TECHNICAL SESSION -II

RESEARCH IN COAL MINE HEALTH

"Overview of Coalminers' Health Findings"

by

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Although this is my first opportunity to attend one of your annual meetings, the organization I represent has participated in the previous five. It is with some regret that I have to report to you that Dr. Marcus Key and Dr. Raymond Moore who were those participants are no longer associated with the National Institute for Occupational Safety and Health which we usually call NIOSH. Dr. Key who was the Institute Director retired from the Public Health Service and is now in Houston, Texas, where he is a professor of Occupational Medicine. Dr. Moore who was Associate Director for Washington Operations has returned to the part of the country he loves above the rest and has become Assistant Commissioner of Health for Texas.

We are very fortunate, however, in the recent appointment of Dr. John F. Finklea to replace Dr. Key. Dr. Finklea has had prior Federal service as Chief, Ecological Research Branch, National Air Pollution Control Administration, from 1969 to 1971. He then became Director, Division of Health Effects Research, National Environmental Research Center. He received his medical degree from the Medical University of South Carolina, and also holds both a master's degree and a doctorate in public health from the University of Michigan.

Dr. Finklea has been an educator in several medical schools and has taught engineering students in the School of Public Health

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at the University of Michigan. Among other things, he has been involved in studies of occupational exposure to pesticides and metals and was project director of South Carolina's air pollution and pesticide studies. He was board certified in pediatrics in 1965 and in preventative medicine (public health) in 1970.

So far, a direct replacement for Dr. Moore has not been named. Dr. Jack Butler, whose name appears in your program, has been temporarily substituting for him at the National level.

Another personnel change which I would like to report to you is that over a year ago Dr. W. Keith C. Morgan resigned from ALFORD, the Appalachian Laboratory for Occupational Respiratory Diseases, of which he was Director. A new Director was selected some time ago, but because of various other commitments was unable to enter on duty until early this month. It is a pleasure to tell you that he is Dr. James A. Merchant who received his degree in medicine from the University of Iowa and a doctorate in public health from the University of North Carolina where he concentrated on epidemiology. His pertinent experience is in occupational lung diseases, environmental medicine, and epidemiology. His is an eminently qualified selection. Prior to coming to ALFORD he was a member of the Medical School at the University of North Carolina and a consultant in occupational health to the State Board of Health. ALFORD feels fortunate in having Dr. Merchant as its Director and anticipates a very successful program under his direction.

INTRODUCTION

An overview of the type I will present to you today probably needs to be given a historical setting if it is to be useful in assessing present conditions in relation to those which prevailed in the past.

It is almost a century and a half since it was generally noted that Scottish coal miners frequently coughed up black sputum and the British began to recognize that an occupational disease could result from the inhalation of coal dust in the work place. This recognition was by no means prompt or universal. It took about a century before it was generally accepted in Great Britain that the inhalation and retention of coal dust in the lungs was a significant health problem. A survey conducted shortly after World War II indicated that about 25 per cent of their miners had some evidence of a chest disease which manifested itself by discrete nodules of the lungs, fibrosis. The British called this disease coalworkers' pneumoconiosis and recognized that it differed from the classic

dust disease, silicosis. They also found that coalworkers' pneumoconiosis was often complicated by bronchitis, the coughing and wheezing that many of us suffer from every winter, and emphysema, the gradual destruction of lung tissue which causes difficulty in breathing and, sometimes, death.

There was also a survey among hard coal miners in the United States in the middle 1930's. It revealed that over 22 per cent of the almost 3,000 men examined showed X-ray evidence of what was decided to be silicotic pulmonary fibrosis, excessive retention of carbonaceous material, and emphysema.

In 1965, Dr. Murray C. Brown, writing in the Mining Congress Journal, summed up the situation prior to 1952 as follows:

> "Despite the findings of the British surveys and the American hard coal survey, many authorities still felt no comparable situation existed in the American soft coal industry. The high chest disease rate in British miners was attributed to their urban, heavily industrialized, and, in many cases, overcrowded way of life, in contrast to the essentially rural or small town environment of American coal miners. In addition, there was the thought that the English climate might contribute to the prevalence of chest disease. The high rates of chest disease in American hard coal miners were attributed to the proportion of free silica or quartz in the coal dust."

Between 1958 and 1963, there were various studies by the Public Health Service and others such as Dr. Jan Lieben of the Pennsylvania Department of Health which showed that American coal miners in bituminous as well as anthracite mines were suffering from occupationally related chest diseases. Depending on the conditions of the studies, however, the reported prevalence of diseases varied considerably. Estimates as low as 10 to 14 per cent and as high as 34 per cent were reported.

It is appropriate to interrupt my narrative about the health of the miners at this point to acknowledge that the coal mining industry working with the Bureau of Mines was aware of and concerned about the medical findings and that the importance of controlling the dust produced during mining was given active consideration. Between 1942 and 1951, the Bureau of Mines conducted dust surveys in coal mines apparently to ascertain the

practical dust levels which could be obtained when due care was exercised during mining. This work must be considered in retrospect in the context of the facts that conventional mining was more common in those days than today and that the midget impinger and light-field particle counting by the microscope was the usual method of evaluating airborne dust in the United States.

Westfield, Anderson, Owings, Harmon, and Johnson summed up the findings in 1951 in Bureau of Mines Information Circular 7615, Roof Bolting and Dust Control. A pertinent paragraph says:

> "In bituminous coal and lignite mines, the average full shift concentration of atmospheric dust to which a workman may be exposed should not exceed 20 million particles per cubic foot of air, and a maximum concentration for any single operation should not exceed 40 million particles per cubic foot of air. When the dust contains silica, not more than 5 million particles of silica per cubic foot of air should be present in the above limiting concentrations. The dust count may be multiplied by the percentage of silica concentration, and if the result is less than 5 million, the dust concentration will be considered safe. The above limiting concentrations are based on impinger samples in which light-field counts are made under a microscope."

The midget impinger and light-field counting techniques left much to be desired. By 1959, as a result of work by engineers, physicians, and industrial hygienists, it was generally agreed that full shift gravimetric measurements of respirable dust could be accomplished with an attendant marked increase in reliability of measurements and that the respirable fraction of the airborne dust should be defined in terms of aerodynamic equivalent to unit density spheres conforming to a curve in which no sphere over 7 micrometers would be included in the sample to be weighed, half the spheres of 5 micrometers would be included, as would all the spheres of a fraction of micrometer. In other words, this is the sampling specification for the MRE Instrument with which we have all become familiar because it is named in the Federal Coal Mine Health and Safety Act of 1969.

Figure 1 is a photograph of a sectional portion of a lung that shows many small dark spots. These small spots are the nodules of pneumoconiosis. They would appear on the X-ray as small light areas because the dark pigment is included in a fibrous nodule which is opaque to the X-ray. The large, dark areas are blood vessels. There

FIGURE 1. Photograph of a Sectional Portion of a Lung Showing Nodules of Pneumoconiosis and Some Emphysema.

is evidence of emphysema at the top of the lung section shown in Figure 1 and also of the lung section shown in Figure 2. These open areas would not obstruct an X-ray beam and would appear as dark areas on a chest X-ray. Also shown in Figure 2 is part of a tumor.

It is not difficult to appreciate that the radiologist must detect and evaluate very subtle changes and differences when he classifies a chest X-ray for pneumoconiosis. But, despite these difficulties, the chest X-ray has been, and remains, the best diagnostic tool for pneumoconiosis. Much of the data we have concerning the health of working coal miners comes from the chest X-ray.

X-RAY EXAMINATIONS

Most of us are familiar with the periodic medical examination programs, including chest X-rays, for working miners in or at underground coal mines called for by the Federal Coal Mine Health and Safety Act of 1969. Some do not realize that the Public Health Service made a study of the prevalence of pneumoconiosis a few years before enactment. Also, it is sometimes not apparent that the Act really calls for two periodic examination programs.

First, there is a cyclic voluntary program for underground coal miners who were already engaged in mining at the time of enactment. This calls for giving the working miner an opportunity to be examined shortly after enactment and three years thereafter. It also provides for additional voluntary opportunities for examinations at intervals of not more than five years.

Second, there is a requirement that after enactment each person who enters the underground coal mining industry for the first time shall be examined at about the time of first employment and three years later. Furthermore, if there is any evidence of the development of pneumoconiosis, there shall be a third examination two years thereafter.

The net result is that our medical examination program for working miners in or at underground coal mines is a continuous program which tends to show a bias toward the health of the new miners in the overall statistics, especially during the intervals when only new miners are being examined.

A chronology of the events which have influenced our findings since 1963 is as follows:

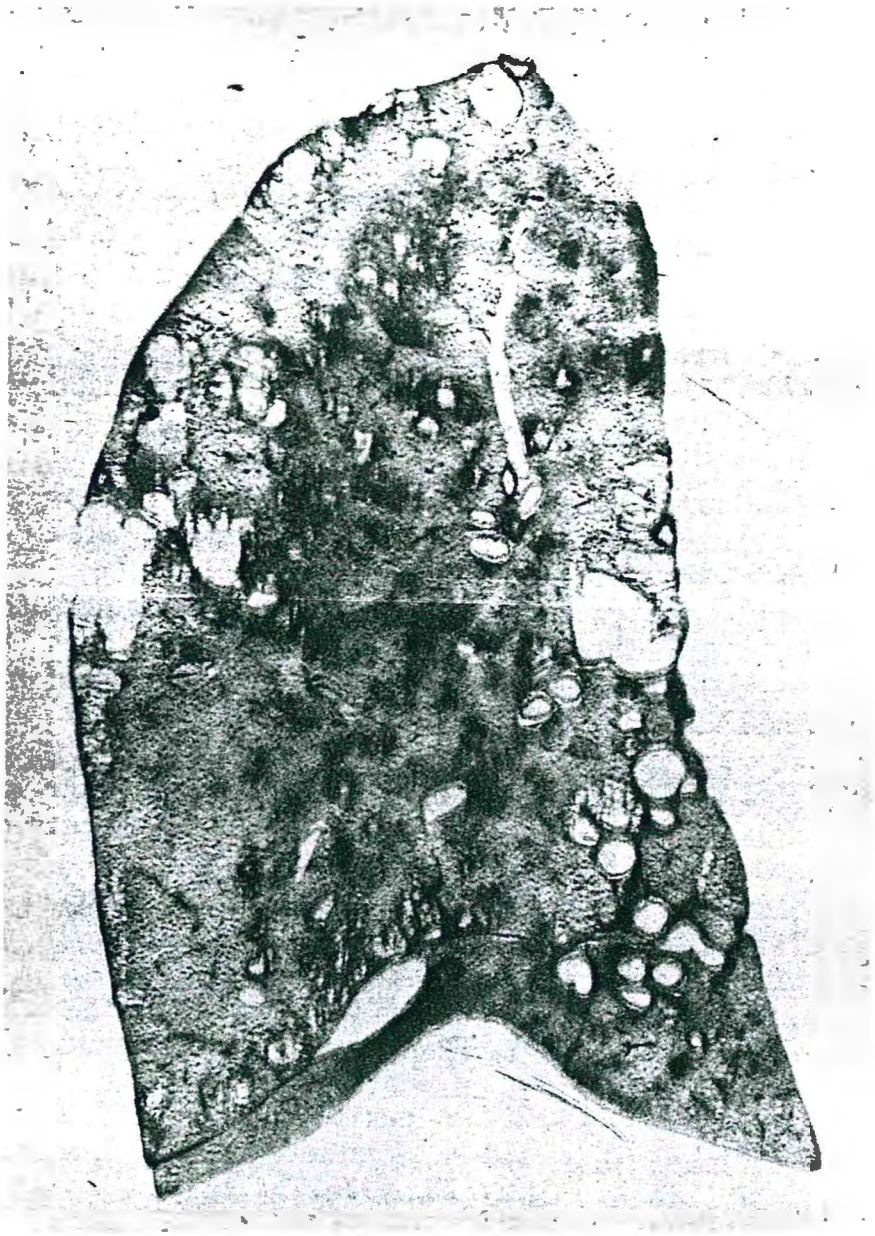

FIGURE 2. Photograph of a Sectional Portion of a Lung Showing Evidence of Emphysema.

CHRONOLOGY

1963 - 1965	Public Health Service Studies of Soft Coal Miners.
August 12, 1969	First round of National Study of Coalworkers' Pneumoconiosis began.
December 30, 1969	Federal Coal Mine Health and Safety Act of 1969 enacted.
August 19, 1970	First round medical examination regulations promulgated.
May 19, 1971	End of first round of National Study of Coalworkers' Pneumoconiosis.
December 30, 1971	End of period for examining miners (persons already in mining on December 30, 1969) under regulations of August 19, 1970.
July 18, 1972	Second round of National Study of Coalworkers' Pneumoconiosis began.
July 23, 1973	Revised (second round) medical examinations promulgated.
February 17, 1975	End of second round of National Study of Coalworkers' Pneumoconiosis.
March 31, 1975	End of period for second round examination of miners under regulations of July 23, 1975.

During the period from 1963 through 1965, the Public Health Service studied a random sample of almost 4,000 soft coal miners from three geographic areas. In considering the results which are given in Table 1, it is necessary to recognize that the chest X-rays involved were classified in terms which sound familiar but that the ILO 1958 system of classification of chest X-rays for pneumoconiosis was still the accepted standard. Simple pneumoconiosis was graded from category 0 (negative) by steps to category 3. Each step represented an increased profusion or concentration per unit area of small rounded opacities each of which cast an X-ray shadow no larger than 10 mm. in diameter. When a larger opacity (i.e. 1 cm., or greater) was found, the case was classified as complicated penumoconiosis or progressive massive fibrosis. Complicated pneumoconiosis can be expected to continue to progress until death even if the miner is removed from the dusty atmosphere.

The two important differences between the 1958 system and the ones which have since been developed and adopted is that it included a Z category which in effect gave the interpreter an opportunity to indicate that he or she could not positively decide whether or not there was pneumoconiosis. The 1958 system also specified that small irregular opacities should be ignored.

The first round of the National Study of Coalworkers' Pneumoconiosis began August 12, 1969, four months before enactment of the Federal Coal Mine Health and Safety Act of 1969, and lasted until May 19, 1971. Examinations were made by the Public Health Service at the mines involved. The results of this study are reflected in Table 2. Twenty-nine bituminous and two anthracite mines employing a total of 10,032 miners of which over 90 per cent were voluntarily examined is a very good participation record. The chest X-rays were each interpreted by three physicians. A concensus was considered as having been reached when two of the three agreed on the finding with regard to category of pneumoconiosis. In 10.4 per cent of the cases no two agreed and a fourth interpretation was required in order to obtain two interpretations which coincided.

In this study, the classification system used was the UICC/ Cincinnati Classification System agreed upon in an international meeting in 1968 and published in this country in Chest (1970, 58, 57). This system is essentially an extension of the 1958 system previously mentioned in which the uncertain Z category is eliminated and the small irregular opacities are included in determining profusion of simple pneumoconiosis.

TABLE 1. 1963-1965 Bituminous Coal Mine Study

Area	Number in Selected Sample	Participation, Per Cent	Category, Per Cent			
			0	Z	Simple 1, 2, 3	Complicated
Appalachia	2, 751	92. 7	84. 9	5. 3	6. 8	3. 0
Illinois-Indiana	520	91. 7	78. 5	15. 4	4. 6	1. 5
Utah	591	97. 5	94. 3	1. 9	3. 1	0. 7
TOTAL	3, 862	93. 5	85. 5	6. 1	5. 9	2. 4

NOTE: Reinterpretation by different interpreters who were required to place the Z category films in one of the definite categories implies that if the Z category had not been available, the total value for category O would probably have been about 88. 8 per cent,

TABLE 2. Prevalence, First Round, National Study of Coalworkers' Pneumoconiosis, August 1969 to May 1971

State	No. Mines	No. of Miners Examined Years in Mining ≤5 Yrs.	>5 Yrs.	Total Participation, Per Cent	Category of Pneumoconiosis, Per Cent 0	1	2	3	Complicated
Pa., anth.	2	18	505	86.0	40.0	23.7	17.6	4.4	14.3
Pa., bit.	6	102	1,360	96.3	53.1	31.8	11.7	1.1	2.3
W. Va.	9	693	1,870	85.5	72.0	19.8	5.3	0.4	2.5
Va.	2	96	464	91.4	71.8	22.5	3.6	0.2	2.0
Ky.	3	228	732	92.2	71.0	23.7	3.2	0.2	1.9
Ala.	2	131	646	97.2	83.3	12.7	2.7	0.1	1.2
Ind.	1	43	231	92.3	65.0	29.9	4.0	0.0	1.1
Ohio	1	131	319	94.9	68.2	24.9	5.8	0.4	0.7
Ill.	2	131	393	78.1	84.9	13.9	1.0	0.0	0.2
Colo.	1	76	143	100.0	95.4	4.6	0.0	0.0	0.0
Utah	2	191	573	95.6	88.7	10.3	0.3	0.0	0.7
Total bit. only - 29		1,822	6,731	90.8	72.0	21.0	4.9	0.4	1.7
TOTAL	31	1,840	7,236	90.5	70.1	21.1	5.7	0.6	2.4

The National Study of Coalworkers' Pneumoconiosis differs from the examinations required by the Federal Coal Mine Health and Safety Act of 1969 since it includes in addition to the examinations required under the Act, a special medical symptom and occupational history questionnaire and some pulmonary function tests.

The first period or round for the examination of miners in accordance with section 203 of the Federal Coal Mine Health and Safety Act of 1969 essentially began on August 19, 1970, with the publication by the Secretary of Health, Education, and Welfare of the first set of regulations for those examinations. The thirty-one mines in the National Study of Coalworkers' Pneumoconiosis were excused from participating, except for miners who might be hired in mining for the first time after we made the examinations at the mine. The period for these examinations ended on December 30, 1971.

The chest X-rays which were an integral part of the examinations were made at local clinics or in mobile facilities which presented evidence of being capable of making good quality chest X-rays and were then approved by ALFORD. The cost of the examinations was borne by the operator. The X-rays were first interpreted by an "A" reader, usually a local physician, who had qualified by participating in a training seminar conducted by the American College of Radiology under the sponsorship of NIOSH. The X-ray was next independently interpreted by one of about twenty "B" readers who were experienced radiologists on the staffs of three major medical centers. If the "A" and "B" readers concurred, the interpretation for pneumoconiosis was accepted as final. On the other hand, when they differed, the X-ray was given to a "C" reader for an independent final evaluation. These "C" readers who were the heads of the departments of radiology at the same three medical centers were called upon about 28 per cent of the time.

The results of the examinations during this period are shown in Table 3. The UICC/Cincinnati Classification System was used to determine pneumoconiosis.

Subsequent to the completion of the first round of examinations by the operators and prior to the beginning of the second round of those examinations, we received a moderate number of examinations made under approved plans. Many of these were new miners or pre-employment examinations. These are reported in Table 4.

TABLE 3. X-ray Findings, Operators' Examinations
August 19, 1970 to December 30, 1971

State	No. of Miners Examined Years in Mining		Category of Pneumoconiosis, Per Cent				
	≤5 yrs.	>5 yrs.	0	1	2	3	Complicated
Ala.	194	949	88.7	9.1	1.3	0.3	0.6
Ariz.	5	23	78.6	17.9	0.0	0.0	3.6
Colo.	201	413	95.1	3.1	1.3	0.2	0.3
Ill.	1,359	2,094	88.1	8.7	2.2	0.2	0.8
Ind.	27	118	87.6	7.6	4.1	0.0	0.7
Iowa	22	22	97.7	2.3	0.0	0.0	0.0
Ky.	3,292	6,268	90.2	7.3	1.8	0.2	0.5
Md.	8	34	83.3	14.3	2.3	0.0	0.0
Mont.	2	12	100.0	0.0	0.0	0.0	0.0
N. Mex.	2	28	83.3	10.0	3.3	3.3	0.0
Ohio	778	722	91.0	6.5	1.7	0.1	0.7
Okla.	18	4	95.5	4.5	0.0	0.0	0.0
Pa., bit.	3,488	8,551	83.5	10.3	4.2	0.3	1.7
Pa., anth.	117	830	67.7	17.8	7.9	0.7	1.7
Tenn.	50	174	87.1	8.5	4.5	0.0	0.0
Utah	163	428	92.2	5.8	1.2	0.0	0.8
Va.	1,353	2,631	89.1	7.1	2.5	0.3	1.1
Wash.	0	19	100.0	0.0	0.0	0.0	0.0
W. Va.	6,281	11,755	85.5	8.6	4.1	0.3	1.5
Wyo.	9	22	93.6	3.2	3.2	0.0	0.0
Total bit. only	17,252	34,267	86.8	8.5	3.3	0.3	1.2
TOTAL	17,369	35,097	86.4	8.7	3.3	0.3	1.3

TABLE 4. X-ray Findings, Operators' Examinations
January 1, 1972 to July 22, 1973

State	No. of Miners Examined Years in Mining		Category of Pneumoconiosis, Per Cent				
	≤5 yrs.	>5 yrs.	0	1	2	3	Complicated
Ala.	106	50	96.8	3.2	0.0	0.0	0.0
Colo.	333	56	99.2	0.5	0.0	0.0	0.3
Ill.	563	183	94.8	4.8	0.1	0.0	0.3
Ind.	15	10	96.0	4.0	0.0	0.0	0.0
Iowa	15	8	95.7	4.3	0.0	0.0	0.0
Ky.	2,500	972	96.9	2.6	0.3	0.0	0.1
Md.	1	10	54.5	18.2	27.3	0.0	0.0
Ohio	1,330	248	97.9	1.8	0.3	0.0	0.0
Pa., bit.	1,770	927	92.0	5.0	1.9	0.1	1.0
Pa., anth.	11	74	67.1	24.7	2.4	1.2	4.7
Tenn.	26	40	89.4	1.5	7.6	0.0	1.5
Utah	82	25	99.1	0.9	0.0	0.0	0.0
Va.	1,254	358	98.4	1.5	0.1	0.0	0.0
Wash.	3	0	100.0	0.0	0.0	0.0	0.0
W. Va.	5,515	1,847	95.8	2.8	1.0	0.1	0.3
Wyo.	1	5	100.0	0.0	0.0	0.0	0.0
Total bit. only	13,511	4,739	95.9	2.9	0.8	0.0	0.3
TOTAL	13,522	4,813	95.8	3.0	0.8	0.0	0.3

The second round of examinations in the National Study of Coalworkers' Pneumoconiosis was begun on July 18, 1972, and extended to February 17, 1975. The number of mines involved was increased to thirty-six. The content of the examinations and procedure for reaching concensus was unchanged. Several of the thirty-one mines in the first round of examinations had shut down during the interval between rounds. They were replaced by other mines and the total number increased so as to maintain a comparable sample and to provide a larger cohort of mines and miners for future studies.

Miner participation decreased between rounds from 90.5 per cent with satisfactory quality X-rays in the first round to 73.1 per cent in the second one. An overall review of the second round, however, indicates that the age groups and years of mining experience of the persons examined are very similar to those who failed to report for the examination.

During the interval between the two rounds of this study, a new system, the ILO U/C International Classification of Radiographs of Pneumoconioses 1971 was adopted and sets of standard films made available for the guidance of radiologists. It was not anticipated that the new system would make an appreciable difference in the interpretation. One small, unpublished study involving about 500 films seems to indicate that the unexpected occurred and that the 1971 system is such that slightly higher interpretations result from its use.

We do not yet have three interpretations of all the chest X-rays in the second round. We do have at least one interpretation of each film. Table 5 is based on the first interpretation of each film in the new system.

About a year after the second round of the National Study of Coalworkers' Pneumoconiosis was initiated, revised regulations were published on July 23, 1973, calling for the second round of examinations to be paid for by the operators. Once again the mines in the National Study were exempted from this group.

The 1971 classification standards were adopted in the new regulations and a new scheme for reaching a final evaluation was provided. The third or "C" reader who had been the final arbiter was replaced in that position by a new kind of "B" or proficient reader whose word with regard to pneumoconiosis would be final. To become one of the new "B" readers, a physician was required to pass a proficiency examination devised and graded by the Johns

TABLE 5. Prevalence, Second Round, National Study of Coalworkers' Pneumoconiosis, July 1972 to February 1975

State	Mines	No. of Miners Examined Years in Mining		Total Participation	Category of Pneumoconiosis, Per Cent				
		≤5 yrs.	>5 yrs.		0	1	2	3	Complicated
Pa., anth.	1	187	55	242	64.9	19.4	4.9	2.1	8.7
Pa., bit.	8	1,406	371	1,777	83.9	11.9	1.9	0.1	2.1
W. Va.	9	1,966	347	2,313	91.1	6.1	1.6	0.1	1.3
Va.	4	542	413	955	92.0	4.8	1.6	0.5	1.0
Ky.	6	907	701	1,608	86.1	11.8	1.6	0.2	0.3
Ala.	1	245	21	266	93.2	5.3	1.1	0.0	0.4
Tenn.	1	65	59	124	98.4	1.6	0.0	0.0	0.0
Ohio	1	345	16	361	95.8	0.8	2.5	0.8	0.0
Ill.	2	342	102	444	97.1	2.5	0.2	0.0	0.2
Colo.	1	215	5	220	96.4	2.7	0.9	0.0	0.0
Utah	2	698	65	763	94.0	3.3	2.4	0.0	0.4
Total bit. only - 35		6,731	2,100	8,831	89.9	7.3	1.6	0.2	1.0
TOTAL	36	6,918	2,155	9,073	89.2	7.7	1.7	0.2	1.2

Hopkins University. About eighty doctors have been qualified by way of this examination since it was first given in 1973.

Because of a strike in the industry and other delays, the second round of examinations by the operators was not closed until March 31, 1975. The results of these examinations are given in Table 6.

Finally, since March 31, 1975, we have continued to receive examinations of miners and new miners. Some of these are examinations of newly employed persons; some are the examination required after three years of miners who entered the industry for the first time since the Act was passed. So far we have received 12,985 examinations made since the end of March. Table 7 reflects the findings of examinations on which we have final interpretations.

In an abbreviated fashion, we can compare the preceding tables in Table 8, but in considering the tabulation one must remember that it is to be expected that wherever we have a large number of miners with short term experience, we should expect to have less disease due to dust inhalation and that some variation results from using different X-ray classification systems.

If one discounts the first round of the National Study of Coalworkers' Pneumoconiosis and the examinations made during those periods when the persons being examined were mostly men with little prior mining experience, it appears that the rate of pneumoconiosis among working underground miners is probably somewhere between 10 and 15 per cent. While this does not appear to represent a significant decrease in the proportion of miners with pneumoconiosis since the Federal Coal Mine Health and Safety Act was passed, there does seem to be a marked decrease in the number of working miners with complicated pneumoconiosis or the higher levels of simple pneumoconiosis.

During the successive rounds or groups of examinations, there has been a general increase in the fraction of the men examined who have had five or fewer years of coal mining experience and who are usually healthy young men whom have also passed a pre-employment examination given by the prospective employer.

Presumably, the improvement we see is due to a combination of the benefits of environmental control and the influx of new miners which may amount to as much as 40 per cent of the work force.

TABLE 6. X-ray Findings, Operators' Examinations
July 23, 1973 to March 31, 1975

State	No. of Miners Examined Years in Mining		Category of Pneumoconiosis, Per Cent				
	≤5 yrs.	>5 yrs.	0	1	2	3	Complicated
Ala.	547	621	85.3	12.4	1.5	0.3	0.6
Colo.	820	397	93.5	4.4	1.6	0.1	0.4
Ill.	2,163	2,431	87.2	10.6	1.7	0.1	0.4
Iowa	28	23	82.4	15.7	2.0	0.0	0.0
Ky.	6,895	4,043	91.6	7.0	1.1	0.1	0.2
Md.	8	6	85.7	7.1	7.1	0.0	0.0
N. Mex.	1	22	60.9	30.4	4.3	4.3	0.0
Ohio	2,998	477	97.2	2.3	0.3	0.0	0.2
Pa., bit.	5,057	5,057	83.5	11.9	3.2	0.5	0.9
Pa., anth.	32	118	54.7	23.3	14.0	2.7	3.3
Tenn.	150	155	84.9	10.8	2.3	0.7	1.3
Utah	547	234	93.3	5.5	1.0	0.0	0.1
Va.	2,782	1,819	91.2	7.5	1.1	0.0	0.2
Wash.	1	11	91.7	8.3	0.0	0.0	0.0
W. Va.	10,876	7,808	87.4	9.1	2.7	0.3	0.5
Wyo.	78	16	98.9	0.0	1.1	0.0	0.0
Total bit. only	33,305	23,120	88.5	8.7	2.1	0.2	0.5
TOTAL	33,337	23,238	88.4	8.8	2.1	0.2	0.5

TABLE 7. X-ray Findings, Operators' Examinations Completed Since April 1, 1975

State	No. of Miners Examined Years in Mining		Category of Pneumoconiosis, Per Cent				
	≤5 yrs	>5 yrs.	0	1	2	3	Complicated
Ala.	48	4	98.1	1.9	0.0	0.0	0.0
Colo.	47	2	100.0	0.0	0.0	0.0	0.0
Ill.	179	11	98.9	1.1	0.0	0.0	0.0
Ind.	9	7	93.8	6.2	0.0	0.0	0.0
Ky.	745	123	97.1	2.6	0.2	0.0	0.0
Ohio	266	39	97.7	2.3	0.0	0.0	0.0
Pa., bit.	516	45	99.3	0.7	0.0	0.0	0.0
Pa., anth.	2	1	66.7	33.3	0.0	0.0	0.0
Tenn.	12	3	100.0	0.0	0.0	0.0	0.0
Utah	92	4	100.0	0.0	0.0	0.0	0.0
Va.	85	19	99.0	1.0	0.0	0.0	0.0
W. Va.	1,373	216	97.4	2.1	0.3	0.1	0.0
Wyo.	14	1	100.0	0.0	0.0	0.0	0.0
Total bit. only	3,386	474	97.9	1.9	0.2	0.1	0.0
TOTAL	3,388	475	97.9	1.9	0.2	0.1	0.0

TABLE 8. Tabulation of Occurence of Pneumoconiosis

Dates	Study	Classification	No. of Miners Examined Years in Mining ≤5 yrs.	No. of Miners Examined Years in Mining >5 yrs.	Reported to Have Disease, Per Cent
August 1969 - May 1971	1st Round National Study	1968 - UICC	1, 840	7, 236	29. 9
August 1970 - December 1971	1st Round National Study	1968 - UICC	17, 369	35, 097	13. 6
January 1972 - July 1973	Misc. Operators Exams	1968 - UICC	13, 522	4, 813	4. 2
July 1972 - February 1975	2nd Round National Study	1971 - ILO-U/C	6, 918	2, 155	10. 8
July 1973 - March 1975	2nd Round Operators Exams	1971 - ILO-U/C	33, 337	23, 238	11. 6
April 1975 - Date	Misc. Operators Exams	1971 - ILO-U/C	3, 388	475	2. 1

ADEQUACY OF DUST LIMITS

We are in the process of cooperating with the Mining Enforcement and Safety Administration in a study in which the chest X-rays of individual coal miners with two years or more between the X-rays will be compared to determine how much change, if any, has occurred over the period. This information will be used in conjunction with the time-weighed dust exposure data for the same periods for each of the same miners in an effort to make a preliminary evaluation of any quantitative relationship between the amount of respirable coal mine dust to which the miner has been exposed and the X-ray changes which have occurred.

In view of the short time between X-ray examinations in our files (from 2 to 5 years) and the slow rate the disease usually progresses even in miners exposed to moderately high dust levels, one cannot expect conclusive evidence of the efficiency of present controls from this study. Adverse results over such a short time would be very disappointing. On the other hand, if there turns out to be little or no progression, it will be slightly encouraging. Conclusive results will come only after this study is repeated with greater and greater intervals between the examinations.

OTHER X-RAY INFORMATION

The findings concerning pneumoconiosis are reported to both the miner and his personal physician. When there are any other potentially important findings or suspected abnormalities, they are reported to the doctor designated by the miner and the miner is advised to consult his doctor. A single X-ray examination is very often only an indication of a possible abnormality. In many instances further investigation is necessary before a definitive diagnosis can be reached.

Based on the single chest X-ray, cancer was suspected to be present in about 750 cases, marked emphysema was reported in more than 3500 miners, and there was a suspicion of tuberculosis, usually in an inactive form, more than 3000 times.

Along another line, we are convinced that the stringent X-ray quality requirements in our program which clinics, hospitals, and others must meet in order to be approved by us to participate have resulted in a general improvement in the quality of chest X-rays made for all purposes in the coal mining areas of the United States. In a moderate number of instances, facilities which were turned down and advised how to improve the quality

of their work made the necessary effort and were able to qualify on the second or third application.

PULMONARY FUNCTION AND BRONCHITIS - NATIONAL STUDY OF COALWORKERS' PNEUMOCONIOSIS

In the two rounds of the National Study of Coalworkers' Pneumoconiosis, we administered a medical sympton questionnaire and asked the miners to participate in a simple pulmonary function test.

From the questionnaire, we determined the presence or absence of chronic bronchitis by using the British standard that bronchitis probably exists in a miner who persistently produces phlegm or has a persistent cough at least three months of the year.

In the first round of these examinations 36.3 per cent of the miners examined were considered to be bronchitic. The corresponding figure for the second round was 40.7 per cent.

The pulmonary function tests which were part of the examination were forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC). An FEV_1: FVC ratio of less than 70 per cent was considered indicative of the possibility of obstructive airways disease. In the first round of the study, 29.3 per cent of the miners examined were below the 70 per cent value and advised accordingly to consult their physicians. The corresponding percentage of men with less than 70 per cent in the second round was 24.1.

Both bronchitis and obstructive airways disease as defined above occurred most frequently among cigarette smokers and least frequently among non-smokers. Ex-smokers fell between the two.

PATHOLOGY

Our pathologists are working with a small group of internationally recognized experts in the pathology of lung diseases with a view toward developing a precise method for quantifying pneumoconiosis in the post mortem lung or a biopsy specimen. They are also searching for clues concerning the fundamental nature of coalworkers' pneumoconiosis by using the scanning electron microscope to identify the constituents of individual coal macules or lung nodules.

An important long range aim is to utilize the pathologist's quantification of disease and chest X-rays made during life to help

radiologists understand more clearly the meaning of some of the more subtle markings they see on the chest X-ray.

Another advantage to the program can come from assisting the widow or surviving next-of-kin establish whether the deceased had pneumoconiosis.

We are also prepared, when authorized by the widow or surviving next-of-kin, to perform forensic autopsies on bodies recovered after a coal mine disaster. The intention is to provide evidence concerning the cause of death and the sequences of injuries to the body for the benefit of those who must reconstruct the events involved in determining the cause of a mine disaster.

IMMUNOLOGY

We have some preliminary laboratory results which encourage us to believe that we may be on the road toward being able to pre-identify persons who, when exposed to an appreciable coal mine dust burden, have a greater or lesser likelihood of developing coal workers' pneumoconiosis.

When a number of genetic parameters were measured in a carefully selected sample of approximately 300 Pennsylvania and West Virginia coal miners, several facts emerged. Of greatest potential significance was the apparent association of a specific genetic marker (termed the W18 histocompatibility antigen) with those miners demonstrating an innate ability to resist the development of complicated CWP. When considered with reference to population genetics, the relative disease risk of a miner possessing the W18 antigen is approximately 100% less than the average non-mining population, and 300% less than miners who ultimately develop complicated CWP. Miners who develop simple CWP are indistinguishable from the average non-mining population with regard to this genetic marker. If these data do not vary when we examine miners in Western coal fields, a simple blood test for the W18 marker may turn out to be of significant value in pre-identifying the employee who is likely to be at a greater risk.

It is important to realize that the genetic markers which we measure are present from birth to death and are not modified by environmental conditions.

CONCLUSION

One cannot promise that research efforts will always be successful. We can assure you, however, that we will continue to press forward in all the areas in which we are working. Before the next round of examinations are begun, we hope to develop improved regulations and procedures which will encourage greater participation by the miners, be more convenient for both labor and management, and which will give even more useful results. One matter under consideration is whether to broaden our evaluation of each examination by recalling from our files all our previous X-ray examinations of coal miners and give their physicians a report of any detectable differences which are present.

No changes will be made, however, without prior consultation with all the interested parties as well as going through the rule making procedures required by the Federal Coal Mine Health and Safety Act of 1969. This procedure makes it mandatory to publish proposed rules and allow at least thirty days for comment. All comments must be considered carefully and the action taken on each reported.

I'm sure we all have the same goal--miners whose health is not being impaired by their work. There are many approaches involved and different ways to evaluate our progress. Periodic medical examinations are useful in helping the working miners protect his health and in giving the rest of us an indication of whether our efforts on his behalf are successful.

We are seeking ways to identify the miner who is developing respiratory disease at the earliest possible time, before it becomes serious. Hopefully, this information would guide the miner and his doctor to take appropriate steps to prevent the disease from becoming disabling.

At this time, we don't know whether some people are more susceptible than others to pneumoconiosis. But, if there is a hypersusceptibility involved, we want to identify its mechanism and find a way to identify at the earliest possible time anyone with above average likelihood of developing pneumoconiosis.

In some ways, the problems associated with protecting the health of the coal miner may seem to be shrouded in darkness. To this pessimistic outlook, wherever it exists, I'd like to recount a bit of history with the following quotation:

"Let us remember that there have been dark days in the past. There was a famous one in New England in 1780 when the sun scarcely appeared at all. Thousands of people took it for the end of the world. Among them were many in the Connecticut Assembly, in which Colonel Abraham Davenport was sitting. It was proposed that the Assembly adjourn. Colonel Davenport said, 'The Day of Judgement is either approaching, or it is not. If it is not, there is no cause for adjournment. If it is, I choose to be found doing my duty. I wish therefore that candles may be brought.'"

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