Grant Number: AFC417-1

Title: Characteristics of Dust and Risk Factors Associated with the Development of Rapidly Progressive Pneumoconiosis and Progressive Massive Fibrosis

Organization: University of Illinois

Principal Investigator(s): Robert A. Cohen

Partnerships: NIOSH, USGS, National Jewish Health Institute

Focus Area: Injury and Disease Exposure and Risk Factors

Topical Area: Respiratory Disease

SYNOPSIS

Research Topic and Problem Statement: Since the mid-1990s, research studies and surveillance reports have documented a significant increase in coal workers' pneumoconiosis (CWP), including the most severe forms of progressive massive fibrosis (PMF) (1) and rapidly progressive pneumoconiosis (RPP) (2), in U.S. coal miners. Alarmingly, many cases are occurring in younger miners. The Appalachian coalfields appear to be particularly affected (3,4). There are several possible explanations for these observations, including excessive exposures to respirable dust and increased exposure to particular dust constituents (e.g., freshly fractured silica and silicates, or greater exposure to smaller particles) that may be the result of changing mining practices (5,6). However, to date the causal links between specific exposure characteristics and the increase in cases of RPP and PMF have not been elucidated, with the result that current protections for active mine workers may not be adequate. The main goal of this study is to characterize the biologically relevant exposures, based on lung tissue mineralogy linked to mine dust and miner exposure characteristics, associated with CWP in its most severe forms.

Holistic Approach: A multidisciplinary approach is essential to understand the relationship between contemporary mine dust exposures and the recent increase in severe disease, in order to identify and ultimately mitigate risk factors. This project brings together experts in mining engineering, mineral science, pulmonology, occupational medicine, pathology, and epidemiology, and includes three primary research components: 1) characterization of occupational exposures, medical history, lung physiology, and chest imaging findings for miners with RPP and PMF; 2) determination of dust burden and biologic response features in lung tissues from miners with RPP and PMF; and 3) characterization of respirable dust exposures for contemporary mining tasks, methods, and mine environments that are similar to those reported by miners with RPP and PMF.

Lung tissue specimens will be selected from a recently developed Miners Lung Disease registry, which contains clinical and exposure information on individuals with RPP and PMF. Tissue blocks from historical cases of coal workers' pneumoconiosis (CWP) from in the National Coal Workers' Autopsy Study (NCWAS), will be made available by NIOSH and serve as historical referent cases. Traditional and newer analytical approaches will be used to define pathologic and mineralogic features of the lung tissues. We will employ light microscopy to characterize the pathologic lesions as well as scanning electron microscopy and energy dispersive x-ray spectroscopy (SEM/EDS) to identify specific mineral particles in situ associated with disease. SEM/EDS will be used to characterize dust particles, by shape, size and mineralogy following lung digestion. Mass spectrometry (MS) will be used to detect metals and other trace elements in the lung digestates.

Under the third research component, dust samples from representative mine environments will be characterized and compared to lung tissue dust. SEM/EDS will be used to determine particle morphology, and mineralogic distributions, and MS analysis to explore potentially bioaccessible metals and other trace elements. Finally, findings from these three research components will be integrated to identify critical factors associated with development of RPP and PMF. This project represents the first attempt to link mine dust exposure characteristics, clinical findings, pathologic responses, and lung dust characteristics to study this disease.

Proposed Outcome and Impact on Mining Health and Safety: A key outcome of this project will be the identification of specific risk factors (i.e. mine dust components, mine geology, and host risk factors) for development of RPP and PMF. Heretofore, cited risk factors have been fairly general (i.e., coal rank, job title) and/or speculative (i.e., mine seam height). While the project will focus primarily on coal miners, our results (e.g., with respect to exposure to particular minerals and particle sizes) will inform risks to other mining populations. The primary impact of our work will be advances in our understanding of the most serious risk factors for disease, which will provide a basis for targeted interventions in exposure control and miner protection. The support of this proposal by NIOSH, miner's unions and coal companies illustrates the broad concerns about this issue and the desire to find solutions that benefit the workers, their communities, and the mining industry.