

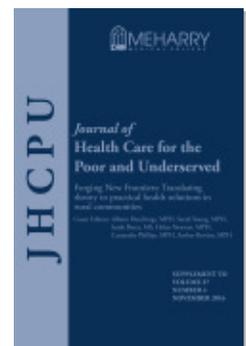


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## **An Innovative Approach to Enhancing Access to Medical Screening for Miners using a Mobile Clinic with Telemedicine Capability**

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*Abstract:* Inadequate access to medical care in underserved and geographically isolated rural communities may limit the delivery of quality screening care to miners. Use of mobile screening clinics, manned by a physician assistant or nurse practitioner, is one way to improve their access. Miners demonstrate a high level of satisfaction with services provided by the mobile screening clinic. The addition of telemedicine to mobile screening clinics allows miners to have access to university-based specialist care and provides an opportunity to specialists to tele-mentor other providers. Although inadequately studied, limited data suggest that miners accept telemedicine consultation. We expect that the innovative use of mobile screening clinics with telemedicine technology might allow efficient utilization of resources to meet the medical screening needs of a large number of miners in geographically remote locations in the United States.

*Key words:* Miners, screening, mobile clinic, spirometry, telemedicine.

**A**bout 250,000 employees worked in various mines in the United States in 2013 alone, of which coal miners were the largest group.<sup>1</sup> While pneumoconiosis, or dust-related lung disease, has always been a health problem among miners, its prevalence has recently increased.<sup>2</sup> The 2005 to 2009 data from the National Institute of Occupational Safety and Health (NIOSH) surveillance program reported a 7% prevalence of radiographic pneumoconiosis nationwide for coal miners with more than 25 years' tenure, nearly double that of the nadir 20 years ago (1995 to 1999).<sup>2</sup> The prevalence of progressive massive fibrosis was 1.1%, almost three times its nadir 20 years ago.<sup>2</sup> Given

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this increasing prevalence, miners need screening, early diagnosis, and treatment, as well as rehabilitation and compensation for their chronic respiratory and other diseases.

Miners in the United States constitute an underserved, isolated, and medically vulnerable rural population. This is particularly relevant in New Mexico, which has disproportionately high rates of inadequate health insurance and poverty and its rural hospitals serve large-sized remote geographic areas with long driving distances that further limit access to medical care.<sup>3,4</sup> Most parts of New Mexico are designated health professional shortage areas (HPSA) and health care underserved areas (HCUA), and face a shortage of specialists such as pulmonologists, with resulting problems in health care access and delivery. In addition, rural mining communities have a disproportionately high prevalence of chronic co-morbidities (such as cardiovascular disease and obesity<sup>5,6</sup>) and co-exposures (such as cigarette smoke<sup>7</sup>), which makes the care of chronic respiratory diseases in miners especially challenging.

In addition to traditional fixed screening clinics, mobile screening clinics are being increasingly used by the NIOSH to break the barrier of geographical access by reaching small mining communities in remote areas.<sup>8</sup> Accordingly, Miners' Colfax Medical Center (MCMC) at Raton, New Mexico, and the University of New Mexico at Albuquerque, New Mexico have jointly developed a unique mobile screening program with telemedicine capability. The mobile screening clinic travels to 20 sites in New Mexico, almost all rural, conducting three-day clinics in communities with high concentration of miners since 1989 (Figure 1). The screening sites were recently extended beyond

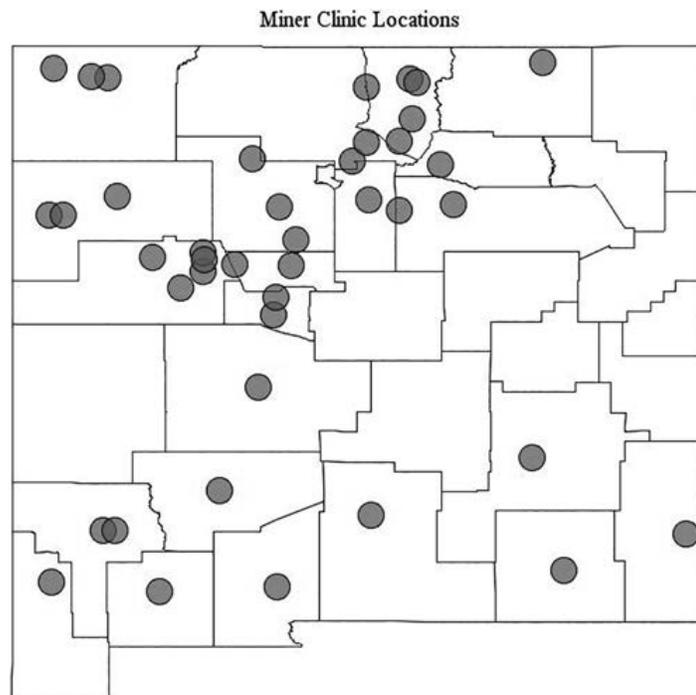


Figure 1. Locations for mobile screening clinics attended by miners in the state of New Mexico, 1989–2014.<sup>a</sup>

<sup>a</sup>Boundaries represent state and county borders.

New Mexico to Kemmerer, Wyoming, confirming the portability of this approach to other rural regions in the United States.

At these mobile screening clinics, miners are assessed for respiratory, hearing, and musculoskeletal disorders associated with mining-related exposures. Assessment also includes risk factors and common health conditions such as cardiovascular disease, obesity, cancer, diabetes mellitus, hypertension, and obstructive sleep apnea, and common exposures such as tobacco use, wood smoke, alcohol use, and illicit drug use. Although our project focuses on pulmonary diseases, we also screen for non-pulmonary chronic diseases for the following reasons. Non-malignant pulmonary diseases are a known risk factor for cardiovascular disease and lung cancer;<sup>9-11</sup> mining exposure is a risk factor for hypertension and hearing loss;<sup>12</sup> select mine workers and patients with lung diseases have a disproportionately high prevalence of metabolic syndrome;<sup>5,13</sup> and our mining communities specifically request programs that additionally target extra-pulmonary diseases.<sup>14</sup>

### **Pre-clinic Advertising**

Prior advertising to announce the upcoming clinic is conducted in the target rural community through print media and radio, as well as by working with community leaders and mine safety officers. Patients are also able to self-refer for screening evaluations. Patients who were previously screened in the mobile screening clinic are also contacted by mail by the clinic coordinator for re-screening every three years to participate in the program. Clinic attendees report that their primary source of information about the upcoming clinic is through a relative or a friend in their community, suggesting that traditional routes of communication remain strong in rural communities (Table 1). Community newspapers and flyers are less helpful. It is currently not known whether cellular text messaging or social media advertising would be an effective way to inform rural communities about upcoming clinics, in addition to traditional modes of communication.

### **Clinic Structure**

The mobile screening clinic is held in a specially outfitted trailer which is 53 feet long with a diesel generator to supply power (Photograph 1). The clinic consists of five separate areas, including a patient reception area, a dedicated digital chest x-ray unit, sound-proof audiometry booth, spirometry room, and an examination room equipped with monitors and viewing boxes to review digital and analytic chest radiographs respectively and a stationary bicycle to measure exercise desaturation (Photograph 2). The staffing model in the mobile screening clinic consists of a physician assistant or a nurse practitioner, a radiology/audiometry technician, and a medical assistant/nursing technician who is certified by the NIOSH for spirometry. In heavily attended clinics, a program manager also attends the clinic to coordinate flow of patients and provide benefits counseling. Use of phlebotomy for metabolic screening is currently being piloted.

Before the screening appointment, patients complete a comprehensive occupational and clinical history intake form. The intake form is currently mailed in paper format to

**Table 1.****MAIN SOURCE OF INFORMATION ABOUT THE RURAL MOBILE SCREENING CLINIC, AS REPORTED BY THE CLINIC ATTENDEES**

Source of Information	Percent
Friend/Relative	50%
Community Newspapers	30%
Community flyers	10%
Other	10%



Photo 1. The mobile screening clinic is run in a specially fitted trailer that is 53 feet long.

the patients prior to the clinic visit but electronic data capture through secure websites is currently being tested. The screening visit includes a vital sign assessment, prebronchodilator spirometry, audiometry, and a standard posterior-anterior chest radiograph. A complete history and physical examination is performed by a physician assistant or nurse practitioner who develops a treatment and care plan for the patient depending on the primary diagnosis. All patients are provided with comprehensive educational information on their disease with tips on self-management. If necessary, the patient is referred to their primary care provider for follow-up care. It takes approximately one hour for each patient to complete their screening visit. Coordination of follow-up care is done telephonically by a registered nurse case manager, physically located at Raton, N.M., with a follow-up call three months following the screening visit.

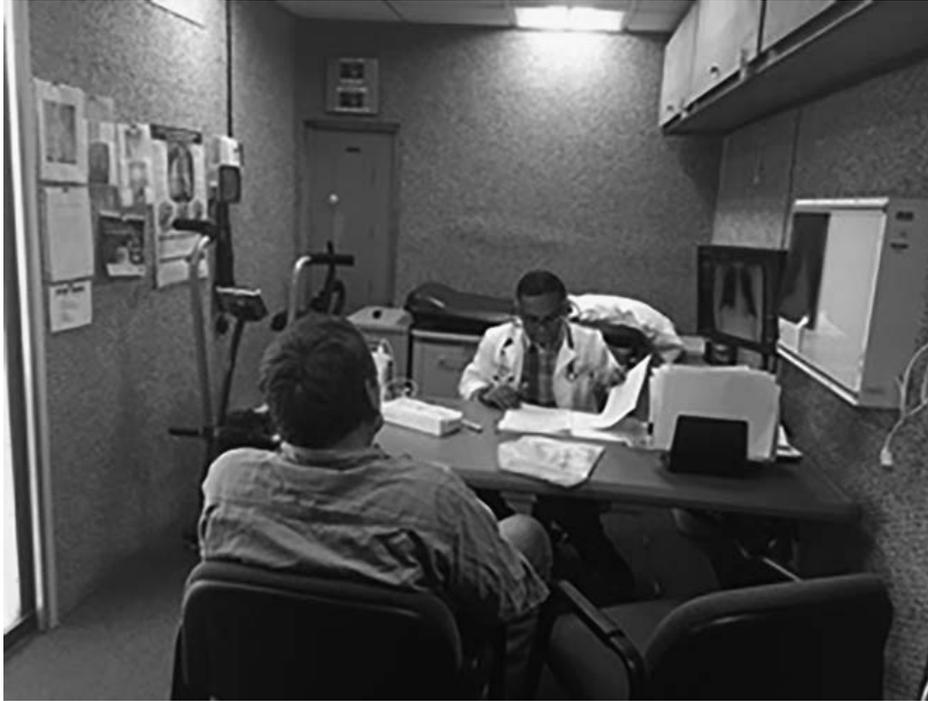


Photo 2. The examination room within the mobile screening clinic is equipped with an X-ray viewing box, computer screen, and a stationary exercise bicycle.

The mobile screening clinic has an advanced digital communication system for telemedicine, comprised of several machines that are networked together using a ground control satellite. This system has a portable satellite dish that is assembled each morning at the roof of the trailer and disassembled at the end of each day and brought back into the trailer. The digital chest radiographs are transferred from the Konica® Computerized Radiology (CR) machine to a laptop using the “Merge” E-film software. The images are then sent in a DICOM (Digital Imaging and Communications in Medicine) format, via the satellite connection, to the Picture Archiving and Communication System (PACS) system CoActive® at the MCMC Hospital for storage. All of the miners’ paperwork, which includes questionnaire, spirometry, audiometry, and clinical provider notes are digitized and similarly sent, via the satellite connection, to the MCMC Centriq® medical records system for storage. Through the satellite connection, the mobile screening clinic can also access the MCMC Centriq® electronic medical records system to obtain data on prior inpatient or outpatient visits. Secure and synchronous videoconferencing is established between specialist site and screening clinic, by using ZOOM® technology over the satellite connection to the Internet.

Those miners who have abnormal test results *and* are deemed by the screening provider to require specialist consultation are requested to return for a telemedicine clinic appointment the same afternoon (n = 15 since start of telemedicine services in 2015). The mobile screening clinic currently offers specialist pulmonary consultations at the University of New Mexico Health Sciences Center at Albuquerque, New Mexico.

The telemedicine clinic allows the specialist and the miner to be able to reconfirm key aspects of history, answer questions, jointly review test results, particularly spirometry and chest radiograph (the latter using the International Labor Organization Classification of Radiographs of Pneumoconiosis by a NIOSH certified B reader), and prepare a joint management plan. In addition, the telemedicine clinic appointment allows an opportunity for the university-based specialist to tele-mentor the non-specialist screening provider in the management of mining-related diseases.

### **Patient Characteristics**

Table 2 provides summary data on demographic characteristics, mining exposure, smoking and use of alcohol, in 6,685 miners who were screened by this program over approximately 10,000 visits since 1989. The table demonstrates that this program focuses on minority populations, particularly Hispanic and American Indian former uranium miners. Contrary to popular perception, 47% of miners in this population never smoked. On the other hand, ever or past year alcohol consumption was frequently reported. Table 3 demonstrates that miners show a high prevalence of primary care illnesses such as hypertension (39%), and diabetes mellitus (16%), compared with the State of New Mexico age-adjusted prevalence rates of 27% and 10%, respectively.<sup>4</sup> Among spirometric abnormalities, obstruction is more prevalent than either restriction or mixed obstruction and restriction.

### **Patient Satisfaction**

In a convenience sample of miners who participated in the mobile screening clinics between July 2014–December 2015 and returned their patient satisfaction surveys by mail ( $n = 278/451$  or 62% response rate), 92% ( $n = 255$ ) rated their experience as very good, 8% ( $n = 23$ ) rated it as good, and 0% rated it as poor. Results summarized in Table 4 demonstrate that all patients reported that they would recommend the mobile screening clinic to their family and friends. Qualitative data obtained from these surveys included the following comments. “They were able to explain my test results to me so that I understood.” “I like visiting with the old retired coal miners and seeing them again.” “I like that when I talk about what work I do at the mine they understand what I’m talking about.” Another measure of patient satisfaction is the loyalty to the mobile clinic screening program, as measured by the proportion of individuals who are returning users versus new users. Even though communities are sampled every three years, our program has a substantial proportion of returning users at repeat clinics (Table 5), demonstrating a good level of patient loyalty. There are currently limited outcome data available for the use of telemedicine in mobile screening clinics for miners. Miners participating in the telemedicine clinic ( $n = 15$ ) however report a high level of satisfaction, stating that they felt they were receiving care that was not available within their own communities because of lack of access to specialist services. Although the mobile screening clinic primarily deals with patients that may not be technologically savvy, our surveys showed that they were comfortable with the tele-medicine consultation process.

**Table 2.****SUMMARY OF CHARACTERISTICS OF SCREENED MINERS  
(N = 6,685)**

<b>Characteristics</b>	<b>%</b>
Male sex %	96.5
Race/ Ethnicity	
Non-Hispanic white	27.5
Hispanic	36.6
Black	0.5
American Indian	33.2
Other	0.0
Age Group (in years)	
<40	14.3
40–59	43.7
60–74	33.5
≥75	8.2
Unknown	0.3
Current Miner	24.1
Past/Current Miner type	
Coal, not uranium	16.4
Uranium, not coal	49.6
Mixed Coal and Uranium	6.6
Other	27.4
Mining Location	
Above Ground	28.5
Below Ground	51.1
Both Above Ground and Below Ground	20.4
Total Mining Years, Median inter-quartile range	12.0 (5.0, 22.0)
Smoker	
Never	46.8
Former	34.6
Current	18.6
Total smoking years, Median inter-quartile range	24.0 (12.0, 36.0)
Ever Consumed Alcohol	88.0
Average Alcohol Consumption, Past Year	
Daily	11.7
2–3 times a week	18.7
Once a week	22.8
2–3 times a month	12.4
Once a month	12.1
Less than once a month	22.3

**Table 3.****PREVALENCE OF COMORBIDITIES AMONG SCREENED MINERS  
(N = 6,685)**

<b>Comorbidities</b>	<b>%</b>
Current Lung Disease, Spirometrically diagnosed	
No Lung Disease	72.8
Restrictive	8.0
Obstructive	15.1
Mixed Restrictive and Obstructive	4.0
Self-Reported Ever-asthma	8.1
Self-Reported Ever-COPD	10.9
Self-Reported Ever- diabetes	16.0
Self-Reported Ever- hypertension	38.6

**Table 4.****SUMMARY OF PATIENT RESPONSES FROM A CONVENIENCE  
SAMPLE OF MINERS WHO PARTICIPATED IN THE MOBILE  
SCREENING CLINICS BETWEEN JULY 2014–DECEMBER 2015  
AND RETURNED THEIR PATIENT SATISFACTION SURVEYS BY  
MAIL (N = 278/451 OR 62% RESPONSE RATE)**

<b>Questionnaire item</b>	<b>Yes</b>	<b>No</b>
Were your questions and needs addressed?	100%	0%
Were you treated in a respectful and, private and professional manner?	100%	0%
Would you recommend us to your family and friends?	100%	0%

**Table 5.****THE PROPORTION OF RETURNING AND NEW PATIENTS  
FROM A CONVENIENCE SAMPLE OF THE LAST FOUR MOBILE  
SCREENING CLINICS (HELD IN 2015–2016)**

<b>Clinic Site</b>	<b># of patients screened</b>	<b>Returning patients</b>	<b>New patients</b>
Dancing Eagle, NM	56	11 (20%)	45 (80%)
Santa Fe, NM	24	12 (50%)	12 (50%)
Raton, NM	16	13 (81%)	3 (19%)
Kirkland, NM	23	17 (74%)	6 (26%)
Total	119	53 (45%)	66 (55%)

## Patient Insurance Characteristics

Our screening service is billable to patients' insurance plans. In the event that insurance plans do not reimburse for the services or if the patient is uninsured, the patient is not charged for the visit and the balance is written off. Contrary to popular perception, most screened miners in our program are insured (45% have commercial insurance, 5% have Blue Cross/Blue Shield plan, 18% have Medicare, 27% have Indian Health Services, 2% have Medicaid, and 2% have Veterans Administration coverage, Figure 2). Despite reports of recent mine closures, uninsured miners in the State of New Mexico are rare, as compared to an uninsured rate of 20% for the general population in the state.<sup>4</sup> Despite having insurance, slightly more than half of the miners screened report that they have a primary care provider. All screened miners are followed up telephonically by a registered nurse case manager approximately three months after the initial screening. The program has no additional funds or mechanisms to guarantee follow-up either with the providers serving in the program or outside. Despite recommendations, many miners do not follow up with post-screening recommended medical care. This is particularly problematic among current miners. Mobile screening clinics for miners therefore need to be coupled with a robust post-screening case management. Additionally, our data suggest that geographical access to health care may be a greater challenge for post-screening medical care than financial access among miners.

## Conclusion

Geographic access to quality screening care to miners may be enhanced by the use of mobile screening clinics, manned by a physician assistant or nurse practitioner. While miners demonstrate a high level of satisfaction to services provided by our mobile

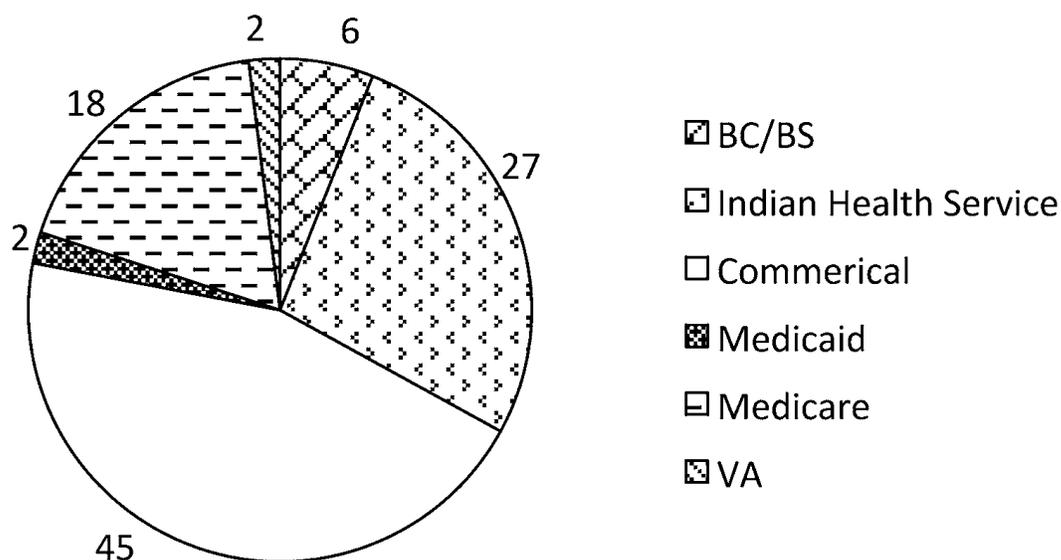


Figure 2. Payor source for miners seen in the mobile screening clinic

screening clinic in their communities, it is currently unclear whether the quality of care and patient satisfaction differs between mobile clinics and traditional fixed clinic settings. Although the addition of telemedicine technology to mobile screening clinics allows miners to have access to specialist care and provides an opportunity to specialists to tele-mentor non-specialist providers, the real world effectiveness of telemedicine and tele-mentoring in this scenario needs to be carefully examined. Although our program is currently supported by federal funds, it is sustainable beyond the period of federal funding due to low uninsured rates of participants, coverage by most insurance plans for screening services, and coverage by the state Medicaid program for telemedicine services. We expect that the innovative use of mobile clinics with telemedicine capability to allow an efficient utilization of resources to meet the medical screening needs of a large number of miners in geographically remote locations in the United States.

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