TECHNICAL SESSION III

COAL DUST AND HEALTH AND SAFETY

"Results of First and Second Rounds of X-ray Examinations Program"

by

Harlan Amandus[1]

In 1969 the Federal Coal Mine Health and Safety Act created a unique health surveillance program for underground coal miners which has been administered by the National Institute for Occupational Safety and Health (NIOSH) and now serves as a model for other industries. The Act was amended in 1977 and among other things requires (Figure 1) that (1) all working coal miners be offered the opportunity for an exam at intervals less than 5 years; (2) new miners be examined as soon as possible after being hired, be examined again 3 years later, and if the second exam shows pneumoconiosis, be examined a third time in two years; (3) the coal mine operators pay for the examination of their miners; (4) the results of the exams be submitted to the Department of Health, Education, and Welfare, and to the Department of Labor; (5) the Department of Labor notify the miner of any rights and benefits he or she may accure under the Act based on the results of his examination; (6) if the miner's medical findings show evidence of the development of pneumoconiosis, he shall be afforded the option to transfer to an area of the mine where the coal mine dust concentration is less than 1 mg of coal mine dust per cubic meter of air or if such an area does not exist, to an area where the coal mine dust concentration is less than 2 mg/m^3; and (7) if transferred, the miner shall retain the same rate of pay which he received prior to transfer.

Miners develop Coal Workers' Pneumoconiosis (CWP) after inhalation of coal mine dust and the disease is characterized radiographically in its early stages (referred to as simple CWP) as nodules less than 1 cm in diameter. In its later stages it is seen as complicated pneumoconiosis or progressive massive fibrosis - classified as nodules greater than 1 cm. It is felt that while simple CWP progresses when the miner inhales coal

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FIGURE 1

The 1977 Federal Coal Mine Health and Safety Act Provides:

(1) Schedule of Examinations for Miners

(2) Coal Operators Pay for Examinations

(3) Exams Submitted to Health, Education and Welfare, and results submitted to Department of Labor

(4) Department of Labor Notify Miner or Rights

(5) Transfer Option/Rate Retention

mine dust and ceases after the miner is removed from a dusty environment, some feel that complicated pneumoconiosis progresses independently of further dust exposure. Thus one purpose of this program is to identify miners with early signs of the disease and afford them the option to transfer to a safe atmosphere.

We require that the ILO U/C 1971 classification (Figure 2) be used by physicians to interpret coal miners' X-rays for pneumoconiosis. The classification provides a scale to classify the type and profusion of the small opacities which are peculiar to simple pneumoconiosis. Two types of small opacities are defined i.e., rounded and irregular and each of these are further subdivided into three types according to size. The profusion of the small type opacities is classified into either category 0 (few or no opacities), 1, 2, or 3 (a scale of increasing profusion). An elaborated 12 point scale is also used.

In regard to the examination program, except for exams made by NIOSH in its National Study of Coalworkers' Pneumoconiosis, a survey of approximately 31 mines and 10,000 miners, all examinations are made at X-ray facilities (hospitals, clinics, or mobile units) according to NIOSH's specifications. To participate, a facility must be approved by NIOSH and have demonstrated that it can make an X-ray of a quality acceptable for classification of pneumoconiosis.

Examinations are arranged by either the coal mine operator or NIOSH and as mandated by the Act are paid for by the operator. Operators are asked to submit plans for their arrangement on a one-page form (Figure 3). The Mine Safety and Health Administration (MSHA) of the Department of Labor routinely notifies us when a coal mine opens and we then request the operator to submit a plan. The plan lists the time of the exams, lists the approved facility where the exams will be made, lists the physician(s) who shall interpret the X-rays, and is to be posted on the bulletin board at the coal mine.

The coal miners' examinations are made at approved facilities and consist of a posteroanterior chest X-ray and several required forms which include an identification document, an occupational history, and an X-ray interpretation. After the examination is given at the facility the X-ray is first interpreted by a physician before it is submitted to NIOSH. The importance of this first reading of the X-ray is to transmit significant findings to the miner's designated physician as soon as possible. The X-ray and documents are then sent to NIOSH in Morgantown, West Virginia for additinal interpretations. NIOSH then notifies MSHA of the miner's medical findings, and MSHA then notifies the miner of any transfer rights to which he or she may be entitled.

We now have approved approximately 300 X-ray units or machines at 178 approved facilities. Table 1 shows the number of machines (facilities)

FIGURE 2

ILO U/C 1971 CLASSIFICATION

Types of Small Opacities	
Rounded: P, Q, R	Irregular: S, T, U

Profusion of Small Opacities

Major Categories:	0			1			2			3		
12 Point Scale:	0/-	0/0	0/1	1/0	1/1	1/2	2/1	2/2	2/3	3/2	3/3	3/4

FIGURE 3

OPERATORS PLAN

(1) Name of Mine Operator

(2) Address of Mine

(3) Mine Name

(4) MSHA ID #

(5) Name of Facility

(6) Number of Miles Facility is From Mine

(7) Name of Physician

(8) Time Exams Given

TABLE 1

THE NUMBER OF FACILITIES, "A" and "B" READERS, AND COAL MINE OPERATORS WITH APPROVED PLANS WHO PARTICIPATED IN THE X-RAY EXAMINATIONS PROGRAM SINCE 1973

Number					
Facilities	164	77	31	17	289
"A" Readers	977	80	6	8	1,071
"B" Readers	63	18	0	2	83
Approved Coal Mine Operator Plan	613	336	344	241	1,534
X-ray Examinations Covered by Plan	3,190 (47%)	42,865 (94%)	26,635 (94%)	13,582 (94%)	86,272 (91%)
X-ray Examinations Not Covered by a Plan (Arranged by ALOSH)	3,546 (53%)	2,849 6%)	1,571 (6%)	939 (6%)	8,905 (9%)

that we have approved each year from 1973 to 1976. Table 1 also indicates the number of physicians whom NIOSH approved as "A" or "B" readers. Only physicians who are approved may interpret X-rays in our program. Physicians become "A" readers by either submitting to us and accurately classifying a sample of X-rays with varying degrees of pneumoconiosis or by taking a course approved by NIOSH on the ILO U/C classification. Physicians become "B" readers by passing an examination which tests the physician's ability to classify radiographs for pneumoconiosis. "A" readers may only participate in providing the first interpretation of a miner's X-ray before it is submitted to NIOSH, while "B" readers may provide the first interpretation but also provide the final interpretation used to determine a miner's eligibility to transfer. I should also point out that our "B" readers are employed by the Department of Labor to interpret X-rays which are submitted by coal miners who apply for black lung compensation. NIOSH's program should not be confused with the compensation program.

Since 1969 we have had two open periods during which all working miners are offered the opportunity for an examination. I should emphasize that coal mine operators are required to routinely examine all new miners according to the schedule mandated by the Act. The first period (or Round 1) was conducted from 1970 to 1971, and the second (or Round 2) was conducted from 1973 to 1975; the third round of examinations began on August 1, 1978.

In the remaining tables are some results of data collected in the first two rounds. Table 2 shows the number and percentage of miners by X-ray category and years mining. Table 3 shows that from July 27, 1973 to July 28, 1978, we reported pneumoconiosis findings to 114,166 miners and between August 18, 1970 and July 27, 1973 we reported similar findings to 71,008 miners. The data in Table 2 also show that (1) few miners who worked less than 10 years in coal mining develop CWP, (2) category 1 seldom develops before 10 years mining, (3) category 2 or 3 seldom develop before 20 years in mining, and (4) PMF seldom develops before 20-30 years in mining.

The percentage of miners with X-rays showing pneumoconiosis is shown in Table 3 by state and round. The data indicate that a higher prevalence of the disease occurred among Appalachian miners as compared to the mid-western and western miners. This is not a new finding. The overall prevalence of CWP among miners examined between July 27, 1973 and July 28, 1978 was 6 percent and the prevalence prior to July 27, 1973 was 10 percent. Lower prevalence rates were found subsequent to July 27, 1973 since more younger miners were examined during this period than prior to July 27, 1973. Overall prevalence rates for the two rounds are compared by years in mining in Table 4. Among those miners who worked greater than 10 years in mining, the data show that the prevalence of CWP in Round 2 was greater than the prevalence in Round 1. This indicates a slight progression of the disease.

The radiographic progression of pneumoconiosis among working miners is also shown in Table 5. The data show that since July 27, 1973, 2650

TABLE 2

ROUND 2: X-RAY CATEGORY BY YEARS WORKED IN COAL MINING FROM JULY 27, 1973 TO JULY 28, 1978

Years Mining	X-Ray Category									
	0		1		2		3		PMF	
	#	%	#	%	#	%	#	%	#	%
0-9	90,520	84	585	11	35	3	2	2	19	7
10-19	7,316	7	973	19	83	8	4	3	22	9
20-29	5,492	5	1635	32	387	36	26	22	69	27
30-39	3,336	3	1467	29	428	40	64	55	88	35
40+	905	1	385	9	149	14	20	17	56	22
Total	107,569		5145		1082		116		254	

TABLE 3

NUMBER AND PERCENTAGE OF MINERS WITH PNEUMOCONIOSIS* BY ROUND AND STATE

	Round 1** Years Mining		Round 2** Years Mining	
	%	Total #	%	Total #
Alabama	10	1, 316	7	2, 268
Arkansas	21	28	0	11
Colorado	3	1, 021	3	2, 543
Illinois	11	4, 200	8	6, 761
Indiana	12	171	1	197
Iowa	3	68	6	51
Kentucky	8	13, 058	4	24, 000
Maryland	21	57	6	68
Montana	0	14	-	-
New Mexico	16	31	5	23
Ohio	5	3, 078	2	7, 815
Oklahoma	5	22	-	-
Pennsylvania	16	15, 705	8	18, 504
Tennessee	12	289	8	599
Utah	7	705	2	2, 613
Virginia	8	5, 638	5	8, 730
Washington	0	19	8	12
West Virginia	12	25, 551	6	39, 543
Wyoming	3	37	1	428
Appalachia	14	61, 661	6	93, 723
Midwest	8	7, 539	5	14, 824
West	5	1, 827	2	5, 619
Total	10	71, 008	6	114, 166

*Pneumoconiosis: Category 1, 2, 3, or Complicated Pneumoconiosis

**Round 1: August 19, 1970 to July 27, 1973
Round 2: July 27, 1973 to July 29, 1978

TABLE 4

NUMBER OF MINERS BY X-RAY CATEGORY AND YEARS WORKED IN COAL MINING FOR EACH ROUND

X-Ray Category	Years Mining											
	0				1-10				< 10			
	Round 1+		Round 2+		Round 1		Round 2		Round 1		Round 2	
	#	%	#	%	#	%	#	%	#	%	#	%
0	15755	99.3	52772	99.9	21255	98.2	39171	98.2	26574	78.1	15626	72.7
1	79	0.5	34	0.1	340	1.6	638	1.6	4716	13.9	4473	20.8
2	15	0.1	2	-	35	0.2	37	0.1	1857	5.5	1043	4.9
3	0	-	0	-	2	-	2	-	143	0.4	114	0.5
PMF**	4	-	1	-	5	-	23	0.1	733	2.2	230	1.07
Total	15853		52809		21637		39871		34023		21486	
% CWP*	0.6		0.1		1.8		1.8		21.9		27.3	

*Coal Workers' Pneumoconiosis
**PMF: Complicated Pneumoconiosis or Progressive Massive Fibrosis
+Round 1: August 18, 1970 to July 27, 1973
Round 2: July 27, 1973 to July 28, 1978

TABLE 5

X-RAY CATEGORY FOR MINERS EXAMINED
IN ROUND 1 AND ROUND 2

Round 1	0	1	2	3	PMF	Total
0	21, 816	2091	185	7	22	22, 121
1	703	635	242	14	15	1, 609
2	49	163	228	54	18	512
3	2	1	19	7	2	31
PMF	6	11	11	4	69	101
	22, 576	2901	685	86	126	26, 374

Above Diagonal = 2650 (10%)
Below Diagonal = 969 (4%)

miners (10%) progressed from one major category to another and 57 miners (0.2%) developed complicated pneumoconiosis. I should also point out that 969 (4%) showed a lower category of pneumoconiosis. This is partially explained by reader variability as miners' films may have been read by different physicians. We feel that a sufficient amount of time had not elapsed between rounds to correlate dust measurements collected by MSHA with our radiological findings. Our third round began in August and by the end of this round we shall have examined enough miners over a sufficient time interval to investigate the present dust standard.

I would like to mention several areas of emphasis for us:

(1) We must maintain high quality X-rays as it is well known that under-penetrated films tend to be over-read and over-penetrated or dark films tend to be under-read. The quality of our X-rays has not been a significant problem as less than 2% of our X-rays were determined to be unreadable. To maintain high quality radiographs, we require that the miner be re-examined if a physician finds the film unacceptable for classification of pneumoconiosis.

(2) We must maintain a base of approximately 20 "B" readers to administer the program. "B" readers are also used by the Department of Labor to administer its Black Lung Compensation Program and by many industries to comply with OSHA's health standards for asbestos exposure and coke oven emissions. We intend to periodically afford training on the pneumoconiosis to interested physicians as well as periodically test and feed back information to physicians so as to maintain a consistent level of interpretation.

(3) We found that only 60% of the working miners were X-rayed in each round. We hope to increase this by better promoting the program. MSHA will be helping us in this by having their coal mine inspectors check that the plans for examinations are posted at the coal mine, thus informing the coal mine operators of the examinations program.

In summary, I believe we can make the following conclusions concerning the data presented:

(1) Apparent declines in prevalence among workers examined prior to July 27, 1973 as compared to those examined subsequent to this date are accounted for by shifts in mining work force toward miners with few years in mining.

(2) No trend toward less CWP is noted since MSHA began its dust control program.

QUESTION/ANSWER PERIOD

Question:

What is the reason only 50% of the people or employees take advantage of the X-ray? Do you have any feel for that?

Answer:

It's an optional examination for the working coal miners. Maybe we could get a consensus among the coal mine operators here. It's speculation. Coal miners are offered the opportunity for an examination, and they don't have to avail themselves of it. We think 60 percent participation in the first round and second round was good as the X-ray program just got off the ground and it was a large job to inform coal operators and miners.

Question:

Unable to hear clearly.

Answer:

These are just working coal miners—miners who work in or at an underground coal mine.

Question:

Comment by previous questioner—question not audible.

Answer:

We have to abide by the provisions of the Act. The Act stipulates that all miners who work in or at an underground coal mine will be afforded the opportunity for an examination. This now also includes, in the 1977 Act, workers or employees of independent contracts who perform services in or at underground coal mines.

Question:

Doesn't the Act define a miner as anyone who works underground?

Answer:

You're correct. In the first section of the Act it defines a miner as anybody employed at a coal mine. We have to abide by Section 203 of Title II of the Act. There are four titles in the Act. Title I sets forth general definitions of coal operators, coal mines, and coal miners. Title II of the Act redefines a coal mine as being an underground coal mine. Our program applies only to underground coal miners—workers in or at an underground coal mine.

Question:

Does this include the supervisors?

Answer:

Yes, this would include the supervisors as well. It's rather academic though, whether or not a coal operator would be afforded the opportunity for an examination. We had an inquiry from a coal operator the other day. He and his brother and another fellow were joint-owners of a mine where there were no other employees. He asked whether they had to afford themselves examinations—and did they have to transfer themselves, and if so, did they have to transfer out of their own mine—and put themselves out of business? The answer is obviously "no". He does not have to afford himself an examination if he doesn't want to.

Question:

Does NIOSH carry out any statistical data on which to establish a basis?

Answer:

This was my point in my slide. We've only obtained information on miners over approximately a 2 to 3 year period. Working miners were offered examinations between 1970-71 and again between 1973-1975. Most miners were examined in 1971 in the first round and in 1973 in the second round. Pneumoconiosis just doesn't progress that rapidly over a 2 to 3 year period. Dust standards in British coal mines were based on examinations made at 5-year intervals over a period of 15 years. We hope that we can start doing some statistical analysis towards the end of the third round when we shall have a significant number of miners examined over at least five years.

In addition to our periodic chest X-ray program for coal miners, we conduct a nationwide epidemiological survey. At the end of the third round we will, for the first time, have standardized physiological measurements and standardized interpretation of X-rays and standardized questionnaires. When I say standardized, I mean we've had the same field teams, the same field practics, the same interpretation techniques performed in the first and third rounds.

Question:

How much confidence do you have in the MSHA dust data?

Answer:

We haven't gotten into it yet. It would be better to refer that question to MSHA.

Question:

If two doctors looked at the X-ray, what is the probability that the two doctors would have the same evaluation?

Answer:

It depends on what you are talking about. In regard to category of profusion, we have performed reading trials and gave films to numerous physicians and the film set was designed to have an equal number with categories 0, 1, 2, and 3 pneumoconiosis. We have seen physicians agree as to major category in as few as 50% of the films and in as many as 95%. The best agreement is generally seen among our "B" readers. That's why we feel it is important to employ readers we have tested and who we feel read most consistently.

Question:

If two facilities took X-rays of the same man, what's the probability that they would come up with the same answer?

Answer:

I really can't answer that. You mean, if we had two identical X-rays? Generally, if you take a "B" reader and we have them reread the same batch of films, they will disagree somewhat. There is a bit of variation from reading to reading, but they will agree again within themselves greater than 95% of the time within $\pm$ one minor category. Usually the agreement within themselves is better than with their colleagues. As long as you have good quality films, you will have reasonably good agreement among physicians.

Question:

Why don't we have X-rays for surface coal mines as well as for underground coal mines, since there is comparable dust sampling programs for the two?

Answer:

Again, Title II of the Act pertains only to underground mines. In fact, we are in the process of sending recommendations to the Department of Labor to recommend examinations be given to certain surface coal miners. This is coming down the road.

Question:

Why do I have to run dust samples on preparation plant personnel?

Answer:

You'd be surprised how much pneumoconiosis we find among tipple workers, prep plant workers.

Question:

Doesn't it apply to only underground?

Answer:

It applies to any worker who works in or at an underground coal mine. This covers surface workers in or at an underground coal mine. I'm glad you pointed this out. Surface coal miners who work at surface mines which are not located in or at an underground coal mine are not covered by the present program.

Question:

You indicated that "B" readers were used the majority of the time making determinations for purposes of notifying the Labor Department and also the employer. Am I correct in assuming that a "B" reader is more of an expert than the "A" reader?

Answer:

Consistency among "B" readers is better than consistency between "B" readers and "A" readers. "A" readers, we have found, tend to read more pneumoconiosis than do "B" readers. We have confidence in a physician's interpretation if he or she is a "B" reader who has passed a test which we have had designed by Johns Hopkins University, and which has the approval of the American College of Radiology. This is the method which we have to

standardize interpretations for thousands of X-rays which we process every month. We process some 5,000 X-rays each month during a round and when miners are periodically examined over a long period of time a consistent diagnosis is needed. We cannot tell the man he has progressive massive fibrosis one day, Category 0 the next. I hope that answers your question.

Question:

You spoke of some variation in the X-rays. Has there been thought of letting the same reader interpret the X-rays of the same person over a number of years?

Answer:

We have turnover in our "B" readers. We process thousands of X-rays during a round; approximately 5-8 thousand a month. With a work-load that size it's difficult to channel all the X-rays to the same reader. It's a logistical problem compounded along with the turnover of "B" readers.

Question:

I doubt that the data on progressive has any validity.

Answer:

One should realize that the results presented are the results of a voluntary examination program. I would be very cautious in stating that 10% progressed from one category to another. Possibly a different amount of progression exists than that which we've reported. We do not have data on the non-participants. Thus, as I mentioned, we conduct a nationwide survey of coal miners called the National Study of Coal Workers' Pneumoconiosis. As part of the survey we will have all of the films on miners who participate in Round 1 and Round 3 interpreted by the same physicians to more accurately estimate progression. However, I should point out that I have presented data on approximately 26,000 miners who were examined in both rounds. The magnitude of this sample size adds validity to the data and cannot be overlooked.

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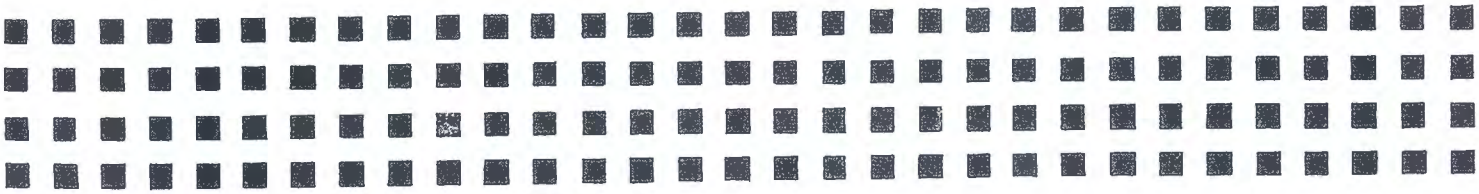

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