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Defeating Silicosis:
Aluminum Therapy's Impact on Industry

Travis Irion
History 430
December 10, 2010

At its peak, Silicosis was defined as the most important industrial disease of the twentieth century. This disease was extremely widespread and affected almost every major industry involved with processing hard rock.¹ Several factors led to the dissemination of this disease among the laborers of the world, especially, the lack of knowledge and understanding of the causes of silicosis and means of its prevention. As industry developed and technology progressed, industry and science made significant advances towards understanding and eliminating silicosis from the factories and mines of the world. This disease's eradication, however, required the cooperation of all affected. Proper use and integration of the various new technologies would be the key to eliminating silicosis. Industries experience in the early twentieth century shows that protection of industrial health must be realized through proper planning and an understanding that no simple answer exists to the problems industry faces.

The Tri-State District of Oklahoma, Kansas, and Missouri was especially hard hit by the ballooning silicosis crisis around the turn of the twentieth century. Mining operations began in the Tri-State District in the early 1900s. By 1917, a government report noted that thirty percent of the area's workers had silicosis.² Some studies found that around sixty-seven percent of workers had some form of silicosis in 1923.³ Investigations found in most mines an unusually high concentration of dust. The average concentration of dust would have exceeded the 1988

¹ Dudley Irwin, "Address of Dr. Dudley Irwin" (address at the meeting of the Jackson County Medical Association, February 27, 1945): 3, Box 69, folder 1403, Pitcher Collection, Pittsburg State University, Pittsburg, KS.

² Gerald Markowitz and David Rosner, "'The Street of Walking Death': Silicosis, Health, and Labor in the Tri-State Region, 1900-1950," *The Journal of American History* 77, no. 2 (Sep., 1990): 531-32.

³ Alan Derickson, "'On the Dump Heap': Employee Medical Screening in the Tri-State Zinc-Lead Industry, 1924-1932," *The Business History Review* 62, no. 4 (Winter 1998): 662.

federal standard for silica exposure by ten times.⁴ The numerous cases of silicosis were in direct relation to the high concentration of silica dust present in the mines.

The economic, social, and environmental make-up of the Tri-State District was the main cause for the spread of silicosis. The mines in the district operated on a piece-rate system, and this meant that mine operators paid men for their output on a given shift.⁵ This exacerbated the dust problem as men often worked harder and longer, which induced heavier breathing within a confined, dust saturated environment.⁶ A social implication relating to silicosis was the increased susceptibility workers with silicosis had to contracting tuberculosis. Once a worker contracted silicosis and tuberculosis, he became a health risk to all those he came in contact with. Often times, workers spread tuberculosis to their families, and this fact lead to an overall rise of tuberculosis cases within the area at a time when the rest of the United States reduced its number of cases of tuberculosis.⁷

The early mining operations were marked by a lack of development in hygiene methods for keeping the mines clear of dust and other industrial toxins. Contributing factors were “drilling, blowing out drill cuttings...blasting, shoveling, boulder popping, tramming, and pillar trimming...dumping ore buckets and crushing mineralized rock in the mill.”⁸ The poor environment that workers endured increased their exposure to silica, accounting for the rapid

⁴ Alan Derickson, ““On the Dump Heap,”” 662.

⁵ Gerald Markowitz and David Rosner, ““The Street of Walking Death,”” 528-29.

⁶ Alan Derickson, ““On the Dump Heap,”” 661.

⁷ *Ibid.*, 532.

⁸ A. M. Gibson, *Wilderness Bonanza: The Tri-State District of Missouri, Kansas, and Oklahoma* (Norman: University of Oklahoma Press, 1972), 185.

development of the disease among the district. The Tri-State District was a perfect example of the problems facing industry in the early years of the twentieth Century.

The development of silicosis as a significant health risk was no doubt a direct result of the industrial revolution. As mechanized processes became more efficient, the need of individual artisans lessened, and the need for factory workers increased. In a speech given in 1945, Dr. Dudley Irwin notes that widespread disease due to dust did not become an issue until individuals began migrating en masse to the factories and mines.⁹ With the increase in factory workers, came new issues of social and health related issues yet experienced by any society. Operators and laborers quickly realized that serious health problems were developing among workers of the industrial nations. Industries which worked with hard rock and sustained high dust concentrations within their work environments experienced some of the worst industrial related disease. As the conditions increased among workers, theories began to develop on how, what, and why dust was causing such a prevalence of disease among labor.

How the dust was coming to affect workers was the easiest question to answer. Several industries worked with hard rock throughout the course of the day: mining, sandstone grinding, and pottery making to name a few. Thus, dust as a result of pulverizing hard rock was quickly located as the source of the various pulmonary diseases in industry.¹⁰ Often times, the work of grinding was carried out in confined factories allowing dust to accumulate, and without proper ventilation the dust would become concentrated in the air. Mining was especially hazardous, and the space where work was carried out was even more confined than in the factories. Blasting,

⁹ Dudley Irwin, "Address of Dr. Dudley Irwin," 1-2.

¹⁰ *Ibid.*, 2.

grinding, and drilling were all environmental factors that produced heavy concentrations of dust, and were quickly located as the source of the dust problem.¹¹

The next step in developing theories on the rampant pulmonary disease of industry was to find what dust was the cause. Various groups began to analyze the dust that was prevalent in the factories and mines. The work of these groups found disease to be most numerous where there was a heavy concentration of silica dust, SiO_2 . Scientists found the silica dust particle to be most damaging below five microns, and the work environment must have a high to medium concentration of around fifty percent free silica dust in the air.¹² Finally silica dust was understood to be the cause, and the name silicosis was applied to the pulmonary disease afflicting various industries which dealt with hard rock.

Why silica dust was so harmful was a more difficult question for doctors and scientists to answer. Early theories postulated that the silica dust particles were sharp and tore at the lungs when inhaled causing the fibrosis seen in x-rays of silicotics. This was quickly discarded as other stronger dust compounds, such as diamond dust, almost never produced fibrosis. Eventually the work of two scientists, Gye and Purdy, in 1921 discovered why silica was so potent. They showed that silica, when dissolved in solution, creates silicic acid, and this acid creates the chronic inflammation known as silicosis.¹³

¹¹ Dudley Irwin, "Address of Dr. Dudley Irwin" (address at the meeting of the Jackson County Medical Association, February 27, 1945): 2, Box 69: folder 1403, Pitcher Collection, Pittsburg State University, Pittsburg, KS; Alan Derickson, "'On the Dump Heap': Employee Medical Screening in the Tri-State Zinc-Lead Industry, 1924-1932," *The Business History Review* 62, no. 4 (Winter 1998): 661-62.

¹² D. A. MacGregor, "Silicosis – Its Prevention and Treatment" (Reprinted from *West Virginia Medical Journal* (Sept. 1945)): 4, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS; Louis W. Spolyar, "Industrial Hygiene Aspects of Silicosis" (Conference on Silicosis and Aluminum Therapy, January 24-25, 1949): 7, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

¹³ Dudley Irwin, "Address of Dr. Dudley Irwin" (address at the meeting of the Jackson County Medical Association, February 27, 1945): 7-8, Box 69, folder 1403, Pitcher Collection, Pittsburg State

Diagnosing silicosis accurately posed other challenges to health professionals. Difficulty arose from the contradicting data that x-rays and respiratory tests often presented. Several studies on silicosis showed that definite fibrosis could be established by an x-ray, yet a patient could show no signs of disability in the lung capacity tests.¹⁴ For this reason, several criteria had to be satisfied in order to establish that a worker indeed had silicosis. Therefore doctors based diagnosis on the combination of a workers x-ray, dust exposure, and respiratory function test.¹⁵ Also, several symptoms were often manifested which pointed to developing silicosis: cough, shortness of breath, chest tightness, and severe fatigue.¹⁶ Silicosis, however, often took years to develop. Only in extreme situations did the disease rapidly destroy the lungs. Furthermore, upon leaving work silicosis could progress further for up to five years.¹⁷ Early research showed one thing-silicosis was a health risk that was not going away. Methods had to be discovered to prevent or cure silicosis, as this disease was rapidly spreading throughout industry around the world.

University, Pittsburg, KS; D. A. MacGregor, "Silicosis – Its Prevention and Treatment" (Reprinted from *West Virginia Medical Journal* (Sept. 1945)): 9, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

¹⁴ Crombie, D. W., J. L. Blaisdell, and G. MacPherson, "The Treatment of Silicosis by Aluminum Powder" (Reprinted from *The Canadian Medical Association Journal* (April 1944)): 19, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

¹⁵ D. A. MacGregor, "Silicosis – Its Prevention and Treatment" (Reprinted from *West Virginia Medical Journal* (Sept. 1945)): 4-5, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

¹⁶ *Ibid.*

¹⁷ D. A. MacGregor, "Silicosis – Its Prevention and Treatment" (Reprinted from *West Virginia Medical Journal* (Sept. 1945)): 4, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS; Dudley Irwin, "Address of Dr. Dudley Irwin" (address at the meeting of the Jackson County Medical Association, February 27, 1945): 34, Box 69, folder 1403, Pitcher Collection, Pittsburg State University, Pittsburg, KS.

Developing preventative measures against harmful dust became a high priority for companies and labor. As labor began to demand regulation of the workplace, often industrial hygiene became a forerunning issue. Taking the position that industrial operators had the necessity to insure the safety of their workers, state governments began to enact laws regulating the employer.¹⁸ Also, workmen's compensation laws in other countries began to put pressure on the United States to follow suit. These developments were strong incentives to finding new ways of curbing the cost that would surely come from the silicosis crisis.

Technological advances helped develop tools for reducing and preventing the amount of dust produced in industrial work environments. Several innovations were wet drilling and mining. This process would keep dust from being expelled into the air by workers. Other popular and necessary methods included ventilation fans in dust filled factories and mines.¹⁹ Mines developed new procedures for workers to follow, especially in the uses of blasting. Mine operators required miners to leave the mines prior to blasting. Then the miners had to wait a certain amount of time before they could enter again.²⁰ Grinding operations replaced sandstone grinding wheels by synthetic abrasive grinding wheels. Factories owners enclosed or partitioned from other plant or mine operations conveyer belts, vibrating tables, and other mechanized aspects within industrial operations.²¹ These methods helped contain the areas where silica dust exposure was possible.

¹⁸ A. M. Gibson, *Wilderness Bonanza*, 186-87.

¹⁹ Paul D. Halley and Alfredo Salazar, "Control of Industrial Dust Exposures" (Conference on Silicosis and Aluminum Therapy, January 24-25, 1949): 12-13, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

²⁰ Alan Derickson, "'On the Dump Heap,'" 663.

²¹ Paul D. Halley and Alfredo Salazar, "Control of Industrial Dust Exposures," 12-13.

The prevention of dust, however, rested on the combined effort of labor and employers. The part that workers would have to play in this process cannot be overstated, as they were the ones who would have to follow the new procedures guiding their work. Dr. Louis Spolyar says this best: "Unless he [the employee] uses the controls provided no amount of money or engineering skills can affect a dust control program."²² Employers, however, had their own responsibilities. The employer's main duty was to provide the necessary environmental protections to their employees, this was made possible monetarily. Only with their cooperation and adherence to existing laws would any significant progress be made in combating silica dust.²³ Even with all these new advances though, a cure or some medical prophylactic treatment for silicosis was yet to be discovered. For that reason, silicosis persisted as an industrial disease, until Doctors J. Denny, W. Robson, and Dudley Irwin pioneered a new and promising method called aluminum therapy.

Doctors Robson, Denny, and Irwin began their work with silicosis in 1932. They worked with the McIntyre Porcupine Mine in Schumacher, Ontario to begin studying silicosis in a scientific fashion. They devoted their early work mainly to understanding the pathology of silica dust once it was inhaled.²⁴ The three doctors quickly discovered that the physical presence of dust in the lungs was not the source of debilitating fibrosis; rather, the solution of silica in the

²² Louis W. Spolyar, "Industrial Hygiene Aspects of Silicosis" (Conference on Silicosis and Aluminum Therapy, January 24-25, 1949): 7, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

²³ Louis W. Spolyar, "Industrial Hygiene Aspects of Silicosis" (Conference on Silicosis and Aluminum Therapy, January 24-25, 1949): 7-8, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS; Paul D. Halley and Alfredo Salazar, "Control of Industrial Dust Exposures." (Conference on Silicosis and Aluminum Therapy, January 24-25, 1949): 11-14, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

²⁴ J. J. Denny, W. D. Robson, and Dudley A. Irwin, "The Prevention of Silicosis by Metallic Aluminum: I. A Preliminary Report," *The Canadian Medical Association Journal* 37 (1937): 1.

lungs caused a breakdown of the lungs normal function.²⁵ As their work progressed, they came upon research by Leroy Gardner that suggested to them that a compound might exist to reverse or inhibit the solution of silica dust in the lungs.²⁶ Following that line of thought, the doctors began researching various compounds that could possibly inhibit the detrimental effect of silica dust.

Up until the early thirties, several other researchers suggested the possibility of a substance that could totally inhibit silica dust from acting upon the lungs, calling these substances antidotal rocks.²⁷ Several anomalies were known to occur amongst various industries that suggested silicosis could be inhibited. One such industry that made the claim was the coal mines.²⁸ The doctors devised a simple experiment based on the knowledge that any inhibiting substance would have to reduce or prohibit the solution of silica. Their results were promising as they found several substances did have an effect: iron oxide, coal dust, and flowers of sulfur; however, the results were not so positive as to show any real promise in combating silicosis.²⁹ After their initial tests with antidotal rocks, the doctors decided to take a break and pursue new avenues for battling silicosis.

They decided to verify new research conducted by Dr. Heffernan who was another doctor researching silicosis and the disease's pathological effect on the lungs. Dr. Heffernan had

²⁵ Dudley Irwin, "Address of Dr. Dudley Irwin," 19.

²⁶ *Ibid.*, 9.

²⁷ *Ibid.*, 10.

²⁸ *Ibid.*

²⁹ Dudley Irwin, "Address of Dr. Dudley Irwin" (address at the meeting of the Jackson County Medical Association, February 27, 1945): 10-11, Box 69, folder 1403, Pitcher Collection, Pittsburg State University, Pittsburg, KS; J. J. Denny, W. D. Robson, and Dudley A. Irwin, "The Prevention of Silicosis by Metallic Aluminum: I. A Preliminary Report," *The Canadian Medical Association Journal* 37 (1937): 1.

postulated that the actual debilitating effect silica had was in its structure and the reaction of the silica's unsaturated oxygen atoms interacting with the tissues of the lungs.³⁰ So with this new research, Dr. Denny suggested that nascent hydrogen should reduce the toxic effect of silica by reacting with the unsaturated oxygen atoms resulting in the formation of water. To test their theory they decided to use metallic aluminum, which, when introduced in the lungs, would create nascent hydrogen, and aluminum hydroxide, neither of which are toxic.³¹

The doctors tested their theory by using guinea pigs, dusting a control group of six with free silica dust and another group of six with a dust mixture that was one percent metallic aluminum dust and ninety-nine percent free silica dust. For sixteen hours a day over a period of six months, the doctors exposed the animals to the dust mixtures. At the end of the study, the doctors autopsied the lungs of the animals, and to their surprise the animals with aluminum showed no silicosis while the control group all had developed silicosis.³² This new discovery was soon proved the result of the aluminum creating a coating around the silica particle preventing its solution in the lungs of the animals.³³ The doctors introduced their findings in a preliminary report in 1937 and a second report in 1939, allowing further progress to be made in verifying and evaluating the possibilities aluminum may have in inhibiting silicosis.

The next step in the process was to determine whether aluminum was suitable for use in humans. Doctors and scientists immediately raised questions over the possible toxicity that aluminum could have on human beings. During the animal testing no result showed any harm caused to the animals subjected to aluminum. To be sure, the doctors administered aluminum to

³⁰ Dudley Irwin, "Address of Dr. Dudley Irwin," 12-13.

³¹ *Ibid.*, 13.

³² *Ibid.*, 20-21.

³³ *Ibid.*, 22.

animals in several different ways. Still no adverse effects were caused in the animals that inhaled aluminum, even in extreme doses.³⁴ This was a significant development in the long history of confronting silicosis. With this knowledge, the doctors began experimental trials in humans. They were soon able to patent their process and began selling licenses to industrial nations around the world.³⁵

The administration of aluminum therapy in human beings produced favorable results for this new method of protection from silicosis. Until the introduction of aluminum treatments, there was no conceivable method for treating silicosis medically. This fact, coupled with the relative harmlessness of aluminum, made treating humans a relatively easy process. Doctors selected Men based on certain criteria to participate in early studies granted by the McIntyre Research Foundation, which owned the patent. In order to gain licensure, the administration of aluminum treatments had to coincide with clinical studies of the men.³⁶ Across the world, companies began employing the use of aluminum therapy at their mines. By 1945, 30,000 men were undergoing aluminum prophylaxis around the world.³⁷

Early studies began producing results that were favorable for the treatment of silicosis by aluminum therapy. One study conducted in Timmins, Ontario, summarized their findings that aluminum therapy produced amelioration of symptoms and increased the work capacity of some

³⁴ Denny, J. J., W. D. Robson, and Dudley A. Irwin, "The Prevention of Silicosis by Metallic Aluminum: II," *The Canadian Medical Association Journal* 40 (1939): 222, 227.

³⁵ Dudley Irwin, "Address of Dr. Dudley Irwin," 29.

³⁶ D. A. MacGregor, "Silicosis – Its Prevention and Treatment," (Reprinted from *West Virginia Medical Journal* (Sept. 1945)): 20, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS; D. W. Crombie, J. L. Blaisdell, and G. MacPherson, "The Treatment of Silicosis by Aluminum Powder" (Reprinted from *The Canadian Medical Association Journal* (April 1944)): 9-10, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

³⁷ Dudley Irwin, "Address of Dr. Dudley Irwin," 30.

men. Furthermore, the doctors of the Timmins study stated, "We believe the inhalation of finely particulate aluminum powder offers every prospect of preventing the development of human silicosis."³⁸ Several other studies conducted by the original developers of the treatment and others in the United States corroborated these results.³⁹ These various studies showed that third party results could duplicate the original research giving more credibility to the use of aluminum as treatment against silicosis.

Despite the incredible advances made by aluminum therapy, silicosis still remained a prominent disease in industry. One issue with studying the impact of aluminum therapy on silicosis arose from the fact that prophylactic benefits could not be measured fully until ten to fifteen years after treatments of aluminum therapy began. This period was the usual length of time that silicosis takes to develop debilitating signs in humans.⁴⁰ All researchers involved also came to the conclusion that aluminum therapy in no way was a cure for silicosis, nor could aluminum alone solve the problem of silica dust in the work place. Only the total eradication of silica dust could truly solve the problem so all industries were still advised to continue in every way possible to prevent the proliferation of silica dust.

The experiences of industry in the early twentieth century shows that industrial health can only be protected through proper planning and understanding that there will never be a simple

³⁸D. W. Crombie, J. L. Blaisdell, and G. MacPherson, "The Treatment of Silicosis by Aluminum Powder," 28.

³⁹ D. A. MacGregor, "Silicosis – Its Prevention and Treatment," (Reprinted from *West Virginia Medical Journal* (Sept. 1945)): 19-23, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS; Paul J. Bamberger, "Aluminum Therapy in Silicosis: A Clinical Study of the Comparative Effects of the Metallic Powder and Hydrated Alumina," *Industrial Medicine* 14, no. 6 (June 1945): 477-79.

⁴⁰ D. A. MacGregor, "Silicosis – Its Prevention and Treatment," (Reprinted from *West Virginia Medical Journal* (Sept. 1945)): 16, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

cure all solution to industrial hazards. Silicosis especially helps teach that there is never any simple solution to industries great problems. Aluminum therapy was seen as a step in that process, a way to augment existing methods of preventing silicosis but was not touted as a cure for silicosis.⁴¹ Without the cooperation of employers instituting appropriate technologies to reduce dust, and without the cooperation of the labor force there could be no end to silicosis. Indeed, this fact was illustrated in the Tri-State District as silicosis and industrial disease largely disappeared as a result of the closing of mining operations in the district between 1950 and 1960, as well as the issue falling by the wayside as industrial labor began an exodus from the area.⁴² They never truly learned this lesson in the mining operations of the Tri-State District, and they have had to face serious social, environmental, and economic problems throughout the entire 20th century. Industry can learn an appropriate lesson with its experience of silicosis. Without proper planning and research, industrial disease can easily become a serious issue. Silicosis was quite right to be called an industrial plague, and easily could happen in today's industry. As always, vigilance and preparation are to be considered goods in industry, and are lessons that must be taught and practiced seriously.

⁴¹ D. A. MacGregor, "Silicosis – Its Prevention and Treatment," (Reprinted from *West Virginia Medical Journal* (Sept. 1945)): 11, Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS; Dudley Irwin, "Address of Dr. Dudley Irwin" (address at the meeting of the Jackson County Medical Association, February 27, 1945): 29-30, Box 69: folder 1403, Pitcher Collection, Pittsburg State University, Pittsburg, KS.

⁴² A. M. Gibson, *Wilderness Bonanza: The Tri-State District of Missouri, Kansas, and Oklahoma* (Norman: University of Oklahoma Press, 1972), 195; Gerald Markowitz and David Rosner, "'The Street of Walking Death': Silicosis, Health, and Labor in the Tri-State Region, 1900-1950," *The Journal of American History* 77, no. 2 (Sep., 1990): 550-51.

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Bamberger Paul J. "Aluminum Therapy in Silicosis: A Clinical Study of the Comparative Effects of the Metallic Powder and Hydrated Alumina." *Industrial Medicine* 14, no. 6 (June 1945): 477-79.

The author in this article explains his experience while experimenting with aluminum. In detail he outlines his attempt to replicate the results of the McIntyre Research Foundation doctors. In his conclusion, he states that no objective improvement was noted and that the aluminum hydrate powder was preferable over metallic aluminum.

Banks, Daniel E., Marvin Balaan, and Mei-Lin Wang. "Silicosis in the 1990s, revisited." *Chest* 111, no. 4 (1997): 837-39. In the *Academic OneFile*, http://find.galegroup.com/gtx.infomark.do?&contentSet=IAC-Document&type=retrieve&tabID=T002&prodId=AONE&docId=A19365592&source=gale&srcprod=AONE&userGroupName=psu_main&version=1.0 (accessed November 4, 2010).

The authors of this journal article discuss their findings of silicosis in industry during the 1990s. The silicosis that was such a plague in early industry by their report is shown to still be a health risk of industry during the 1990s.

Crombie, D. W., J. L. Blaisdell, and G. MacPherson. "The Treatment of Silicosis by Aluminum Powder." Reprinted from *The Canadian Medical Association Journal* (April 1944). Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

In this article, the authors recount the results of their experiment with aluminum therapy over a period of three years. They concluded that aluminum administered to silicotics was completely harmless. Some cases even showed improvement and so aluminum therapy was recommended as a prophylactic treatment.

Denny, J. J., W. D. Robson, and Dudley A. Irwin. "The Prevention of Silicosis by Metallic Aluminum: I. A Preliminary Report" *The Canadian Medical Association Journal* 37 (1937): 1-11.

In this report, the authors outline their experimental work with aluminum in the treatment of silicosis. At the time this was printed, the work surrounding aluminum therapy was still in its early stage at the McIntyre Research Foundation. Currently the experiments have been limited to animal testing and the researchers present their findings from the test animals in this report.

Denny, J. J., W. D. Robson, and Dudley A. Irwin. "The Prevention of Silicosis by Metallic Aluminum: II." *The Canadian Medical Association Journal* 40 (1939): 213-28.

The journal article discusses the findings of further studies having taken place after the preliminary report issued in 1937. The article offers a conclusion that aluminum does work in halting the harmful effects of silica dust.

Gardner, Leroy U., Morris Dworski, and Anthony B. Delahart. "Aluminum Therapy in Silicosis." Reprinted from *The Journal of Industrial Hygiene and Toxicology* 26, no. 7 (September 1944). Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

The article is a description of the experiment that the authors performed to validate aluminum as an effective treatment in preventing and treating silicosis. They conclude that aluminum hydrate is superior to the metallic aluminum used by the McIntyre Research Foundation.

Halley, Paul D. and Alfredo Salazar. "Control of Industrial Dust Exposures." Conference on Silicosis and Aluminum Therapy, January 24-25, 1949: 11-14. Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

In this report, the authors outline the current industrial methods for controlling dust in the factories and mines. They advocate the notion that industrial hygiene must be factored in when planning new facilities. They state that long term sustainability of industry is tied to the control and promotion of good hygiene in industry.

Irwin, Dudley. "Address of Dr. Dudley Irwin." Address, meeting of the Jackson County Medical Association, February 27, 1945. Box 69, folder 1403, Pitcher Collection, Pittsburg State University, Pittsburg, KS.

In his speech, Dr. Irwin presents a current history of the silicosis problem affecting industry. He outlines his work with aluminum therapy and the advances that have been made to date at the McIntyre Research Foundation.

Kimberly, B. C. "An Introduction to Aluminum Dust Treatments at the Sullivan Mine." Box 61, Pitcher Collection, Pittsburg State University, Pittsburg, KS.

In this pamphlet, the author writes a brief description of the aluminum therapy treatment. The pamphlet was mainly a resource for miners at the Sullivan mine to become acquainted with aluminum therapy and its clinical benefits. Also outlined in the pamphlet was how the aluminum was to be dispersed and what the men needed to do while being treated.

MacGregor, D. A. "Silicosis – Its Prevention and Treatment." Reprinted from *West Virginia Medical Journal* (Sept. 1945). Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

In his report, Dr. MacGregor gives a clinical understanding of silicosis and aluminum therapy's effect on the disease. He comes to several conclusions among which he notes that

aluminum therapy is not an answer to eradicating silicosis but one method among many in its necessary prevention.

Spolyar, Louis W. "Industrial Hygiene Aspects of Silicosis." Conference on Silicosis and Aluminum Therapy, January 24-25, 1949: 7-10. Box 61, Pitcher Collection, Pittsburg State University Library, Pittsburg, KS.

In his report, Dr. Spolyar discusses the groups that must work together in controlling silicosis. He notes especially the importance of the workers cooperation without whom no progress can ever be made.

Tabershaw, Irving R., and Bernard D. Tebbens. "The Use of Aluminum in Silicosis Control." *Industrial Medicine* 14, no. 9 (Sept. 1945): 709-11.

In this article, the authors conclude that aluminum therapy has great potential in improving health conditions in the work place. They do, however, caution that aluminum therapy should only be administered in conjunction with health professionals and regular study of the patients.

Secondary Sources

Derickson, Alan. "'On the Dump Heap': Employee Medical Screening in the Tri-State Zinc-Lead Industry, 1924-1932." *The Business History Review* 62, no. 4 (Winter 1998): 656-77.

In his article, Mr. Derickson examines the relationship between business, labor, and government in combating the growing silicosis problem from 1924-32.

Gibson, A. M. "A Social History of the Tri-State District." *Chronicles of Oklahoma* 37, no. 2 (1959): 182-95.

In this article, Mr. Gibson documents the social situation of the tri-state district in the early mining camps. Comparatively the western mining boom and the tri-state area were fairly alike; however, Gibson notes the peculiarity and uniqueness that set the Tri-State District apart.

----- "Early Mining Camps in Northeastern Oklahoma." *Chronicles of Oklahoma* 34, no. 2 (1956): 193-202.

Mr. Gibson concerns this article with the history behind the mining boom in Northeastern Oklahoma. He documents the early discovery of lead and zinc in the early 1800s to the growth of the mining camps around the turn of the century.

----- *Wilderness Bonanza: The Tri-State District of Missouri, Kansas, and Oklahoma*. Norman: University of Oklahoma Press, 1972.

Mr. Gibson in this article describes the overall economic and social situation that led to a plague of silicosis in the Tri-State District. He discusses the contributing factors that led to the precarious situation and what the general response was to silicosis among business and society.

Markowitz, Gerald and David Rosner. "'The Street of Walking Death': Silicosis, Health, and Labor in the Tri-State Region, 1900-1950." *The Journal of American History* 77, no. 2 (Sep., 1990): 525-52.

This article is concerned with the predominant economic and social factors surrounding the silicosis endemic in the Tri-State District. The authors discuss the difficulties faced by labor during this era and their efforts in combating and recognizing silicosis.