, dry pleurisy and asthma. In any illness in a coal trimmer, convalescence tends to be slow and adequate time for complete recovery must be allowed to prevent rapid deterioration in the patient's condition.

3. The principal symptoms displayed are:- (a) cough, at first infrequent and due to upper respiratory tract irritation, later due to bronchial and pulmonary damage. (b) The presence of sputum usually mucoid, becoming muco-purulent or purulent due to secondary infection of the damaged pulmonary tissues (c) Pain in the chest usually present in the men actively engaged at work. (d) Haemoptysis, usually only a streaking of the sputum with blood, though small frank haemoptyses may occur. This is present most commonly in men who continue at work despite the presence of symptoms and may be taken as evidence of an extension of the pathological process (e) Shortness of breath, a later symptom, best marked in the older workers and the most important cause of cessation of work.

4. Physical signs are variable and become more definite with extended experience. The early physical signs are auscultatory and comprise areas of diminished air entry into the lungs with rales, rhonchi and occasional crepitations. Alteration in the character of the breath sounds is not often found in these workers and if present may be due to disease of the lung not caused by coal dust. Impairment in the percussion note is later in appearing and is chiefly confined to the middle and upper zones of the lung and is patchy in distribution. It is rarely well marked and does not amount to actual dullness except in a small proportion of cases. Hyper-resonance is frequently found at the bases of the lungs.

5. An hereditary predisposition to chest ailments has little or no effect on the clinical findings. A history of previous ill health mainly due to chest infections, pneumonia, bronchitis and pleurisy, is very frequent in these workers and predisposes to the onset of pulmonary damage due to the dust.

6. The radiological appearances can be grouped into three stages according to the extent of the fibrotic process. A description of the three stages is given.

7. The appearances in the X-ray films in coal trimmers differ in certain respects from the typical films seen in workers in dust containing much silica. These differences have been pointed out. The main destruction is that the typical second - stage film found in workers suffering from silicosis,

is not found in coal trimmers.

8. Pulmonary Fibrosis in coal-trimmers is due chiefly to the excessive amount of dust which is inhaled and may be partly due to the small percentage of silica present in this dust. Its onset is hastened and its severity increased by previous infective damage to the lung, but this is not essential to the production of the fibrosis found in these workers.

9. The development of the X-ray appearances is as follows:- (a) Enlargement of the hilar glands and increase in the trunk shadows (b) The presence of mottling beginning in the zone adjacent to the hilum and spreading thence to the sub-apical regions due to blockage of the smaller lymph.channels consequent on earlier changes in the peribronchial and perivascular channels. The mottling is usually of the "faint" type. (c) Increase in the density of the mottling with the production of the "fine" or "woolly" type and the formation of nodules either of uniform density or, in the larger nodules, of varying density. The changes are usually symmetrical and begin to involve the basal portion of the lung and diaphragmatic adhesions occur. (d) Further union of nodules to form areas of dense fibrosis, or increase in the extent of the mottling to form a film over a part of the lung field - usually the upper - or the presence of pseudo-neoplasm-like shadows. These latter pseudo-neoplasm shadows are due to retained coal dust in certain defined areas.

10. The time taken to develop a first stage radiogram is on an average 8 years. A second stage

film is seen on an average after 20 years of work and the third stage after 25 to 30 years' work.

11. Variations in the radiological appearances are common and development of the fibrosis does not proceed in an orderly manner. No fibrosis may occur. A mild degree of fibrosis may occur. The fibrosis may advance to a marked degree and then remain stationary. Fibrosis may develop to the third stage and leave evidence of each of the earlier stages in the film. Fibrosis may progress rapidly and reach an advanced stage in a very short space of time as little as 6 to 8 years.

12. The reasons advanced for this variability in X-ray appearances in men working under practically identical conditions are:- (a) That there is some degree of susceptibility to the effects of the inhaled dust. (b) Infective respiratory illnesses in the previous medical history may predispose to more severe degrees of fibrosis. (c) Tuberculous lesions of long standing, i.e. healed, may assist in the development of the fibrosis in certain cases. (d) In some cases cardiovascular disease may play a part.

13. Clinical findings alone are unreliable for accurate diagnosis even with a knowledge of the patient's occupation. X-ray examination must be the mainstay in the diagnosis of this condition.

14. The differential diagnosis must always exclude the presence of an active tuberculous infection.

It is considered that all the appearances described in this thesis are due solely to the effects of the

inhalation of the coal dust.

15. In the coal trimmers there is not a complete correspondence between the symptomatology and physical signs and the radiographic appearances. A marked degree of pulmonary fibrosis may be present in a man presenting few symptoms or physical signs and the opposite state of affairs also occurs. The powers of resistance against secondary bacterial infection displayed by each man are of considerable importance in determining capacity or incapacity for work.

16. The resultant condition due to inhalation of the coal dust is one which is definitely injurious to the health of the worker. It is not a condition of true silicosis but resembles silicosis in many ways. It may produce sufficient pulmonary damage to cause complete disability and in some cases even death.

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