Occupational Lung Disease Among Coal Miners

Edward L. Petsonk, M.D.

BACKGROUND

Since the beginning of the industrial revolution, coal has been the fuel that provided the energy for industry. In the United States, coal production is at near record levels and in 2003 1,972 active mines and about 70,000 working coal miners (1) were engaged in the commercial exploitation of the major U.S. coal deposits in 38 states (2, 3) (Figure 1). After World War II, mechanization in the U.S. coal mining industry brought an end to most pick-and-shovel mining, and resulted in dramatic increases in productivity and consequent sharp and progressive declines in mine employment. However, recent increases in energy prices have led to an increased interest in coal, and current industry figures suggest that coal mine employment is now increasing. (Coal mine employment statistics are available at http://www.msha.gov/stats/statinfo.htm) To maintain the required high levels of production with a small workforce, modern miners commonly operate powerful and sophisticated mining equipment. Despite extensive mechanization, however, coal mine work often involves strenuous manual labor in cramped and hazardous conditions. The high levels of production that are being achieved in confined spaces present continuing challenges for controlling dust and assuring the safety of miners.

RESPIRATORY DISEASE

Knowledge of the diseases of coal miners has progressively accrued since the early 1800s, when Laennec differentiated 'melanosis' or what was later called 'miners black lung' from malignant melanoma. During the early applications of the roentgenogram, it was noted that the lungs of coal miners demonstrated abnormalities that were not seen in unexposed workers. Chest radiography emerged as an essential tool for the investigation, diagnosis, and monitoring of health risks among coal miners, and, by 1930, the International Labour Office had published a system of classification for the radiographic appearances of pneumoconiosis (4). Over the last fifty years, investigators have undertaken comprehensive laboratory, clinical, and epidemiologic studies of coal miners, and it is now known that inhalation of dust during underground or surface coal mine employment can result in at least eight distinct respiratory tract conditions: chronic bronchitis; mineral dust airways disease; centrilobular emphysema; silicosis; silicotuberculosis; simple coal workers' pneumoconiosis; complicated coal workers' pneumoconiosis or progressive massive fibrosis; rheumatoid pneumoconiosis. Not all of these are reliably detected using radiographs (5). Despite evidence that coal miners are at risk of silicosis and obstructive airway diseases and that both of these conditions are risk factors for lung cancer, current epidemiologic evidence does not demonstrate an increased risk of lung cancer from the inhalation of coal dust (6).

RECENT TRENDS

In the United States, current federal regulation of working conditions in underground coal mines was initiated following the passage of the Coal Mine Health and Safety Act of 1969. The success of the Act in reducing underground coal mine dust exposures has been corroborated by the reduction in radiographic evidence of pneumoconiosis seen among participants in the U.S. National Coal Workers' X-ray Surveillance Program (Program) (7, 8). This Program, administered by the National Institute for Occupational Safety and Health (NIOSH), was established under the 1969 Act and requires all operators of underground coal mines to offer chest radio-

graphic examinations to working miners every five years. Under current coal mine regulations, miners who are determined by the Program to exhibit evidence of pneumoconiosis have the legal right to transfer to a job with reduced dust exposure, if available. To enhance the quality and reliability of the examinations, Program chest films must be taken in NIOSH-approved facilities and interpreted by NIOSH-certified physician readers. (See website at http://www.cdc.gov/niosh/topics/chestradiography/.)

Figure 2 illustrates the progressive decline in the tenure-related risk of radiographically-evident pneumoconiosis among coal miners who have participated in the Program. Whereas in 1974-8, over 1 in 3 participating miners with at least 25 years tenure demonstrated changes consistent with pneumoconiosis, the prevalence declined to 1 in 5 by 1987, and by 2002 only about 1 in 20 of these miners showed radiographic evidence of disease. The number of persons dying with coal workers' pneumoconiosis has also declined in recent years, although at least in part this has been a result of the reduction in the number of individuals employed in coal mining jobs. From 1990 to 1999, coal workers' pneumoconiosis was listed as the underlying or contributing cause of death for an average of 1504 deaths per year in the United States. (9).

FUTURE CHALLENGES

Despite remarkable progress in controlling pneumoconiosis in the United States, a number of difficult challenges remain in achieving the goal of preventing occupational lung disease among coal miners. First, although the overall progress has been impressive, recent studies have indicated that the improvement has not been uniform (8, 10). Program data have demonstrated that the prevalence of radiographic evidence of pneumoconiosis among working miners in certain states is 3-5 times the national average. Miners currently working in smaller mines (less than 50 employees) and in certain jobs at the coal mining face demonstrate significantly greater disease prevalence. Of particular concern, a number of cases of advanced and rapidly progressive disease have recently been reported among younger miners whose entire working career has been under current dust regulations (10). Explanations for these "hot spots" of pneumoconiosis must be sought.

A second concern relates to the occurrence of dust-related lung diseases among surface coal mine workers. Mandated surveillance does not cover employees or contractors at surface coal mines, and thus there is much less data regarding this group of miners. However, severe cases of pneumoconiosis have been reported among surface coal mine workers, and recent health surveys taken at surface coal mines have documented radiographic evidence of disease (8).

A third concern has been raised regarding the risk for chronic obstructive pulmonary disease (COPD) from inhalation of coal mine dusts (7, 11). Although pneumoconiosis was the initial focus of study in relation to miners' respiratory health, extensive epidemiologic investigations and supporting pathologic studies have demonstrated that chronic airflow limitation, including chronic bronchitis, emphysema, and mineral dust airways disease may result from coal mine dust exposures (5, 7). The current enforceable dust exposure limits, implemented in 1973, were targeted at the prevention of disabling pneumoconiosis, but were not intended specifically to address airways diseases. More recent evidence indicates that coal miners exposed at the current dust exposure limits (2 milligrams of respirable coal mine dust per cubic meter of air, mg/m3) may experience important dust-related lung function declines (7, 12). To address this risk, NIOSH has recommended the addition of pulmonary function monitoring to the currently-required coal mine radiographic health surveillance, in addition to recommending a reduction in permissible exposures to 1 mg/m3 in order to prevent all the respiratory diseases associated with coal mining (7).

A final issue in the control of occupational lung disease among coal miners, as well as among individuals in other dusty work, relates to the application and interpretation of chest imaging studies in diagnosis, monitoring, and research. Developments in imaging technology, including digital imaging systems and computerized axial tomography, present challenges to the traditional film screen approaches to chest radiography. The optimal role of these newer modalities requires clarification. Additionally, in spite of standardized classification methods and efforts in training and certification, considerable variability remains among physicians interpreting chest images for pneumoconiosis (13). It is the objective of these workshop proceedings to address the current status and future directions in the application of chest imaging in occupational lung disease. Recommendations from this workshop are not consensus statements, but individual opinions of some, not necessarily all, of the participants.

REFERENCES

1. National Institute for Occupational Safety and Health. Coal Operator Mining Facts-2003. Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, 2005; DHHS (NIOSH) no. 2005--114. Available at http://www.cdc.gov/niosh/mining/pubs/pdfs/2005-114.pdf.

2. Energy Information Administration. State Coal Profiles January 1994. Washington, D.C.: Department of Energy, 1994; DOE/EIA-0576. Available at http://tonto.eia.doe.gov/FTPROOT/coal/0576.pdf.

3. Energy Information Administration. U.S. Coal Reserves: 1997 Update, Washington, D.C.: Department of Energy, 1999. Available at http://www.eia.doe.gov/cneaf/coal/reserves/chapter1.html.

4. International Labour Office. Guidelines for the Use of ILO International Classification of Radiographs of Pneumoconioses. Revised Edition 2000. Geneva:ILO; 2002.

5. Petsonk EL, Attfield MD. Respiratory diseases of coal miners. In: Rosenstock L, Cullen M, Brodkin CA, Redlich CA, editors. Textbook of Clinical Occupational and Environmental Medicine, Second Edition. Philadelphia: W.B. Saunders Company; 2005:393-407.

6. International Agency for Research on Cancer. Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 68. Silica, Some Silicates, Coal Dust and para-Aramid Fibrils. Lyons: IARC; 1997:337-406.

7. National Institute for Occupational Safety and Health. Criteria for a Recommended Standard: Occupational Exposure to Respirable Coal Mine Dust. Cincinnati, OH:U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. DHHS (NIOSH) Publication No. 95-106, 1995. Available at http://www.cdc.gov/niosh/coaldust.html

8. Centers for Disease Control and Prevention. Pneumoconiosis prevalence among working coal miners examined in federal chest radiograph surveillance programs---United States, 1996--2002. MMWR 2003; 52(15):336--40. Available at http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5215a3.htm

9. National Institute for Occupational Safety and Health. Work-related Lung Disease Surveillance Report 2002. Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, 2003; DHHS (NIOSH) no. 2003--111. Available at http://www.cdc.gov/niosh/docs/2003-111/2003-111.html

10. Antao VC, Petsonk EL, Sokolow LZ, Wolfe AL, Pinheiro GA, Hale JM, Attfield MD.

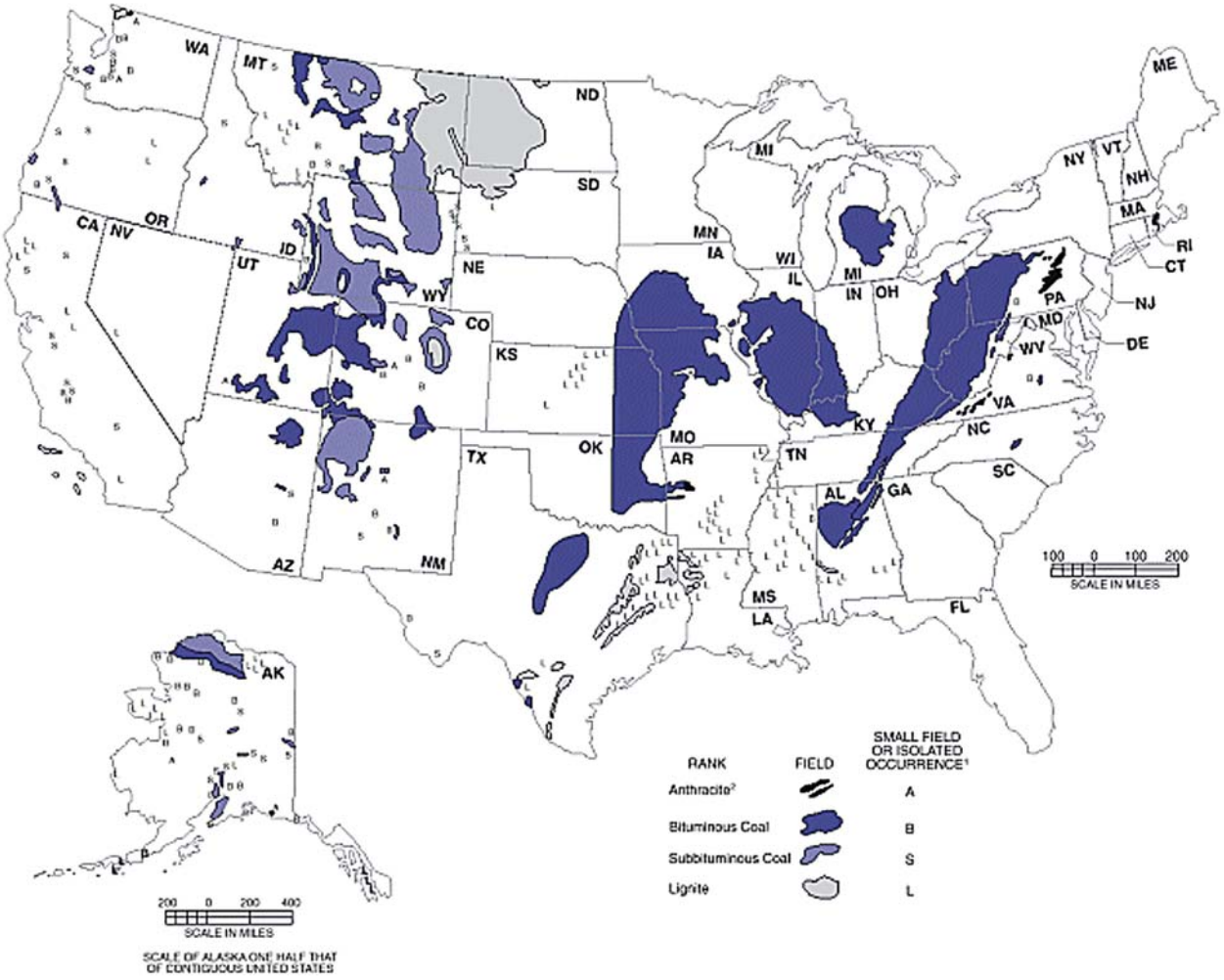
Rapidly progressive coal workers' pneumoconiosis in the United States: geographic clustering and other factors. *Occup Environ Med* 2005; 62:670-674.

11. Marine WM, Gurr D, Jacobsen M. Clinically important respiratory effects of dust exposure and smoking in British coal miners. *Am Rev Respir Dis* 1988; 137:106-112.

12. Carta P, Aru G, Barbieri MT, Avataneo G, Casula D. Dust exposure, respiratory symptoms, and longitudinal decline of lung function in young coal miners. *Occup Environ Med* 1996; 53:312-9.

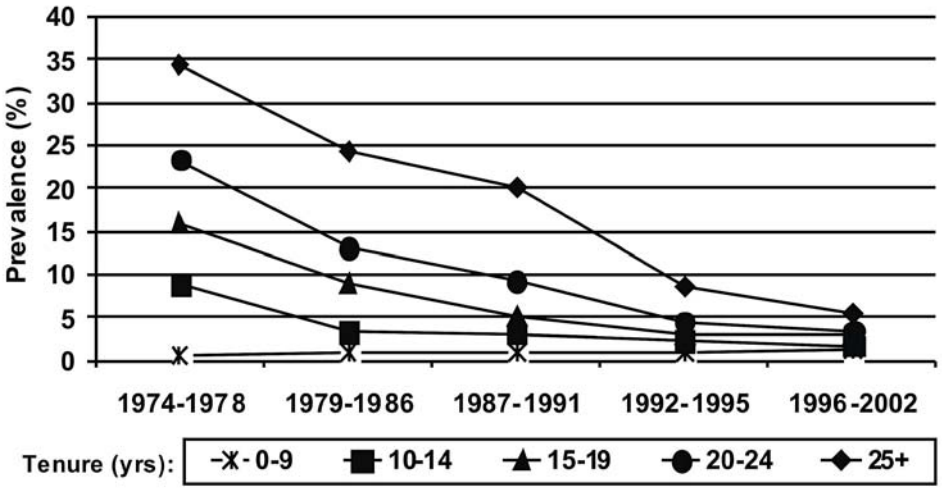
13. Attfield MD, Petsonk EL. Proficiency, procedures, and "B" readers - classifications of radiographs for pneumoconiosis. *Acad Radiol* 2004; 12:1323-1325.

Figure 1. Coal-Bearing Areas of the United States



Source: See reference 3

FIGURE 2. Trends in coal workers' pneumoconiosis prevalence by tenure among underground miners examined in the U.S. National Coal Workers' X-Ray Surveillance Program, 1973-2002



Source: See references 8 and 9

The NIOSH B Reader Certification Program:

Looking into the Future

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

CDC Workplace Safety and Health

National Institute for Occupational Safety and Health NIOSH

Disclaimer

Ordering Information

To receive documents or other information about occupational safety and health topics, contact NIOSH at

1-800-CDC-INFO (1-800-232-4636)
TTY: 1-888-232-6348
E-mail: cdcinfo@cdc.gov
or visit the NIOSH Web site at
www.cdc.gov/niosh

For a monthly update on news at NIOSH,
subscribe to NIOSH eNews by visiting
www.cdc.gov/niosh/eNews

DHHS (NIOSH) Publication No. 2009-140