A Critical Review of the Paper "Coal workers' pneumoconiosis in the United States: regional differences 40 years after implementation of the 1969 Federal Coal Mine Health and Safety Act" by Surathana, E., Laney, A.S., Storey, E., et al.

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Summary and Comments on Surathana, E., Laney, A.S., Storey, E., et al. "Coal workers' pneumoconiosis in the United States: regional differences 40 years after implementation of the 1969 Federal Coal Mine Health and Safety Act". Occup Environ Med (2011) Published online.

We offer the following critique of a recent paper authored by scientists from the National Institute for Occupational Safety and Health ("NIOSH") that has yet to be published in hard copy in the medical literature but has been published online in the journal *Occupational and Environmental Medicine* entitled, "Coal workers' pneumoconiosis in the United States: regional differences 40 years after implementation of the 1969 Federal Coal Mine Health and Safety Act".[1] This paper is a most important contribution to the coal dust literature which examines whether the recently reported increases in the prevalence of coal workers' pneumoconiosis ("CWP") among underground U.S. coal miners is related to coal mine dust ("CMD") exposures. The study found regional differences in the prevalence of CWP that could not be explained by respirable dust measurements from inspections conducted by the Mine Safety and Health Administration ("MSHA"). In particular, the prevalence of CWP in the MSHA coal mine safety and health districts ("MSHA districts") of southern West Virginia, western Virginia and eastern Kentucky, referred to in the paper as the central Appalachian region, was considerably higher than the prevalence estimated using a published exposure-response model from a large epidemiological study among US coal miners using dust exposure, tenure, miner's age and coal rank as predictors.[2]

Specifically, the NIOSH researchers conducted this study to assess whether the recent increases in the prevalence of CWP in the USA reflect increased measured exposures over recent decades, and to identify other potential causative factors for the observed increased CWP prevalence. The NIOSH researchers noted that following passage of the 1969 Coal Mine Safety and Health Act, the overall CWP prevalence among underground coal miners declined from 11.2% for the period 1970-1974 to 2.0% for 1995-1999. Beginning around 2000, NIOSH reported that the prevalence of CWP had increased to 3.3% for the 2005-2006 period.[3] This increased prevalence of CWP since 2000 led NIOSH, with assistance from MSHA, to intensify coal miner surveillance efforts and epidemiological studies through the introduction of an enhanced surveillance program to find explanations for the increasing trend. The MSHA program was called the Miners' Choice Health Screening program ("MCP") and the NIOSH counterpart was called the Enhanced Coal Workers' Health Surveillance Program ("ECWHSP"). These programs sought to increase program participation rates in CWP 'hot spot' locations by use of a mobile examination unit to

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[1] Suarthana E, Laney AS, Storey E, et al. Coal workers' pneumoconiosis in the United States: regional differences 40 years after implementation of the 1969 Federal Coal Mine Health and Safety Act. Occup Environ Med published online May 19, 2011.

[2] Attfield MD, Morring K. An investigation into the relationship between coal workers' pneumoconiosis and dust exposure in U.S. coal miners. Am Ind Hyg Assoc J 1992;53:486-92.

[3] National Institute for Occupational Safety and Health. Coal Workers' Health Surveillance Program (CWHSP). 2010. http://www.cdc.gov/niosh/topics/ surveillance/ORDS/CoalWorkersHealthSurvProgram.html (accessed 15 Mar 2011).

obtain radiographs at or near mine sites.[4] According to NIOSH, the studies from these efforts identified changes in the epidemiology and clinical disease course of pneumoconiosis among coal miners characterized by an increased disease severity, geographical clustering in eastern Kentucky and southwestern Virginia, rapid disease progression, advanced disease in younger miners, more prevalent disease in small mines (< 50 miners), and a possible relationship with excessive exposures to concentrations of crystalline silica.[5 6 7 8 9]

NIOSH considered that these studies clearly demonstrated a troubling excess of respiratory disease in US coal miners in recent years. However, the Agency acknowledged that many questions remained unanswered as to what were the most important factors contributing to the recent trends in pneumoconiosis. To elucidate some of these potential factors NIOSH conducted the current study to relate the dust exposure data from the MSHA Standardized Information System ("MSIS") with the medical data from the Coal Workers Health Surveillance Program ("CWHSP"). As described, the primary objective of the analysis was to assess whether the increases in disease is reflected in increased exposures over recent decades and to examine additional factors of potential importance that have previously gone unreported.

The study included underground miners examined from 1 January 2005 to 31 December 2009 in the CWHSP from MSHA Districts 2 through 10. MSHA District 1 was not included since it is an anthracite coal region and had few miners participating in the surveillance program. In addition to radiograph readings, data from the CWHSP included miner age and tenure, coal type, mine size (*i.e.*, the number of underground miners per mine) and mine location. Data from the MSHA MSIS database included seam height and hours worked per miner per year were obtained from MSIS for the same time period. Inspector-collected coal mine dust concentration data at mine level were obtained from MSIS for the period 1970-2008. Predicted CWP prevalence was estimated using the Attfield and Morring exposure-response model that has been used in other NIOSH studies of coal miners.[10]

Of particular interest to the NIOSH researchers in this study were MSHA districts 4-7, comprising southern West Virginia (District 4);western Virginia (District 5); eastern Kentucky (District 6); and central Kentucky, North Carolina, South Carolina and Tennessee (District 7) previously identified by NIOSH as 'hot spots' for CWP. The NIOSH researchers noted that the

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[4] It needs to be stated that while both of these programs were successful as a public health measure that they could have biased participation of eligible miners and be another factor for the increased prevalence beginning around 2000. More on this provided later in our comments.

[5] Antao VC, Petsonk EL, Sokolow LZ, et al. Rapidly progressive coal workers' pneumoconiosis in the United States: geographic clustering and other factors. Occup Environ Med 2005;62:670-4.

[6] Centers for Disease Control and Prevention. Pneumoconiosis prevalence among working coal miners examined in federal chest radiograph surveillance programs United States, 1996-2002. MMWR Morb Mortal Wkly Rep 2003;52:336-40.

[7] Centers for Disease Control and Prevention. Advanced cases of coal workers' pneumoconiosis--two counties, Virginia, 2006. MMWR Morb Mortal Wkly Rep 2006;55:909-13.

[8] Centers for Disease Control and Prevention. Advanced pneumoconiosis among working underground coal miners in Eastern Kentucky and Southwestern Virginia, 2006. MMWR Morb Mortal Wkly Rep 2007;56:652-5.

[9] Pollock D, Potts J, Joy G. Investigation into dust exposures and mining practices in the southern Appalachian region. Mining Engineering 2010;62:44-9.

[10] Attfield MD, Morring K. An investigation into the relationship between coal workers' pneumoconiosis and dust exposure in U.S. coal miners. Am Ind Hyg Assoc J 1992;53:486-92.

observed CWP prevalence exceeded that predicted in miners aged 40 years and older in MSHA districts 4-7, while the other five districts showed the opposite with observed prevalences below predicted. Moreover, high CWP prevalence (two-four-fold higher than predicted) was observed among young miners aged 40-49 years in MSHA districts 4-7 and not in the other five districts. Figure 1 below from the NIOSH paper shows the observed CWP prevalence (black bars) versus the predicted CWP prevalence (gray bars) in underground coal miner participants in the CWHSP stratified by MSHA district for the period 2005-2009. Observed prevalence was significantly higher than predicted in MSHA districts 4-7 and significantly lower than predicted in other districts.

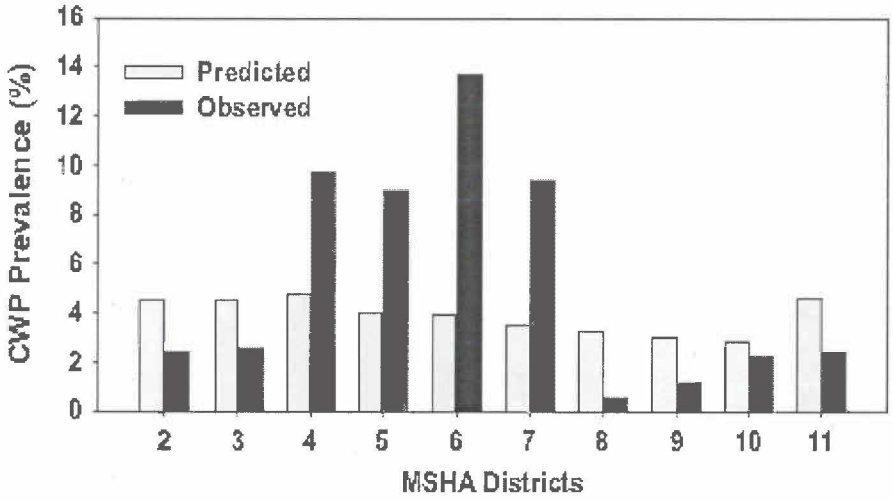

Figure 1 The observed CWP prevalence (black bars) versus the predicted prevalence (grey bars) over MSHA districts in underground coal miners who participated in the CWHSP for period 2005-2009.

For other analyses the NIOSH authors aggregated MSHA districts 4-7 (the central Appalachian region) versus other regions. The overall observed and predicted CWP prevalences were 10.1% and 4.2% in the central Appalachian region (prevalence ratio 2.4; $p<0.001$) and 1.6% and 3.6%, respectively in other regions (prevalence ratio 0.4; $p<0.001$). When the analysis was restricted to miners with over 20 years of tenure, the same pattern was observed with 14.9% observed prevalence compared to the 5.2% predicted in the central Appalachian region (prevalence ratio 2.9; $p<0.001$) in contrast to the other regions where the observed prevalence was 3.4% compared to the 5.4% predicted (prevalence ratio 0.6; $p<0.001$).

The NIOSH investigators observed that MSHA Districts 4-7 with excessive CWP had lower coal seam heights than the other districts. The central Appalachia region had a median seam height of 60 inches (range 26-138) inches compared with a 79 inch median seam (range 31-168) inches ($p<0.001$).

Thin seam mining is common in the central Appalachia region which poses particular difficulties because the rock surrounding the coal seam often has to be cut to permit equipment to be employed effectively. Pollock, et al. noted that MSHA inspectors reported that rock cutting in the central Appalachian region was a common occurrence and those operations mined through substantial rock layers to maintain roof height.[11] Thickness of rock in five mines ranged from 6-12 inches and one mine was cutting through three feet of rock. A large amount of rock (20-30% of mine output) was being cut in these mines and the mines in this region had the highest percentage of mines with respirable dust containing more than 5% quartz. Cutting through this much rock has to appreciably contribute to the quartz exposure of these miners increasing their risk of developing silicosis. Another NIOSH study by Laney, et al. conducted among coal miners from Kentucky, Virginia and West Virginia, showed that the proportion of radiographs showing r-type opacities, which are typically associated with silica dust exposures, increased in the 1990s and 2000s compared to the 1980s.[12] This important factor of the contribution of quartz in producing cases of silicosis being identified as CWP has not been adequately studied by NIOSH.

Another factor investigated by the NIOSH researchers was mine size. NIOSH researchers recently reported that CWP and PMF were more prevalent in miners from mines with fewer than 50 employees than from larger mines after adjustment for age and within-miner[13] correlation.[14] The average number of employees was 72 in the Appalachian MSHA districts compared to 273 elsewhere. This finding lends support to the previous NIOSH work that mine size is a possible factor contributing to the increased pneumoconiosis prevalence in the central Appalachian region.

The NIOSH researchers concluded that the observed prevalence of CWP substantially exceeded predicted levels in central Appalachia, and that the increased prevalence was not explained by the measured levels of dust exposures, reported tenure, age or coal rank. Coal seam height and mine size were likely factors contributing to this observation.

Additional Comments and Critique of Surathana, E., Laney, A.S., Storey, E., et al. (2011)

A factor that has not been examined or commented on by NIOSH or MSHA in the recent database demonstrating an increased prevalence in CWP, which is used in the Notice of Proposed Rulemaking as support for lowering the CMD exposure limit, is a potential ascertainment bias of cases of CWP resulting from the MSHA MCP and the NIOSH ECWHSP. In medical statistics, ascertainment bias is when a sample is collected in such a way that some members of the intended population are more, or less, likely to be included than others. It results in a biased sample, a non-random sample of the population being studied in which all individuals were not equally likely to have been selected. If this is not accounted for, results can be erroneously attributed to the phenomenon under study rather than to the method of sampling.

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[11] Pollock D, Potts J, Joy G. Investigation into dust exposures and mining practices in the southern Appalachian region. Mining Engineering 2010;62:49.

[12] 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.

[13] Some miners had multiple radiographs over the period of the study.

[14] Laney AS, Attfield MD. Coal workers' pneumoconiosis and progressive massive fibrosis are increasingly more prevalent among workers in small underground coal mines in the United States. Occup Environ Med 2010;67:428-31.

The type of bias that could be functioning in the NIOSH X-ray studies of coal miners is termed a self-selection bias. Such a bias is possible whenever the group of people being studied has any form of control over whether to participate. If the miner's decision to participate is correlated with a factor that affects the study, then the participating miners are a non-representative sample. For example, the MCP was a special MSHA initiative that ran concurrently with the NIOSH CWHSP, but the examinations were paid for by MSHA, MSHA had a public relations effort encouraging miners to participate, and MSHA communicated the results of the testing to the miners. Unlike the NIOSH CWHSP, the MCP operated independently of coal mine operators. Thus, if a miner's choice to participate in the MCP was influenced by factors such as examinations being independent of coal mine operators, or because of the MSHA health promotion effort, or because of an individual experiencing respiratory symptoms, the prevalence data could be biased. The MCP was carried out at 444 underground mines. Results for the numbers participating in the MCP could not be found on the MSHA website but from a presentation by Melinda Pon at the American Industrial Hygiene Conference and Exposition in 2005, we interpolate that approximately 7,000, 1,000 and 500 miners participated in the MCP for the years 2000, 2001 and 2002, respectively.[15]

In response to the observed onset of advanced pneumoconiosis among younger coal miners, and the apparent regional clustering of rapidly progressive cases, NIOSH, in collaboration with MSHA, developed, staffed, and implemented the ECWHSP. Surveys were completed that included specifically designed standardized health questionnaires, work histories, spirometry testing, radiographic examinations, and collection of other relevant health information, which are gathered in a specially designed mobile examination unit by trained personnel. The mobile examinations and encouragement from NIOSH staff to participate likely influenced a miner's decision to participate and biased the results for comparison with previous rounds of X-ray examinations. The enhanced program by NIOSH had 1476, 3299, 1113 and 689 miner participants for the years 2006, 2007, 2008 and 2009, respectively.

Both the MCP and ECWHSP were successful in increasing miners' participation in the medical surveillance program and as such are laudable public health objectives; however, caution must be exercised in interpreting the database and comparing these data to past rounds of examinations for assessing trends in prevalence data.

The increased prevalence first noted around 2000 could also be related to MSHA and NIOSH oversampling hot spots of disease in the central Appalachian region. NIOSH noticed that the increase in CWP occurrence appears to be concentrated in hot spots of disease mostly concentrated in the central Appalachian region of southern West Virginia, eastern Kentucky, and western Virginia. To gain a better understanding of the increased CWP prevalence, NIOSH undertook a series of field surveys in the hot spot regions in an attempt to enhance the quality of data (i.e., improve participation).[16] The field surveys were undertaken as part of the Coal Workers' X-ray Surveillance Program ("CWXSP") administered by NIOSH, as mandated by the 1969 Coal Mine Act. The targeted surveys comprised an "Enhanced Program" to complement the regular CWXSP program. A conclusion of the NIOSH investigation was that the pattern of CWP occurrence across the nation is not uniform and that hot spots of disease appear to be concentrated in the central Appalachian region.

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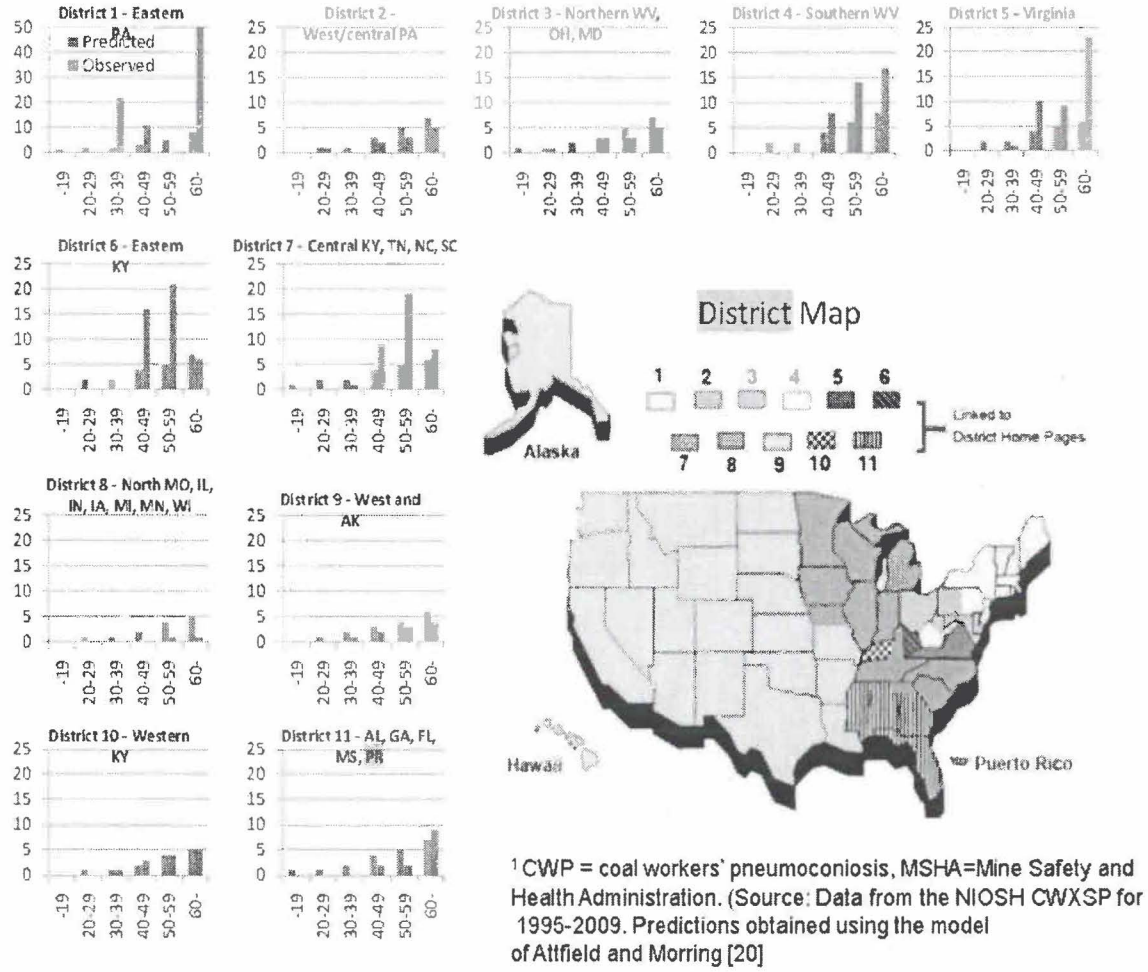
[15] Pon, Melinda, Coal Miners' Health Update, MSHA, American Industrial Hygiene Conference and Exposition, Anaheim, CA, 2005. Last accessed May 9, 2011, http://www.aiha.org/aihce05/handouts/rt220pon.pdf.
[16] NIOSH CIB

Similar to the analyses in the Surathana, et al. paper, NIOSH examined observed and predicted prevalences by MSHA District in its Current Intelligence Bulletin, "Coal Mine Dust Exposures and Associated Outcomes" and Figure 9 of the paper (reproduced below) illustrates quite remarkably how dissimilar the observed and predicted prevalences are by MSHA District. Because the districts from the central Appalachian region are so heavily weighted with radiographic cases of CWP the ECWHSP and the MCP likely oversampled miners from these endemic areas of CWP. If so, these likely influenced the national prevalence data and, on the whole, there is likely no increase in CWP among coal miners nationwide. Rather than gain a better understanding as intended by NIOSH in conducting this examination it is possible they have now taken a myopic view of the CWP problem.

Figure 9. Observed and predicted prevalences (%) of CWP category 1+ by age group and MSHA District.[1]



[1] CWP = coal workers' pneumoconiosis, MSHA=Mine Safety and Health Administration. (Source: Data from the NIOSH CWXSP for 1995-2009. Predictions obtained using the model of Attfield and Morring [20]

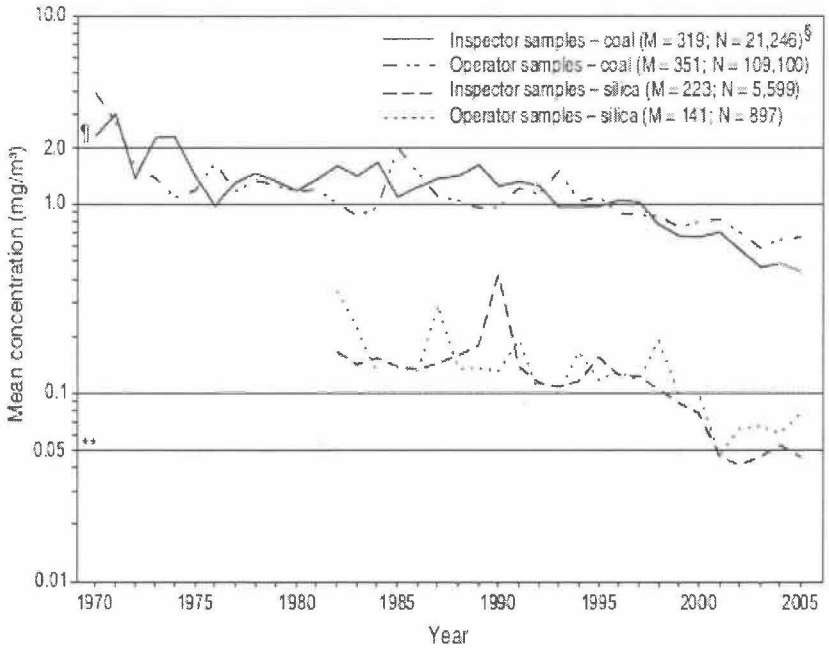
A factor that has been discussed by NIOSH as a reason for the increased CWP in the central Appalachian region is the likelihood of concurrent excessive high exposure to crystalline silica (quartz) in the dust aerosol produced when mining in this region. The region is geologically characterized by thin coal seams that require significant cutting of rock to maintain roof height to allow room for the machinery to operate. Depending on the rock strata the quartz content of the

rock being cut can be 70% or more in the case of a sandstone formation. Another indication that quartz exposure is a significant factor in the region is the NIOSH study that found that the radiographic opacities observed in coal miners from Kentucky, Virginia and West Virginia, showed that the proportion of radiographs showing r-type opacities, which are typically associated with silica dust exposures, increased in the 1990s and 2000s compared to the 1980s.

Further evidence that quartz exposures are significant in the region can be found in the paper "Advanced cases of coal workers' pneumoconiosis--two counties, Virginia, 2006" reported in the *Morbidity and Mortality Weekly Reporter*.[17] The report described what are said to be 11 cases of advanced CWP in two counties of Virginia. However as can be seen from the Figure in the paper (reproduced below) CMD levels in these two counties were below the standard from 1970 to 2005, and were below the NIOSH Recommended Exposure Limit ("REL") of 1.0 mg/m^3 since 1995. On the other hand, sampling for quartz began in the early-1980s and average concentrations remained above the standard of 0.1 mg/m^3 until about 1998. About 65% of quartz samples collected in 1982-2000 exceeded the NIOSH REL for crystalline silica of 0.05 mg/m^3; only since 2001 have mean county levels been below the NIOSH REL for silica. When average quartz levels are above the MSHA exposure limit by a factor of two to four for 18-years, while CMD is consistently under the MSHA exposure limit for 32-years it is highly likely the pneumoconiosis observed is silicosis and not advanced CWP.

[17] Centers for Disease Control and Prevention. Advanced cases of coal workers' pneumoconiosis--two counties, Virginia, 2006. MMWR Morb Mortal Wkly Rep 2006;55:909-13.

FIGURE. Mean concentrations of respirable coal mine dust and crystalline silica in coal mine dust* for underground workers at the coal face† — Lee and Wise counties, Virginia, 1970–2005



* Data from Mine Safety and Health Administration (MSHA) coal mine inspector and mine operator samples.

† The cutting surface where coal is sheared from the wall and dust levels typically are greatest.

§ M = number of mines sampled; N = number of samples taken.

¶ MSHA permissible exposure limit for coal mine dust with <5% silica content.

** National Institute for Occupational Safety and Health recommended exposure limit for crystalline silica in coal mine dust.

While additional studies are needed to confirm that quartz is the primary causative factor in these cases in the central Appalachian region, the evidence is nonetheless convincing that the rapidly progressive cases of pneumoconiosis being reported are silicosis which is based on very high quartz exposures and short latency, both factors clearly being consistent with silicosis and unlike CWP. The higher proportion of r-type opacities in the SAR than in the rest of the US is likewise consistent with a silicosis interpretation. Other factors also related to increased quartz exposures include working in small mines, increased hours worked per day, and smaller coal seams.

Conclusion

The new study by Surathana, et al. is a most important contribution to the coal mine dust medical literature and pinpoints a number of factors likely responsible for the recent assertions that the CMD standard is not protective of miners' health and needs to be reduced. These deficiencies are identified above and are outlined below. Along with other comments we have submitted to the docket, this critique points out flaws in the NPR that necessitate MSHA and NIOSH to engage in

additional studies and analyses to determine if the scientific weight of the evidence truly supports a lowering of the CMD exposure limit. In summary, an exposure-response model, previously used in NIOSH epidemiology studies, and MSHA inspector dust data, failed to predict radiographic CWP risks by MSHA District. Specifically, the predicted prevalence from the model for MSHA Districts in southern West Virginia, western Virginia and eastern Kentucky (MSHA Districts 4, 5 and 6, respectively), along with District 7 (Central Kentucky, Tennessee, North and South Carolina) was significantly higher than NIOSH observed from its X-ray surveillance program database from these areas. Conversely, for other MSHA Districts (1, 2, 3, 8, 9 10 and 11) the model under predicted the radiographic prevalence from the NIOSH X-ray database. MSHA Districts 4, 5, 6 and 7 have been identified as hot spots for increased prevalence of CWP by NIOSH and MSHA. The results from this paper point toward factors other than respirable CMD being responsible for the increased prevalence of CWP in this region.

The most compelling explanation for the observed discrepancy in the paper is that excess quartz exposures are responsible for the increased pneumoconiosis in the region and that the disease endpoint is silicosis and not CWP, or a mixed-dust combination of silicosis and CWP lesions with quartz exposure being the more important contribution to radiographic evidence of disease. Indeed, NIOSH has investigated these factors in a number of studies but has failed to single out quartz exposure as the most important cause. The evidence that points to quartz as the guilty party includes both regional geological characteristics and disease characteristics:

Geological Characteristics. Several geological factors emphasize quartz as a plausible explanation for the central Appalachian region being a geographic "hot-spot" area for clustering of quartz-related silicosis cases. Increased mining has reduced available coal in the most easily accessible coal seams. The high demand for coal, its increasing price and increasingly productive equipment for extracting and cleaning coal has led to mining thinner and thinner seams. Silica-rich containing-rock commonly surrounds and intrudes into the coal seams in this region. The thinner the seam the greater the proportion of rock and quartz that has to be cut relative to coal to allow for modern day machine mining techniques. Almost all (96%) of thin coal seams (less than 43 inches) are located in Kentucky, Virginia, and West Virginia. It appears there is no more "easy coal" left to mine in this region. All mines have high proportions of rock through which miners must cut. This fact results in increased silica exposure that requires more preventive maintenance, and in the absence of adequate ventilation at the roof bolter and cutting machine faces, produces excessively high coal dust and quartz exposure levels. Under these mining conditions one would expect elevated quartz levels in personal samples taken to enforce the CMD standard. Such increases have been noted in compliance samples, but the relationship between quartz exposure and disease endpoint has not been conducted.

The geological characteristics of the region coupled with the fact that small mines are concentrated here create conditions that add to the probability of overexposure of quartz to working miners. Seventy percent of the mines in MSHA Districts 4, 5 and 6 are small mines that are more likely to have thin seams of coal and therefore more quartz-bearing rock being cut, thereby producing higher exposure to both coal dust and silica. Since small mines are more common in the central Appalachian region than elsewhere in the country, it is not necessarily unexpected that a high proportion of rapidly progressive cases of silicosis occur in this area. Also, these small mines are more often out of compliance than large mines, especially when quartz levels are excessive. Small mines may have higher actual CMD levels than operator-

sampled levels indicate. MSHA inspectors made inspections of coal mines to sample CMD levels at the face, and compared them to operator-based samples. At large mines the results were comparable. As the size of the mine decreased, the operator-based sample results tended to become smaller as mine size became smaller. The maximum difference shown was when MSHA samples were about two-fold greater than operator samples (MSHA 1993).[18]

In sum, the geological characteristics of the region include small (thin) seams of coal requiring mining methods that cut large amounts of stone. The coal mines in the region are small mines (in terms of numbers of employees).Higher dust exposures are not uncommon, and very high proportions of quartz are contained in the dust. All of these are major factors contributing to the radiographic disease observed in miners from this region. These factors are highly correlated in the central Appalachian region and provide strong indirect evidence supporting quartz as an etiological agent in the development of rapidly progressing CWP.

Disease Characteristics. In the past decade, an apparent increase was reported in what was thought to be severe and rapidly progressive CWP and progressive massive fibrosis ("PMF") appearing in younger miners exposed for a short period of time after the 1970s reduction in the CMD standard, despite stability in measured CMD levels over the period. This finding was a stimulus for NIOSH recommending that MSHA reduce the current CMD standard from 2.0 mg/m^3 to 1.0 mg/m^3. Of interest to the hypothesis of quartz as the reason for these cases of rapidly progressive CWP should be the fact that in this area of the country around half of the mines in MSHA Districts 4, 5, and 6 are on a reduced dust standard due to the high percentage of quartz in the CMD, per the requirements of the current provisions of 30 C.F.R. §70.101. Thus, silica exposure is a major concern. A NIOSH investigation of these "rapidly progressive cases" in two Virginia counties lends some support to the quartz hypothesis.[19] In a review of the MSHA dust data this study found that only 2.5% of individual CMD samples were above the MSHA limit, while on the other hand 65% of the MSHA samples analyzed for quartz were above the NIOSH Recommended Exposure Limit for crystalline silica. With every two out of three samples analyzed for quartz being above the NIOSH recommended safe level for up to an 18-year period, there is sufficient justification to suspect the development of cases of silicosis given the intensity and duration of exposure. Without a doubt the etiology of chronic silicosis is compatible with the patterns of exposure experienced in this study.

In another study by NIOSH, researchers investigated whether the presence of r-type opacities on chest X-rays were an indication that quartz exposures were a factor for the pneumoconiosis in this region.[20] According to NIOSH, the greater severity and rapid progression of CWP being observed in the region are more characteristic of silicosis than CWP and are associated with r-type opacities on the chest radiograph. The authors conclude that the increasing reported prevalence of r-type opacities, rapid progression and more severe disease (PMF) in the Appalachian coal fields is consistent with an increased exposure to crystalline silica (quartz) and silicosis etiology.

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[18] Mine Safety and Health Administration. Report of the Statistical task team of the coal mine respirable dust task group, U.S. Department of Labor Mine Safety and Health Administration, 1993.

[19] CDC Centers for Disease Control and Prevention. Advanced cases of coal workers' pneumoconiosis – two counties, Virginia, 2006. MMWR Morb Mortal Wkly Rep 2006;55:909-13.

[20] 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.

In another NIOSH analysis trends in CWP prevalence were examined by mine size (i.e., employment).[21] The hypothesis investigated was that smaller mines lack resources in many areas for the full protection of workers, including dust suppression and up-to-date knowledge of means to prevent disease development. It should also be noted that smaller mines tend to be those mining the thinner coal seams. The results show that CWP prevalence is increasing in mines of all sizes, but the trend is much more obvious and much greater among miners employed in smaller coal mines. Interestingly, the prevalence of CWP-related progressive massive fibrosis (PMF) was higher among large mines in the 1970s and 1980s, but changed dramatically in the 1990s and 2000s when PMF became increasingly higher in small mines for the next two decades. Adjusting for age, miners from small mines in the 1990s were three times more likely to have PMF than miners from large mines and five times more likely in the 2000s. The medical observation that the cases in these small mines are more likely to progress to complicated disease (PMF) is more consistent with an etiology of silicosis given that quartz is a much more fibrotic dust than coal.

In summation, these studies provide strong evidence that the quartz in CMD is producing rapidly progressive silicosis that has been misidentified as CWP. The recent increase in CWP prevalence is due to the increasing prevalence of r-type opacities suggestive of crystalline silica exposure effects. These exposure-response studies of coal miners exposed to high quartz concentrations do not appear to be showing increases in rapidly progressive CWP caused by CMD. Instead, these increases are due to rapidly progressive silicosis associated with quartz concentration; and, in fact, there is no association with CMD and CWP.

Recommendations for Further Study

There are a number of studies that should be undertaken prior to proceeding with the recommended lowering of the CMD standard.

NIOSH should conduct a properly designed case-control study to produce more definitive conclusions as to the etiologic agent and exposure-response relationships for CMD and quartz in the central Appalachian region. It would be informative to investigate causes more specifically by conducting a case-control study to explore specific mine characteristics of cases such as CMD exposure, quartz exposure, rank of coal, seam height and mine size. This type of investigation would provide direct evidence regarding the etiology of rapidly progressive pneumoconiosis and PMF in the region.

NIOSH has conducted analyses of exposure-response relationships for respirable CMD and CWP through its nationwide chest X-ray database and exposure data from MSHA's MSIS database. NIOSH should assess the exposure-response of quartz to observed CWP in the central Appalachian region using the quartz percentage in the MSHA database to determine the gravimetric concentration of quartz in the CMD aerosol. Since a large percentage of the mines in this region are on a reduced CMD limit because of quartz occurring in amounts greater than 5%

[21] Laney, A. and M. Attfield (2010). "Coal workers' pneumoconiosis and progressive massive fibrosis are increasingly more prevalent among workers in small underground coal mines in the United States." Occup Environ Med 67: 428-431.

a sufficient sample database for quartz exposure should be available for exposure-response analyses.

NIOSH should remove the X-ray results obtained from the MCP and ECWHSP from the database and compute prevalence data for CWP for the nation and by state and MSHA district. The results should be compared with previous rounds of examination to determine if these programs biased the prevalence data based on case ascertainment, and whether there is a true increase in CWP prevalence taking place.

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