

Resurgence of Progressive Massive Fibrosis in Coal Miners — Eastern Kentucky, 2016

David J. Blackley, DrPH¹; James B. Crum, DO²; Cara N. Halldin, PhD¹; Eileen Storey, MD¹; A. Scott Laney, PhD¹

Coal workers' pneumoconiosis, also known as "black lung disease," is an occupational lung disease caused by overexposure to respirable coal mine dust. Inhaled dust leads to inflammation and fibrosis in the lungs, and coal workers' pneumoconiosis can be a debilitating disease. The Federal Coal Mine Health and Safety Act of 1969 (Coal Act),* amended in 1977, established dust limits for U.S. coal mines and created the National Institute for Occupational Safety and Health (NIOSH)—administered Coal Workers' Health Surveillance Program with the goal of reducing the incidence of coal workers' pneumoconiosis and eliminating its most severe form, progressive massive fibrosis (PMF),† which can be lethal. The prevalence of PMF fell sharply after implementation of the Coal Act and reached historic lows in the 1990s, with 31 unique cases identified by the Coal Workers' Health Surveillance Program during 1990–1999. Since then, a resurgence of the disease has occurred, notably in central Appalachia (Figure 1) (1,2). This report describes a cluster of 60 cases of PMF identified in current and former coal miners at a single eastern Kentucky radiology practice during January 2015–August 2016. This cluster was not discovered through the national surveillance program. This ongoing outbreak highlights an urgent need for effective dust control in coal mines to prevent coal workers' pneumoconiosis, and for improved surveillance to promptly identify the early stages of the disease and stop its progression to PMF.

On June 9, 2016, a radiologist contacted NIOSH to report a sharp increase during the past 2 years in the number of PMF cases among patients who were coal miners seen at his practice serving the easternmost counties of Kentucky. The radiologist requested assistance in conducting an investigation

and developing and implementing interventions to reduce the prevalence of disease in the community. NIOSH personnel traveled to Pike County, Kentucky, to assist with the investigation. A case of practice-identified PMF was defined as an International Labor Office classification of large opacity category A, B, or C pneumoconiosis (PMF) in a current or former coal miner receiving a chest radiograph from a single

INSIDE

- 1390 Assessing Change in Avian Influenza A(H7N9) Virus Infections During the Fourth Epidemic — China, September 2015–August 2016
- 1395 Leading Causes of Cancer Mortality — Caribbean Region, 2003–2013
- 1401 Monitoring of Persons with Risk for Exposure to Ebola Virus — United States, November 3, 2014–December 27, 2015
- 1405 Use of a 2-Dose Schedule for Human Papillomavirus Vaccination — Updated Recommendations of the Advisory Committee on Immunization Practices
- 1409 Preliminary Report of Microcephaly Potentially Associated with Zika Virus Infection During Pregnancy — Colombia, January–November 2016
- 1414 Notes from the Field: New Delhi Metallo- β -Lactamase–Producing Carbapenem-Resistant Enterobacteriaceae Identified in Patients Without Known Health Care Risk Factors — Colorado, 2014–2016
- 1416 QuickStats

Continuing Education examination available at http://www.cdc.gov/mmwr/cme/conted_info.html#weekly.

* <http://arlweb.msha.gov/solicitor/coalact/69act.htm>.

† PMF is a fibrotic pneumoconiotic lesion at least 1 cm in diameter; both coal workers' pneumoconiosis and silicosis can progress to PMF.



radiology practice in Pike County, Kentucky, during January 1, 2015–August 17, 2016, with completed radiograph classification and occupational history forms. All radiographic classifications were performed by the reporting radiologist, who is an experienced, board-certified radiologist and a NIOSH-certified B Reader (i.e., a physician certified by NIOSH as proficient in classifying radiographs of pneumoconiosis) (3).

Sixty male patients who were active or former coal miners had radiographic findings consistent with PMF, including 49 (82%) whose radiographs were taken during 2016. Fifty-six (93%) patients were residents of Kentucky; 48 (86%) of the 56 resided in four contiguous counties (Floyd, Knott, Letcher, and Pike) in the southeastern part of the state that are part of the central Appalachian coalfield. The mean age of patients was 60.3 years (range = 44.9–77.4 years; median = 59.4 years). The mean coal mining tenure was 29.2 years (range = 15–47 years; median = 30.0 years). Thirty-one patients (52%) were determined to have category A PMF (one or more large opacities each >10 mm in diameter with combined dimension ≤50 mm); 23 (38%) had category B (combined dimension >50 mm but not exceeding equivalent area of right upper lung zone); and six (10%) had category C (size larger than category B).[§] All

60 patients had radiographic evidence of pneumoconiosis, including 12 (20%) with a small opacity profusion classified as major category 1, 30 (50%) classified as major category 2, and 18 (30%) classified as major category 3. Seven patients had large, rounded opacities, a finding associated with silicosis lung pathology (4). Twenty-six patients reported being roof bolters (persons who install the bolts that support the roof of an underground coal mine) for most of their careers, and 20 reported being operators of continuous miners, a type of mining machine that produces a constant flow of coal or other solid material from the working face of the mine (Figure 2).

Discussion

The voluntary Coal Workers' Health Surveillance Program stipulates that active coal miners be offered no-cost medical monitoring that includes a chest radiograph at entry into coal mining and then at approximately 5-year intervals. During August 2011–July 2016, a total of 99 unique cases of PMF were detected nationwide by the Coal Workers' Health Surveillance Program, including 19 in Kentucky residents. Although surveillance data have indicated a resurgence of PMF in recent years (Figure 1), this large cluster of cases brought to the attention of NIOSH by a single local radiologist was not discovered through the national surveillance program offered to active miners. The finding in the current report of 56 cases among Kentucky residents indicates that many cases were not identified through routine national surveillance; however, this finding is consistent with historically low Coal Workers' Health

[§]Radiographs for the pneumoconiosis are classified by small opacity profusion and large opacity size, compared with standard radiograph images from the International Labour Office. Large opacities are classified as category A, B, or C. Small opacity profusion is classified into four major categories (0, 1, 2, 3), with category 1 or higher considered to be radiographic evidence of pneumoconiosis (<http://www.cdc.gov/niosh/topics/chestradiography/breader.html>).

The *MMWR* series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. *MMWR Morb Mortal Wkly Rep* 2016;65:[inclusive page numbers].

Centers for Disease Control and Prevention

Thomas R. Frieden, MD, MPH, *Director*
Harold W. Jaffe, MD, MA, *Associate Director for Science*
Joanne Cono, MD, ScM, *Director, Office of Science Quality*
Chesley L. Richards, MD, MPH, *Deputy Director for Public Health Scientific Services*
Michael F. Iademarco, MD, MPH, *Director, Center for Surveillance, Epidemiology, and Laboratory Services*

MMWR Editorial and Production Staff (Weekly)

Sonja A. Rasmussen, MD, MS, *Editor-in-Chief*
Charlotte K. Kent, PhD, MPH, *Executive Editor*
Jacqueline Gindler, MD, *Editor*
Teresa F. Rutledge, *Managing Editor*
Douglas W. Weatherwax, *Lead Technical Writer-Editor*
Soumya Dunworth, PhD, Teresa M. Hood, MS,
Technical Writer-Editors

Martha F. Boyd, *Lead Visual Information Specialist*
Maureen A. Leahy, Julia C. Martinroe,
Stephen R. Spriggs, Moua Yang, Tong Yang,
Visual Information Specialists
Quang M. Doan, MBA, Phyllis H. King, Terraye M. Starr,
Information Technology Specialists

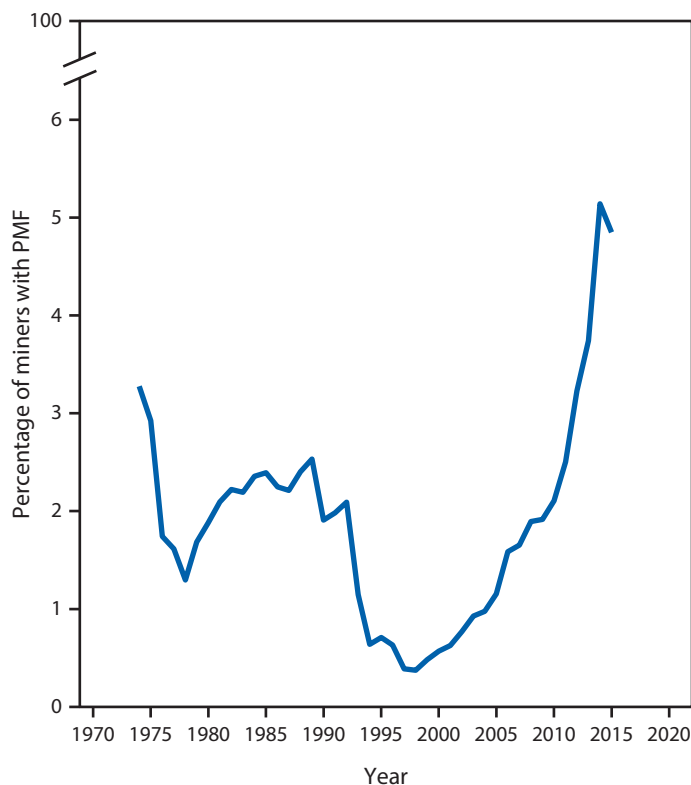
MMWR Editorial Board

Timothy F. Jones, MD, *Chairman*
Matthew L. Boulton, MD, MPH
Virginia A. Caine, MD
Katherine Lyon Daniel, PhD
Jonathan E. Fielding, MD, MPH, MBA
David W. Fleming, MD

William E. Halperin, MD, DrPH, MPH
King K. Holmes, MD, PhD
Robin Ikeda, MD, MPH
Rima F. Khabbaz, MD
Phyllis Meadows, PhD, MSN, RN
Jewel Mullen, MD, MPH, MPA

Jeff Niederdeppe, PhD
Patricia Quinlisk, MD, MPH
Patrick L. Remington, MD, MPH
Carlos Roig, MS, MA
William L. Roper, MD, MPH
William Schaffner, MD

FIGURE 1. Prevalence of progressive massive fibrosis (PMF)* among underground-working coal miners with ≥ 25 years of underground mining tenure — Coal Workers' Health Surveillance Program, Kentucky, Virginia, and West Virginia, 1974–2015



Source: Blackley DJ, Halldin CN, Laney AS. Resurgence of a debilitating and entirely preventable respiratory disease among working coal miners. *Am J Respir Crit Care Med* 2014;190:708–9. Adapted with permission.

* Data are 5-year moving average (e.g., data plotted for 1974 = $[PMF_{1970} + PMF_{1971} + PMF_{1972} + PMF_{1973} + PMF_{1974}] / [Total\ participants_{1970-1974}]$); surveillance is conducted on a 5-year national cycle.

Surveillance Program participation rates among Kentucky coal miners: during 2011–16 only 17% of Kentucky coal miners participated (personal communication, Coal Workers' Health Surveillance Program data, October 5, 2016).

The factor or combination of factors that led to this increase in cases of PMF in eastern Kentucky and whether there are more unrecognized cases in neighboring coal mining regions are unknown. Because PMF takes years to become manifest, the specific exposures or mining practices that led to these cases are also unknown. New or modified mining practices in the region might be causing hazardous dust exposures. While obtaining detailed occupational histories, the reporting physician identified the practice of “slope mining” (5) as a potential exposure in eastern Kentucky (slope mining involves teams of miners operating continuous miner machines, designed to cut coal and other soft rock, to cut shafts through hundreds of feet of sandstone to reach underground coal seams) (Figure 2). The sandstone formation underlying eastern Kentucky is >90%

FIGURE 2. Photographs of workers and equipment under typical conditions in an underground coal mine*



* A. Two miners use a roof-bolting machine to install the bolts that support the roof of an underground coal mine. B. A continuous miner machine extracts coal from the mine face with a rotating drum.

quartz (6), and dust generated during the slope cutting could expose miners to hazardous dust containing high concentrations of respirable crystalline silica. Previous research found that 25 of 37 (68%) Kentucky and Virginia coal miners with “advanced pneumoconiosis” (defined as PMF or simple coal workers’ pneumoconiosis with high small opacity profusion) reported working as roof bolters, a mining job associated with high silica dust exposure (7). The current investigation was limited to miners with PMF and found that 26 (43%) reported working as roof bolters, and 20 (33%) reported working as continuous miner operators. Operating a continuous miner machine has typically been considered a “coal-face position” (i.e., a work position located at the face, or seam, of coal), and therefore not a position usually associated with higher silica dust exposures.

However, the use of a continuous miner machine during shaft cutting or thin seam coal mining (i.e., occurring when the height of the coal seam requires that rock above and below the coal seam is cut along with the coal) requires cutting through rock and creates the potential for respirable silica exposures, which might explain why working as a continuous miner operator could pose an increased risk for PMF.

In addition, recent industry trends might have led to a higher number of miners seeking radiographs, either to gather information about their health status or to seek benefits through state workers' compensation or federal black lung programs. A steep decline in coal miner employment and coal production during recent years has occurred (8), with 1,501 jobs lost in Kentucky (17.9% of state coal workforce) during the first quarter of 2016. Miners might feel that future coal-related employment is unlikely and that previous barriers to health-seeking behaviors have been removed. For example, in Kentucky a miner has 3 years to file a state compensation claim "after the last injurious exposure to the occupational hazard or after the employee first experiences a distinct manifestation of an occupational disease in the form of symptoms reasonably sufficient to apprise the employee that he or she has contracted the disease, whichever shall last occur."[‡] Because the earlier stages of coal workers' pneumoconiosis can be associated with few or no overt symptoms, and because coal mining jobs have historically been among the best-paying in the region, some miners might have chosen to not seek radiographs or other health-related information during the earlier stages of their career to avoid threatening their ability to continue working in the industry.

The findings in this report are subject to at least three limitations. First, the cases highlighted in this report represent the recent experience of one single-radiologist practice in eastern Kentucky and might underestimate the actual extent of PMF in coal miners in the broader region. Second, classifications of chest radiographs were performed by a single B Reader, who was aware of miners' occupational histories and other clinical data, such as results of chest computed tomography scans. For classifications performed for worker monitoring and surveillance, NIOSH recommends that a single reader is generally sufficient, particularly for radiographs that are clearly normal or abnormal. However, for radiographs with findings at the boundary between normal and abnormal, or for settings such as epidemiologic research or contested proceedings where it is important to ensure a high degree of accuracy, NIOSH recommends summary classifications derived from multiple independent readers (3) and is taking measures to obtain independent confirmation of the classifications by sending them to additional B-readers. Finally,

[‡] <http://www.lrc.ky.gov/statutes/statute.aspx?id=32472>.

Summary

What is already known about this topic?

The prevalence of coal workers' pneumoconiosis fell precipitously after implementation of the Coal Mine Health and Safety Act and reached historic lows in the 1990s, with the most severe form, progressive massive fibrosis (PMF), nearly eradicated. Since that time, increases in the prevalence and severity of coal workers' pneumoconiosis have occurred, especially in central Appalachia.

What is added by this report?

During January 1, 2015–August 17, 2016, a total of 60 patients identified through a single radiologist's practice had radiographic findings consistent with PMF; 49 had their radiograph taken during 2016. Surveillance data have indicated a resurgence of PMF in recent years, but the cases described in this report represent a large cluster not discovered through routine surveillance.

What are the implications for public health practice?

Effective dust control, enhanced educational outreach, and improved surveillance are needed to protect the respiratory health of U.S. coal miners.

cases in this report were not identified through standard coal workers' pneumoconiosis surveillance, and whether similar clusters of cases exist in other communities is not known. Thus, the actual extent of PMF in U.S. coal miners remains unclear. Because the cases described in this report were identified during a span of fewer than 2 years and previous radiographs were not available, it was not possible to ascertain the time of PMF onset for these patients.

Although PMF is preventable through well-established dust control practices, each of the 60 patients in this report was exposed to coal mine dust over a period of years in an amount sufficient to cause this severe disease. Finding these cases in such a small geographic area is a strong signal that action is needed in the area to identify existing cases at an earlier stage and prevent future cases. A new federal rule has been implemented to protect all U.S. coal miners through expansion of medical surveillance, including respiratory symptom assessment and spirometry testing (9). The rule also mandates lowering the amount of respirable dust allowed in U.S. coal mines and the use of a continuous personal dust monitor, a device that can measure respirable coal mine dust in real time. Availability of real-time respirable dust measurements, lower exposure limits, and expanded medical surveillance are intended to prevent future cases and identify early signs of respiratory impairment in coal miners before a disabling condition has developed.

The findings in this report serve as a reminder that more than 45 years after the Coal Act's passage, one of its core objectives has not been achieved. In the coming years, NIOSH will focus active surveillance measures on miners in central Appalachia and will continue to work with miners, mine

operators, regulatory and disability compensation agencies, and others to better characterize the scope of the problem, expand educational outreach to miners to increase their awareness of the right to confidential medical screening, and prevent over-exposures to coal mine dust.

Acknowledgments

Heather Wilson, United Medical Group; the NIOSH Coal Workers' Health Surveillance Program; participating miners.

¹Respiratory Health Division, National Institute for Occupational Safety and Health, CDC; ²United Medical Group, Pikeville, Kentucky.

Corresponding author: David J. Blackley, dblackley@cdc.gov, 304-285-6379.

References

- Blackley DJ, Halldin CN, Laney AS. Resurgence of a debilitating and entirely preventable respiratory disease among working coal miners. *Am J Respir Crit Care Med* 2014;190:708–9. <http://dx.doi.org/10.1164/rccm.201407-1286LE>
- Laney AS, Weissman DN. Respiratory diseases caused by coal mine dust. *J Occup Environ Med* 2014;56(Suppl 10):S18–22. <http://dx.doi.org/10.1097/JOM.0000000000000260>
- National Institute for Occupational Safety and Health. Chest radiography. Atlanta, GA: US Department of Health and Human Services, CDC, National Institute for Occupational Safety and Health; 2011. <http://www.cdc.gov/niosh/topics/chestradiography/>
- Laney AS, Petsonk EL, Attfield MD. Pneumoconiosis among underground bituminous coal miners in the United States: is silicosis becoming more frequent? *Occup Environ Med* 2010;67:652–6. <http://dx.doi.org/10.1136/oem.2009.047126>
- Kentucky Geological Survey. Methods of mining. Lexington, KY: University of Kentucky, Kentucky Geological Survey; 2012. https://www.uky.edu/KGS/coal/coal_mining.htm
- Rice CL. Sandstone units of the Lee Formation and related strata in eastern Kentucky. Professional Paper 1151-G. Washington, DC: US Department of the Interior, US Geological Survey; 1984. <https://pubs.usgs.gov/pp/1151g/report.pdf>
- CDC. Advanced pneumoconiosis among working underground coal miners—Eastern Kentucky and Southwestern Virginia, 2006. *MMWR Morb Mortal Wkly Rep* 2007;56:652–5.
- Kentucky Department for Energy Development and Independence. Kentucky Quarterly Coal Report (Q1–2016). Frankfort, KY: Kentucky Department for Energy Development and Independence; 2016. [http://energy.ky.gov/Coal%20Facts%20Library/Kentucky%20Quarterly%20Coal%20Report%20\(Q1-2016\).pdf](http://energy.ky.gov/Coal%20Facts%20Library/Kentucky%20Quarterly%20Coal%20Report%20(Q1-2016).pdf)
- Lowering Miners' Exposure to Respirable Coal Mine Dust, Including Continuous Personal Dust Monitors. 79 FR 24813 (2014). <https://www.federalregister.gov/documents/2014/05/01/2014-09084/lowering-miners-exposure-to-respirable-coal-mine-dust-including-continuous-personal-dust-monitors>