TECHNICAL SESSION III

BLACK LUNG PROGRAM

"Overview of Coal Miner Health Research at the Appalachian Laboratories"

by

Robert B. Reger[1]

The purpose of this paper is to make known the various areas of research being conducted at the Appalachian Laboratories in Morgantown, West Virginia, which relate to coal miners in the United States. My apologies for not presenting this work with the traditional introduction, methodology, results, and discussion.

MANDATED CHEST EXAMINATIONS FOR UNDERGROUND COAL MINERS

Although not a research study per se, there is sufficient importance attached to the periodic x-ray program that it should be mentioned. Through surveillance, the major purpose of the examination program is to protect the health of the nation's coal miners, and likewise, to determine the effectiveness of the current coal dust standard. The Coal Mine Health and Safety Act of 1969 specifies that coal mine operators will provide the opportunity for all of their workers to receive periodic chest examinations. Further, every new miner shall be given a chest x-ray within six months of commencement of his employment at an underground coal mine and at established intervals thereafter. The results of these periodic examinations are furnished to the miner, and if so designated, to his (the miner's) personal physician. In addition to coalworkers' pneumoconiosis, indications of other significant chest conditions are also given.

Both the first and second rounds of examinations of the nation's coal miners have been completed and we are currently making ready for the

[1]Chief Epidemiological Investigations Branch, Appalachian Laboratory for Occupational Safety and Health (ALOSH) Department of Health, Education and Welfare, Morgantown, West Virginia.

third round of examinations under the Act. Although the regulations regarding the methodology employed in the reading of the films has changed slightly from round to round, mention of the current methodology seems appropriate. There are two types of readers who are qualified to read the films. The first is designated as an "A" reader. This is a physician who has ordinarily taken a short course sponsored by the American College of Radiology regarding the reading of films for the pneumoconioses conducted by a major university in the United States.

All films receive a minimum of two readings. The first reading is generally made by either an A or a B reader at the local level where the x-ray was taken. These readings, along with the films, are sent to Morgantown, where the readings are recorded, and the films are then mailed to a certified B reader. Once returned, the second reading is matched with the first, and if agreement exists regarding major category of disease, then it is regarded as the final reading. If no agreement is reached with these two readers, then the film is mailed to a third certified B reader, and again, this reading is compared with the previous readings to ascertain if a match occurs. At this point, if no consensus is obtained, the film is sent to a panel of experts whose determination is final. Most films only require two readings and rarely are films sent to a panel.

Great care is taken to insure that the technical quality of the radiographs is sufficient, as this factor is a significant variable in the reading of the films.

This surveillance program serves several purposes, the first of which is major: to monitor the health of the nation's miners and to determine the prevalence of coalworkers' pneumoconiosis in the coal mine work force. However, equally important is the ability of the Appalachian Laboratories to partially assess the impact of the dust standard by comparing films on the same men taken over a period of time and assessing change in relation to known dust concentrations which have been measured on these men by the Mine Enforcement and Safety Administration (MESA). This program shall continue for an indefinite period of time and is likened to its sister program run by the National Coal Board of Britain which has been in existence for many years.

AUTOPSY SERVICE

Again, this service is authorized under the 1969 law primarily to assist widows and families of deceased coal miners in determining the cause of death and degree of pneumoconiosis suffered at the time of death. In many cases, the autopsies have enabled miners' dependents to establish eligibility for benefits. As the name implies, the major function of the program is to provide a service. However, there are some research facets involved in the work.

Established procedures for classifying the pneumoconioses from the radiograph have existed for a number of years. Yet, no analagous system for pathological use is in service. Accordingly, an example of research evolving from this service program is the development of standards for the type and severity of coalworkers' pneumoconiosis from the examination of lung specimens. Comparative work correlating patterns appearing on the chest x-ray to underlying structural and chemical changes in the lung tissues are being made.

In relation to the pool of working and retired coal miners in the United States (possibly over 300, 000), the number of autopsied cases forwarded to our laboratories are indeed small. If one were to use standard mortality tables, one could calculate that between 5, 000 and 6, 000 deaths would occur annually in this population. Based on these gross figures, we are sure that considerably less than 15 percent of the estimated deceased miners have been included in the National Coalworkers' Autopsy Program.

Sampling problems encountered by the autopsy service are similar to those reported for similar studies in the United States and elsewhere. The major problem, of course, is our inability to know the precise biases of the autopsy population. The autopsies are accepted regardless of cause of death.

NATIONAL COAL STUDY

Whereas the surveillance program for all coal miners in the nation involves a major emphasis on service with a minor emphasis on research, our National Coal Study is quite the opposite. Since 1969 and in congruence with the mandated x-ray program, the Appalachian Laboratories has conducted a more detailed examination on samples of miners throughout the United States coal fields. Several purposes are involved in the continuation of this more detailed study. Similar to the mandated program, there is the ability (through tighter controls) to monitor the progression of coalworkers' pneumoconiosis and other health indicators to assess the adequacy of the current dust standard. Also, it provides the tool to conduct research into unresolved issues regarding coalworkers' ailments. Studies relating to attack rates of massive fibrosis, industrial bronchitis in relation to the known dust burden, the relationship of simple coalworkers' pneumoconiosis to other health parameters, and the identification of the hypersusceptible miner are examples of unresolved research issues.

Both the first and second rounds of examinations have been completed, and in both rounds more than 9, 000 miners in ten states were given detailed examinations. These examinations are achieved by using mobile medical laboratories at the mine site. The examinations include the

following: (1) posterior-anterior and lateral chest films. Although the posterior-anterior films are of major importance in the radiographic classification of disease, the lateral is useful in that it is used in conjunction with the PA film to obtain an estimate of total lung capacity by utilizing physical measurements on the films. (2) A minimum of five spirometric maneuvers are performed. These are in the form of flow volume curves whereby information is extracted such as the forced vital capacity, forced expiratory volume in one second, and flow rates at 5 percent intervals of the forced vital capacity exhaled. Two major indicators are put forth from these maneuvers. The first being indications of obstructive airways disease and the second relating to restrictive problems. (3) A respiratory symptom questionnaire is administered by trained interviewers. The questionnaire is an adapted form of the Medical Research Council questionnaire on chronic bronchitis and has been used in this and other countries for many years. (4) A complete work history starting from the present job and working backwards to the beginning of a person's employment is taken. Special emphasis is involved in the collection of this information for every job a person had which concerns mining. (5) A complete smoking history is obtained. (6) Basic demographic information such as age, height, weight, etc., is ascertained.

As a service function of this study, there is immediate feedback to the miners and their personal physician regarding their spirometric and radiographic results. Moreover, and in line with the stated aims of the study, no less than 40 pertinent research articles have been published in medical and research journals.

The third round of examinations will begin in November and there is no deviation from the methodology previously employed. There is, however, one major change in the format of the study. Due to closures of some mines which were in the first and/or second rounds, new operations have been added to the sample. In total, the third round will involve 37 district sites.

ADJUNCT TO THE NATIONAL COAL STUDY

As an important adjunct to the previously mentioned study, we are currently involved in a survey of underground coal miners exposed to diesel exhaust. The major purpose of this work is to assess the biological effects of diesel emissions and their potential interaction with respirable coal dust. Presently there are only over 20 mines in the United States (the majority in the west) utilizing diesel engines in underground coal mines. However, only five of these mines have any significant usage. Accordingly, we have examined over 800 men in these five operations, and in addition to the procedures specified for the National Coal Study, we also performed before and after shift spirometry on a sample of the miners.

In addition, every miner examined before and after shift was asked to wear personal samplers to ascertain exposures to respirable coal mine dust and nitrogen dioxide. Area sampling was done to determine concentrations of total dust, respirable dust, CO, CO_2, NO_2, NO_x, SO_2, and HCHO. As in the National Study of Coalworkers' Pneumoconiosis, there is feedback to the miner and his personal physician regarding the current health status of the miner. The analysis to answer research questions will be forthcoming in the near future.

The analysis will involve two basic facets; the first relating to acute changes over a work shift and the second relating to chronic effects. Appropriate control groups for comparison to these miners are available.

Some environmental work in this particular effort is yet to be done which will involve complete characterization of mine atmospheres which utilize diesel equipment, and secondly, we would hope in the future to restudy these same people so as to better estimate the possible effects (over time) of diesel emissions on their health.

EX-MINER STUDY

A shortcoming of the National Coal Study revolved around the concept that we have studied only a survivor population. This is well recognized, and estimation of the prevalence of dust-induced conditions in coal miners as determined from the aforementioned work may be underestimated. Accordingly, this is being rectified by studying miners who have left the industry whether for medical or other reasons. The work is being performed by utilizing past information on miners who have been examined from the first and second rounds of the National Coal Study.

Briefly, the methodology is to determine potential ex-miners from lists of participants in the first and second rounds. Potential is the key word here, as it is not necessarily the case that a person is an ex-miner because he participated in the first round and not in the second round of examinations. A follow-up on these potential cases is anticipated by direct interview and/or questionnaire to determine which are truly "leavers" and moreover, to determine their reason for leaving mining. Once this has been determined, an analysis (before the fact of leaving) of the first round data for this group compared to data for those who have not left mining may provide clues regarding the health status of the ex-miners immediately prior to their leaving the industry.

NEW MINER STUDY

Another area where information is currently lacking involved the early identification of factors associated with hypersusceptibility. Through local

arrangements in the Morgantown area, a study is being devised to examine new miners just coming into the industry and to follow them for a specified period of time to determine information regarding acute effects and hypersusceptibility to various respiratory conditions. Due to logistics and the detailed testing procedures comtemplated for this group, the study is being limited to a 50 mile radius of Morgantown. A specially equipped examination trailer will be used in this study and will do a "round robin" circuit to several large mining operations to examine new men. Examinations will be before exposure to coal mine dust and at 3, 6, 12, 18, 24, and 36 month intervals. In addition to the ordinary tests and questions relating to respiratory ailments, detailed procedures such as diffusing capacity, airways resistance, and other non-routine tests will be performed. New men who leave the industry before the study period terminates will be followed to the extent possible.

MORTALITY STUDIES

Last but not least I would like to mention our continuing efforts in the area of mortality studies. In a general sense, the purpose of these studies is to determine age-standardized death rates for coal miners for: (1) all deaths; (2) specific causes, especially coalworkers' pneumoconiosis, cardio-pulmonary disease, and cancer of the respiratory system.

Also, our goal is to study interactions among coal dust exposure, coalworkers' pneumoconiosis, cigarette smoking, airways obstruction, dyspnea, and chronic bronchitis on elevating death rates.

Currently, there are three cohorts of miners being evaluated. The first involves over 2,500 miners who were employed and given examinations during a 1963-1965 study period. The second involves nearly 1,200 exminers examined during the 1963-1965 study period, and the third, 3,700 miners examined at two large hospitals for workmen's compensation. All of these cohorts have previously been followed through 1971 and the data have been previously published. The current work involved updating the mortality experience of these groups through 1976.

Although there are many detailed research facets which come about as "off-shoots" of these major studies, this concludes a synopsis of the major studies at the Appalachian Laboratories involving coal workers.

QUESTION/ANSWER PERIOD

Question:

In reference to the diesel study, are preliminary data available? Do you have any indication whether or not miners are suffering adverse effects from diesel emissions?

Answer:

Preliminary data are available. We are currently mailing letters to the miners and their personal physicians regarding the examinations given.

On first examination, it appears that around 4 percent of the miners we studied have some degree of coalworkers' pneumoconiosis. There are no cases of massive fibrosis. There appears to be an ordinary amount of what you would call obstructive airways disease. I don't remember seeing any cases of restriction. Every miner studied was compared to a national norm.

The environmental samples taken were generally below the threshold limit value established for each substance. We will (in the future) look into the amount of progression (coalworkers' pneumoconiosis) seen in these miners studied over a time frame. Many of these companies and miners studied participated some years earlier in the Congressionally mandated x-ray program; and we have the x-rays of these people in Morgantown for comparison.

Question:

Would it be safe to say (in your opinion) that coalworkers who are exposed to diesel equipment are no more worse off than coalworkers exposed to electrical equipment?

Answer:

I think it's a little early to say anything about that. I should say that we're noticing roughly 4 percent of the diesel exposed miners as having coalworkers' pneumoconiosis. In the nation, the latest estimates of all miners were running around 10 - 12 percent with coalworkers' pneumoconiosis. The men in the current study were younger than miners in the nation as a whole. Hence, they have worked less, had less dust exposure, and as might be expected, less coalworkers' pneumoconiosis. So, any comparisons will have to be age standardized.

We are currently analyzing our data in two ways to answer the question you put forth. The first analysis involves acute respiratory effects, while the seond approach involves chronic problems. Suitable control groups are being utilized for comparison purposes.

Question:

A dust control program has been in effect for a number of years. What is the impact of these lower dust levels on progression of coal-workers' pneumoconiosis?

Answer:

We have examined about 4000 miners who were common to both rounds of examinations. This was during the 1969-1972 time frame—when the 2 mg/m^3 standard was in force. It should be noted that approximately 5 percent of the people progressed. That is, there was (on average) more retention of dust in their lungs than when they were first examined. Another question is, on average, how much did they progress? On average, the progression was less than one minor category on the ILO/UC scale of abnormality.

Question:

Is there more work being done on the blood test for susceptibility?

Answer:

The last work that was done in that area was reported in 1975 in Scotland. It seemed that there may be an immune mechanism associated with histocompatibility antigens W18 and A1. The work has been repeated. Although the study is continuing, we still think there is something with the A1 antigen—possibly not the W18 antigen.

Question:

Going back to another question, would you expect an interaction ... that the 5 percent got worse (progressed) from smoking cigarettes?

Answer:

No. We haven't tied that in with smoking. Certainly smoking plays a significant role in all respiratory diseases.

Question:

Do you have quantitative data on the effects of smoking?

Answer:

Yes. For example, here is a slide (this is published information) on peak flow. This is peak flow by age group for smokers by different exposure groups. As you can see, each of the lines on this chart relate to a group of people who have been exposed underground a certain length of time. Also, each of these exposure groups have people of the same age. These are all smokers. The first thing that is obvious from the slide is that as you get older, the rate drops off; it is quite obvious regardless of the amount of exposure. Secondly, within a single age group—40-49, you can see a decrement associated with the exposure.

Let's look at the nonsmokers. The first thing is that the age effect here is not nearly so obvious. This would suggest (and this is not a wild assumption) that there's a smoking-by-age interaction. Secondly, it appears that the change across the exposure group in an age category is more distinct than exists for the smoker group. The possibility here might be that it EXISTS for the smokers but it is being masked by the smoking effect. If I were to lay this slide (nonsmokers) on top of this one (smokers), you will see the smoking effect quite clearly. They are all the same age by exposure group--all of them the same exposure group, the same age—only one group is smokers, the others nonsmokers. You see quite clearly the effect due to smoking here.

Question:

There is a great impact of smoking as they get older?

Answer:

That's true. There seems to be a smoking by age interaction.

Question:

Are these coal miners only?

Answer:

Yes.

Thank you.

Eighth Annual Institute On Coal Mining Health Safety And Research

Participants And Sponsors

Mining Enforcement And Safety Administration

United States Department Of The Interior Bereau Of Mines

Department Of Mining And Minerals Engineering Virginia Polytechnic Institute And State University

Proceedings Edited By:
Dr. William E. Foreman
Associate Professor

Department Of Mining And Minerals Engineering
Virginia Polytechnic Institute And State University

Blacksburg, Virginia

172 Pages