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The Radium Dial Painters: Workers' Rights, Scientific Testing, and the Fight for Humane Treatment

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Abstract

From the early 1910s through the Great Depression, the dial painting industry provided opportune jobs for young female workers. Dial painting jobs did not require many skills but were well-paying professions. These careers attracted many young women and girls to work there. However, unknown to the painters at the time, the radium that they were using to paint the dial faces was slowly poisoning them and would later cause major health defects. Many of these women that did not die directly from the radium developed various forms of cancer and radium poisoning, which led to many lawsuits. New industrial and health reforms for workers were created as a result. Along with their impact on workers rights, the women contributed to the scientific understanding of radium by consenting to be test subjects after the court cases. Their unique history helped researchers determine safety levels of radioactive materials in a human being and set precedents for workers working in highly dangerous fields or projects, such as the Manhattan Project. Declassified documents from the testing facilities that these women visited, such as Argonne National Laboratory, help to shed light on the impact of the female dial painters. Doctors' memos, letters from the women, and test results illuminate the importance of the women's consent to becoming subjects and also shows that the dial painters' histories did not end after their trials in court. These documents help to show the importance of the women as subjects and that their legacies impact not only industrial reform, but also the understanding of radioactive materials.

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Introduction

The young women who worked in the dial painting industry from the 1910s to the 1930s are often referred to as the 'Radium Girls' and are best remembered for the changes their cases had on labor legislation. Despite the devastating ends to many of their lives, they are often memorialized for their testimonies and judicial fights that helped to transform workers' rights in the New England area and in Illinois. The court cases helped to reaffirm that certain legislations such as the Occupational Disease Act, were indeed constitutional. After their trials had finished, and many had died due to various cancers, the remaining dial painters submitted themselves to testing conducted by researchers at national laboratories. The studies conducted on the women were used to further research the impact of internal deposits of radium in human beings. These tests could not have ethically happened except for for the availability of a large population of former dial painters diagnosed with radium poisoning. These tests helped advance scientific achievements such as the Manhattan Project and understanding of the effects of radium on bone tissues.

While the women's history is best remembered for the court cases that were incredibly important to advancing workers' rights, and the numerous environmental changes in their home towns, their impact on the scientific research of radium has left an even longer legacy. While their story covers many fields and encompasses many issues, the main question surrounding their history is how did their lives impact the scientific field? Specifically, how did their situation lead to the advancement of understanding the effects of the element radium? Also, another question to be analyzed is why, when they were so valuable to the study of radium, were they never fully debriefed about the experiments? The dial painters were an invaluable group of women, whose

bodies, contained massive amounts of radium and who made their bodies available to be studied by scientific researchers to better understand how radium affects the human body with the hopes of discovering a cure for radium poisoning. However, they never received full results back from their physicians on what the tests found and were left in the dark about their own health. This was despite the fact that the main reason any of the dial painters helped the researching clinics was to get test results back to see if there was any way to cure them. The testing conducted on the dial painters benefitted the scientific community and helped advance knowledge of the effects of internally deposited radium but left the subjects frustrated with practices that appear unethical by current standards.

This paper uses newly released sources to reveal the importance of the dial painters' lives on the scientific research on radium such as: medical records, memos from Argonne researchers, and test results. Collections from the National Archive in Chicago were consulted and previously classified documents from Argonne National Laboratory were analyzed to reach this conclusion. These collections have just recently been opened up to researchers and gave insight into the practices of one of the testing facilities. Within these records there were also letters sent between the dial painters and their doctors that help us understand the thought processes of the medical staff conducting the tests. These sources are added to a larger group of records from the New England area, where testing was conducted on the New Jersey and Connecticut women. Combined, these sources provide a new perspective on the scientific legacy of the dial painters. These sources show that their impact on the scientific study of radium was just as important as their impact on labor legislation.

The Luminous Dial Painters

From the 1910s to the 1920s dial painting factories appeared in various cities throughout the United States. Three of these cities, Orange, New Jersey, Waterbury, Connecticut, and Ottawa, Illinois, housed dial painting factories that had the prestige of selling glow-in-the-dark watches and clocks. The key ingredient in making these products glow in the dark was radium. Mixed with a paint that consisted of radium, water, gum arabic, and a radium isotope called mesothorium, the luminous paint helped create a high demand for the trendy glow-in-the-dark clocks.[1] Run by two major radium companies, United States Radium Corporation in New England, and Radium Dial Company in the Midwest, these companies needed workers who could do precise paint jobs for factory wages. The factories ended up hiring mostly young women, aged anywhere from fifteen into their late twenties, to sit at desks and carefully paint numbers onto the dial faces. Throughout the decades that these facilities were in place, over 3,000 women were hired to paint the numerals on the clock and watch faces.[2] In order to get the most precise job done, the dial painters were instructed to lick the tips of the brushes, dip the brushes into the paint, and repeat as many times as necessary. By using the technique of 'lip-pointing,' as they called it, they were able to do their job faster and more efficiently.

As lip-pointing was the more efficient method, it became one of the main causes behind the dial painters' radium poisoning, as it caused the dial painters to continuously ingest more of the radium infused paint. After so many strokes the women would lick their brushes before placing them into the paint again, causing radium buildups in their mouths. In the 1920s, and into

[1] Joseph C. Aub et al., "The Late Effects of Internally-Deposited Radioactive Materials in Man," Department of Physics, 1952, Pg. 222
[2] Rowland, R. E., and H. F. Lucas Jr. Radium dial workers. No. CONF-8205170-1. Argonne National Lab., IL (USA), 1982.

the 1930s for the Ottawa workers, many dial painters ended up contracting serious diseases after leaving the companies. Many developed sarcomas and other forms of cancer in their mouths, hips, and arms. Some other women who went on to be mothers gave birth to stillborn children or children with deformities. Despite being assured during their time at the factories that the job was completely safe, many of the dial painters who remained in the factories continued to get sick while others left and began to see medical professionals. The cancers the dial painters developed were vastly different from each other and there was no uniform disease among them. Since the conditions of the women were so different from any other cancer or sarcoma previously seen, the doctors of the towns came to realize that the one common trait between the dial painters was their workplace.

In each town, both dentists and doctors struggled to figure out how these women contracted their cancers. In all three of the towns, the first professionals that the women went to see were their dentists. Mollie Maggia from Orange was one of the first dial painters to notice she was ill. She began to notice her mouth hurting and went to her dentist, Dr. Joseph Knef, to have her teeth pulled. Soon other dial painters were quickly going to their dentists and physicians to also have their teeth pulled. Numerous doctors and dentists in Orange quickly reached out to each other trying to figure out the connections between these dial painters and if the doctors of Orange had an answer. Eventually, the women were directed by their physicians to Dr. Harrison Martland, who would go on to help them in the court cases and would be their main physician throughout their lives. It was after collaborating with Orange's other doctors that Martland realized that the only connection these women had was their workplace. It was Martland who

pieced together that they needed to hold their employers accountable for their illnesses and suggested that they should get the company to help pay their medical bills.

Taking advice from their doctors and coming together, the dial painters demanded compensation from their employers. In each city, the companies fought compensating the dial painters and eventually were taken to court by the dial painters. After investigations and reports had been filed showing there was maltreatment of the women while they were working there, the women were able to find lawyers willing to take their cases to court. Each set of dial painters faced different trials in their cities. The dial painters in Waterbury found the company willing to comply if only to prevent any further damage to the business. The company quickly agreed to a settlement to prevent a large media presence in the court. The settlement was quickly agreed to but was a meager one that the Waterbury dial painters quickly found did not cover their medical needs.

In contrast to the dial painters in Waterbury, the women in Orange, New Jersey had a very public trial with massive amounts of media attention. The Orange dial painters had the best documented case as they dealt with a long and drawn out trial that resulted in a compromise between the dial painters and the company. It was agreed that the dial painters were lied to about the nature of their work and not given proper safety precautions, and needed to be compensated. It was also clear that the women needed continuing medical attention. The courts agreed that three doctors would continue to examine the women, and if at any point they deemed them cured of their cancers, then the company no longer needed to compensate them. The dial painters would choose one doctor, the company another, and both would agree on a third, neutral party. This became problematic to the Orange dial painters as they need two out of the three doctors to

agree they were sick, and if two decided they were cured then they would no longer receive the small, but necessary compensation they were receiving. Compared to the women in Ottawa who struggled to continue paying for their lawyers and trials. In contrast to the Orange dial painters, the Ottawa women received little to no sympathy from the media and had difficulty even getting their cases to court. They did eventually receive compensation, but it was a much longer and drawn out procedure.

After the women went through their court trials, and despite their different outcomes, the next chapter in their story involves the medical testing that was done on them. For over sixty years, there have been some 2,400 studies done on people with internal radium deposits in the United States, most of them being the former dial painters.[3] From the 1930s to the 1940s, Robley D. Evans from MIT conducted research on former dial painters to determine the tolerance level of radium in a human being, which would later be used by the National Bureau of Statistics. One of the first impacts that the women had was to help scientists studying radium or radon, especially with nuclear weapons, determine the safety levels of certain radioactive elements in a human body. This would benefit researchers working on the Manhattan Project, and was one of the largest lasting impacts of research done on the dial painters.

Although MIT was the first to begin testing on the radium in the dial painters, it was not until the 1960s that the Argonne National Laboratory in Illinois would conduct the most experiments done on the women. At Argonne, the Center of Human Radiobiology was created with the primary focus of studying the radioactivity in the dial painters. There, most research was conducted on the Ottawa dial painters and aimed to determine which types of radium or radon

[3] R. E. Rowland. "Radium in Humans: A Review of U. S. Studies," *Argonne National Laboratory* (1994): 1.

were the most dangerous and in what amounts. The women who participated did agree to the experiments, mostly in order to help prevent any similar accidents from happening again, however, the testing done did not follow ethical practices. For starters, the women never received the results of the experiments done on them. For over three decades, Charlotte Purcell, one of the dial painters, was constantly asked to return to Argonne. The constant demand for the women to return to Argonne for mentally and physically difficult tasks lasted until the 1990s when the program ran out of funding. Marie Rossiter recalls the demanding tasks that they asked her to perform and being at Argonne for hours while not being allowed to move very much, all without ever finding out the results from the laboratory.[4] Argonne never returned the results to the women, or if they did return results, they were just confirmations that they were ill. The responses just assured the former dial painters that their health was not going to worsen. Argonne sent out less alarming results while continuing to experiment on the women without the proper consent. Even though the story of the dial painters continues long after their trials, and their tribulations continued throughout the rest of the century, the testing done on the women has led to their greatest impact. Most of the dial painters have passed away by the writing of this paper as there is only one known survivor, 104-year-old Mabel Williams. A majority of the women died without receiving full results from Argonne.

At the same time, the Environmental Protection Agency became interested in the Ottawa dial painters and their factories. After the shutdown of the factories, the companies were told to dispose of the radium. However, the companies in Ottawa did not follow the proper procedures. They dumped the radium in the two local rivers, the Fox and Illinois, and under various parks in

[4] *Radium City*, directed by Carole Langer (1987; Carole Langer Productions) minutes: 45-46

the town. To the present day, the radium is still a problem as there are high levels of radioactivity in the area and the EPA has been trying for decades to properly remove the radium now turned radon. Originally there were 14 areas that were contaminated in Ottawa. Now the EPA has reduced those areas to just two, but clean up is still needed to remove the final traces of the Radium Dial Companies' mark on the town. The contamination of Ottawa is the final effect of not only Radium Dial but the radium dial painting business. Spanning almost a century, the effects of the luminous dial painting industry and its workers have been a quiet, but prevalent, event that has transformed legislation, geography, and scientific knowledge of radium.

Historiography

Previous historians investigating the 'Radium Girls' have been fascinated with understanding why these deaths happened and what legacy these women have left behind. From there, researchers have been divided in their answers to those questions and have taken unique approaches to retelling the stories of the luminous dial painters. Although there are masses of records on the dial painters and the scientific observations done on them, there are actually only a few secondary accounts on the dial painters. After researching this topic, it is understandable why there are so few sources on the dial painters outside of the scientific community. Historians recording these stories have to deal with the lack of cooperation from the towns, the inability to read sources about the dial painters as they have been classified as confidential by the laboratories that conducted the studies, difficulty in reaching major participants in the story, and many other problems. For those who have been able to use the resources available to them, they have all asked the same fundamental questions regarding these cases: who is responsible for

these accidents, and is it even possible to pin it on one party? How were these accidents permitted to occur? In what ways are these accidents relevant to the study of industrial hygiene in the United States?[5]

When the women were still alive, there was an abundance of interest in understanding what effect the women's plight would have on industrial legislation. Journalists, scientists, and lawyers kept the dial painters in the limelight with a plethora of reports, conferences, and hearings surrounding the dial painters' cases, which has provided an abundance of primary sources on the dial painters. Once the major court cases had subsided, federal laboratories took interest in the women and conducted tests on them. The testing was meant to help determine the effects of radium internally deposited in a human body. The testing on the women led to reports on them, radium, and radiation that would go on to help scientists involved in major experiments, such as the Manhattan Project, determine the safest amounts of radiation allowed in a human being. After the end of the Atomic Era, there was a decline in research on the levels of radiation in humans.

Now that the majority of the dial painters have died off, along with the lack of urgency by the government to understand the impact of radium on human individuals, there has been less interest on the radium dial painters' stories, with the exception of a play by Melanie Marnich. It would be negligent to ignore the play, *These Shining Lives*, that has inspired a spark of interest in the public and investigators alike.[6] Although the play has been useful as it has inspired many to take interest in the story of the women, it has led to a collection of biased researching that makes

[5] "Industrial Hygiene" was the science concerned with the protection of workers' health and safety. The term gained popularity around the early 20th century and industrialist hygienists focused the improvement of health for workers. Their main job was to make sure the work environments were safe and that all workers were protected from workplace hazards.
[6] Marnich, Melanie. "These Shining Lives".

historians place the characters in this story into villain and victim categories. Despite the fact that the people involved in these stories can be painted in black and white easily, and understandably, it has still led to emotional and partial research that makes it difficult to separate history from editorial remarks.

One of the most recent authors to research the dial painters is Kate Moore, author of *The Radium Girls: The Dark Story of America's Shining Women*. Moore has unearthed masses of sources that had previously been sitting buried in archives. She has also written a heavily editorialized version of the events surrounding the women in Ottawa, Illinois, and Orange, New Jersey. Her book recounts the events of the women in both cities, along with touching a little on the dial painters in Waterbury, Connecticut, and recounts their stories from the beginning of the dial painting industry to the court cases of the women, ending by giving a few remarks about them being tested on in the epilogue. It is clear that she got her inspiration from the play, as she "directed an acclaimed production" of it in 2015, and her narrative echoes the tone of the play.[7] Moore's research covers mostly the girls' trials and the impact of their suits, which is what most people discuss when writing about the dial painters. She begins with the start of the more important radium companies and the eventual hiring of the dial painters. The book continues their story all the way through their lawsuits and trials, ending in the epilogue with small details on the women become experimental subjects. Her focus is mostly narrowed down to the court trials of the dial painters, but she does still shed some light on the story and can continue to be useful to researchers investigating the stories of the dial painters.

[7] Kate Moore, "Author's Background," in *The Radium Girls: The Dark Story of America's Shining Women*. (Naperville: Sourcebooks, Inc., 2017), back cover flap.

Moore's strength comes from her ability to give each historical figure involved in the story individuality, something that has been lacking in other recountings of the history. She gives each figure depth that makes it easier to keep track of the important members and the details of the story. Moore's book is a decent starting point for first time investigators trying to understand the story and what happened. She describes each individual figure in great detail by providing each major dial painters' background and history, giving them personality, and allowing them to stand out and be memorable. Her ability to painstakingly explain every change, reversal, and development in the trials makes the trials easy to understand and helps break down the legal jargon for confused readers. Her book gives a nice outline of the radium dial painters' story from their time as dial painters through to their trials and lawsuits. Her book has its drawbacks as it has an emotional account of the history, but it is a good starting place to understanding the story of the radium dial painters.

On the flip side, Moore's book reads more like a novel rather than historical research. It is clear that her inspiration for doing research came from the play by Marnich, which in itself is fine. By reading her work, it is clear that Moore is an author first, historian second. She has styled her research in the form of a play. She begins her book with a few pages dedicated to a "List of Key Characters," and lists the various major historical figures from Orange, Newark, and Ottawa, ranging from the dial painters to doctors, lawyers, investigators, and businessmen.[8] She treats the history more as an interesting backdrop for a story rather than history itself. She still is very concerned with accurately retelling the history, and has gone to great lengths in researching the topic, but her final version of the story is a dramatized one. Even though her

[8] Moore, *The Radium Girls*, xi-xiv.

research, for the most part, is sound, she does have some questionable sources such as "findagrave.com" and "medicinenet.com" that she lists. That being said, she has uncovered many missing letters and reports on the women. At the LaSalle County Historical Museum in Ottawa, Moore asked to look at any artifacts the museum had and happened upon letters from one of the dial painters, Catherine Donohue. When Moore told the archivists that the letters were in a random folder, one archivist responded that they had no idea that they were there.[9] She takes these resources and uses them to tell a story where each historical figure is placed in a specific role of oppressor or victim. She uses incredibly flowery language that makes her book read more as a tragic novel rather than research and is unable to give an impartial account.

Moore's book is still insightful and has helped many future researchers by helping local archives relocate and rehouse important resources related to the story such as the Catherine Donohue letters in LaSalle County Historical Society.[10] The local historians had thought the artifacts to be lost and have undergone a mission to catalog many of the artifacts that are important to telling the story of the dial painters. Moore also gathered her research by interviewing many surviving family members of the dial painters. Although the material that she wrote using these interviews was more anecdotal, and therefore not very useful for this research as it was used more to understand the personality of the dial painters, she still did track down numerous family members and was able to gather interviews in order to write her work. She uses interviews, the court cases, and newspapers from the time to construct her narrative.

[9] Kate Moore, "The Girls with Radioactive Bones: How the 'radium girls' revealed the danger of radiation, and fought for safety standards*,"* interviewed by Sarah Zhang, *The Atlantic*, March 1st, 2017, https://www.theatlantic.com/science/archive/2017/03/radium-girls-kate-moore/515685/

[10] Kate Moore, "The Girls with Radioactive Bones" Interview with Sarah Zhang, *The Atlantic*, 2017.

To contrast Moore's work, Claudia Clark's *Radium Girls: Women and Industrial Reform 1910-1935*, lacks the stylized storytelling but makes up for it in the academic research. A much more scholarly version of the story, Clark utilizes newspapers, scientific journals, reports, court transcripts, and industrial laws to explain the history of the dial painters. Clark's book has the most scholarly research and is still the best source on the radium dial painters. Whereas Moore's book is an easier read for casual readers, it is clear that Clark wrote her book specifically for the intended audience of academic scholars, and does the best job at examining both the historical contexts and impacts of the dial painters.

Clark shows her knowledge on the topic by including a thorough explanation of not only the history of the radium dial painters, but also the importance of radium, business, legislation, industrial hygiene studies, and government in the women's stories. She carefully devotes chapters to each of these categories and goes into great depth explaining the history of each one. She begins by retelling the history of radium, and how the scientific field and the public's opinion constantly shifted on the validity of its healing powers. She uses scientific reports and journal articles to explain not only the discovery of the element but also the science behind it and the impact radium had on the scientific and industrial fields. From there she begins discussing what is at the heart of her story: the changes between industrial legislation and industrial hygienics because of the radium dial painters. She continues to use scientific reports and journal articles to clarify the importance of both fields, including their historical backgrounds and goes on throughout the book to examine how they changed as a result of the dial painters. Clark does a solid job at providing the context surrounding the women's plight and does the best at showing

the surrounding circumstances while trying to answer her own question of why the radium dial painters were so influential at changing industrial reforms.

Her other strength is that she takes a more nuanced approach to understanding the main characters and circumstances in the story. Unlike Moore, Clark is more sympathetic and paints each historical figure as human, rather than as a villain or victim. Not to be mistaken as a corporate apologist, Clark still does present the story as the women being wronged, but rather Clark at least presents multiple perspectives to the story showing that this history is more complex than just the dial painters being taken advantage of. Clark shows that legislation, capitalism, and other intangible concepts were more at fault than any human, giving her book more distinction from her contemporaries as her research and presentation are the most scholarly.

Clark's book is the strongest source on the dial painters although it does have its drawbacks. By providing the different contexts necessary to tell the radium dial painters' stories, she almost spends more time discussing industrial reforms rather than the women themselves. To contrast Moore, who almost went too in-depth on each girl, Clark barely touches on the individual dial painters themselves and rather views them as a group that pertains to industrial reform rather than the main actors in their own history. Her intent is clearly to discuss how the women impacted industrial legislation and the field of industrial hygiene, but she focuses more on the political and social factors surrounding the cases rather than the cases themselves. The narrative is more about the industry during the interwar period rather than the dial painters.

The other big drawback to Clark's book, which is a fault that most researchers investigating this topic seem to have, is that she covers very little on the dial painters in Waterbury, Connecticut. Whether it is lack of resources or relevancy, many researchers,

including Clark, seem to gloss over the Waterbury dial painters and usually only include them when they are relevant to the dial painters involved in Orange, New Jersey. On top of giving the Waterbury dial painters less attention, she also places heavy importance on the Orange women over the Ottawa ones. Clark frequently references the importance of the Orange dial painters on industrial reform throughout the book. To contrast, she only gives the Ottawa dial painters one chapter, and the Waterbury women have to share a chapter with the women from Orange. She does often reference all three cities and their dial painters throughout the book, but the Orange dial painters are much more prioritized compared to the others.

Even with these criticisms, Clark's book is excellent source that expands on the history of the dial painters. For those doing further research beyond just the tragic version of the dial painters, Clark's book is the key secondary source to be read.

When discussing the story of the dial painters, there is a documentary that every researcher comes across. Carole Langer's *Radium City* is an unpolished, unrefined, but accurate and candid, documentary about the radium dial painters in Ottawa, Illinois.[11] The documentary focuses more on just the Ottawa women, yet it still does at least acknowledge the Orange and Waterbury women as well as providing quick context about the dial painting industry, industrial legislation, and radium itself. It is easy to point out the faults of Langer's work and is the easiest to criticize and dismiss. Langer's work does make the best use of testimonials and interviews, better than any book. Langer, and Ken Ricci as the narrator, utilize in-depth interviews that give not only an insider's perspective on the factories and the courtrooms but also gives the actual dial painters the loudest voice out of all the secondary sources as there are interviews with some of

[11] Carole Langer. 1987. *Radium City,* 1st ed. Ottawa, IL; Carole Langer Productions

them. Langer's strengths come from the personal connections with the town, Ken Ricci is a local from Ottawa, and he is able to get in-depth interviews with the women, locals, and others involved. Even if her documentary is one of the older secondary sources, as it is from the 1980s, it is still beneficial as hers was one of the last chances to get a comprehensive collection of memoirs and interviews from the main figures directly involved in the history of the luminous dial painters.

In order to understand Langer's work, the faults and drawbacks must be addressed. Poor quality even for 1980's standards, the documentary is simply unpolished. Ricci as a narrator brings a local perspective to the story but also, he is not the most professional as he appears to often start scenes without any script or goes off book very often. Frequently, Ricci just says what he is thinking without any editing to fix it later. This does not matter to the historical accuracy but it leads viewers to question the skill of Langer to investigate the history. Even with these drawbacks, Langer's work is still beneficial and deserves to be used as a valid source for researching the radium dial painters.

There are other works on the 'Radium Girls', but these three historians, and their work, are the most relevant to this paper's research as they all focus on a majority of their history. These three follow the dial painters from the time they are hired, and mostly, until the end other testing with the national laboratories. They focus on the industry of the times, the trials of the women, and the scientific tests conducted on the women. All of these topics relate to the subject of the paper and are the context in which it is written. It is important to not only understand the historical discussion about the women, but also the historical context during their lives.

Radium

To understand the intensity and impact of the dial painter's stories, it is necessary to first understand the element that shaped their lives. Radium was first discovered by Marie and Pierre Curie in 1898 from a uraninite sample. It has had a constantly evolving reputation; from the unstable and dangerous element to the miracle cure, only to revert back to a killer element. In its pure silvery-white form, radium is incredibly radioactive, and when it is isolated it can glow in the dark while radiating heat. Radium is measured in Curies, a unit which calculates the radioactivity of the element. The Curie judges the speed with which radiation leaves an unstable atom within an element and thus measures how radioactive an element is. A Curie would be formed around the radioactivity of radium. For example, it can be shown as 226Ra, and will be used as a reference for measurements throughout this paper; for a comparison, one unit of radioactivity is measured as 3.7 x 10^10, which is the amount of one gram of radioactivity.

When the Curies first discovered Radium, they were not immediately able to isolate radium from the radium chloride that they found in their sample, and it was not until 1902 that they were able to isolate it completely to call it its own element. Throughout this process, many scientists were wary of the element as it was incredibly unstable due to the large size of the atoms. Along with the unnerving size of the atoms in radium, there was the fact that it had the ability to burn skin with very little physical contact. As observed by physicist and chemist Henri Becquerel, who in 1901 carried around a small radium sample in his vest for a day. After the end of the day, Becquerel realized there were large burns on his skin just under where he had placed the sample.[12] The reasons for the burns was because of the different types of radiations that came

[12] W. J. Hammer, "Edison's Tungstate of Calcium Lamp - The Nernst Lamp - Radium, Polonium and Actinium," in *Transactions of the American Institute of Electrical Engineers.* vol. XIX, pp. 67-75, (Jan. 1902).

from radioactive elements. When an atom in a radioactive element becomes unstable by either having too much energy or mass, it needs to release some of that extra energy or mass, and it does so in the form of radiation. Now, when particles are released in order to stabilize the atom, they can take form as either alpha, beta, or gamma rays. Alpha particles are positively charged and have a larger size and are able to disrupt other atoms on their path of movement. An alpha particle is large, but it is unable to travel very far and cannot pass through any real thick material. Compared to beta particles, which are negatively charged and fast moving. They also can disrupt close atoms and are able to pass through both clothes and skin. Gamma radiation is from the other two but is the most similar to X rays because both rays can destroy tissue. Gamma is able to pass through far thicker surfaces and is able to pass through the entire body. Although gamma can pass through far more tissues, it does not do as much damage as alpha or beta if they are close to the target.[13] These distinctions will prove relevant to the dial painters' cases when discussing their medical findings. The distinctions also show why radium, and other radioactive elements, were seen as dangerous and unstable. As soon as any atom becomes unstable, radiation is emitted and serious harm can happen to bodies near it, such as what happened to Becquerel, and would later happen to the dial painters.

It is also important to note that there are different types of radium. They are all the same element but appear in different forms. The two major forms, and the ones relevant to this case, are radium 223 and radium 226. There the largest difference between the two is their weight, and what they are used for. Radium 223 is typically used in medical treatments, such as chemotherapy, and mainly for advanced cases, and is less dangerous. Also, it is important to note

[13] Aub, J., "The Late Effects of Internally-Deposited Radioactive Materials in Man" Pg. 225

that no actual radium is directly applied to the patient; instead the alpha rays are sent out, kill the dead tissue, and leave the body relatively quickly. Radium 223 typically decays after a month, and any radioactivity leftover usually disappears after the month as well. There is a major difference in that radium 226 is much heavier and has a far longer lifetime. Radium 226 has a half-life of 1,600 years, meaning that only half of the radium will decay after that time, and after 3,200 years, the radium, in theory, would finally decay all the way. Should a person come into contact with radium 226, it would take 1,600 years for half of it to leave their body, and the person would have radioactivity in his or her body well after they had died. The distinction here is important because radium 226 is the version that most scientists refer to when discussing radium, and it was also the radium that the dial painters used for the paint.[14]

When radium first began circulating into use, scientists tried using radium in its purest forms for medical purposes. One way that radium was used was similar to the way X-rays were used to fight cancer. When X-rays were first becoming popular for examining bones in the late 19th century and early 20th century, many scientists found the biggest side effect was that sometimes X-ray radiation burned the skin it was examining. Many felt uneasy about using X-rays for further use as it was controversial, still, researchers realized that X-rays, and eventually radium, had the ability to target unhealthy cells and eliminate them. Scientists began using these rays and the radiation from radium to target unhealthy cells in diseases, such as cancer, and attempted to eliminate them. The earliest forms of chemotherapy came from the time that radium was first being understood. Since the radioactivity of radium was able to successfully help eliminate various medical issues, not only cancerous cells but also unfavorable cosmetic

[14]Maria Rentetzi. "The Women Radium Dial Painters as Experimental Subjects (1920-1990) Or What Counts as Human Experimentation," *NTM International Journal of History & Ethics of Natural Sciences, Technology & Medicine*, September 2004, pg. 1

blemishes such as unwanted body hair or warts, scientists began applying radium to other experiments.[15]

By the early twentieth century, radium was perceived to be the miracle cure for many ailments. If radium was too difficult to obtain, due to its rarity and high price, radon became a popular alternative. Radon is a decay product of radium after radium transmits energy or mass into other elements due to an unstable atom, the radiation emits radon. Products such as radon or radium water, the later product of Radithor being the most popular, became incredibly prominent. The product was made by distilling water and exposing it to various amounts of radium. Patients were prescribed it by their doctors for any abnormality from cosmetic differences, to be used as an aphrodisiac, a treatment for gout, or for anyone that desired a mineral water to feel better.[16]

Along with vitamin supplements, radium became the poster medicine for all cures, and much of it was promoted by the Standard Chemical Company. They promoted radium as a treatment for anything from arthritis to diabetes to gout. Radium and radon were starting to be added to medicines and were sold as either a part of a prescription or as a vitamin supplement. Along with the medicines, the rise of radium spas grew. Health spas had already been on the rise, especially in European countries after alpha-particle emitting isotopes of radon were found in an Austrian hot spring and were seen as natural panaceas.[17] Since it was a gas, radon could be pumped into the spas and since it had a shorter life than radium, it was not as harmful to participants. The spas were a huge success and introduced a larger population to the intriguing

[15] Roger M. Macklis, "Radithor and the Era of Mild Radium Therapy," *Journal of American Medical Association,* 1990. Pg. 617
[16] Ibid.
[17] Macklis, R.M. "Radithor and the Era of Mild Radium Therapy," Pg. 615

healing properties of radium. They also led to the rise of radium-induced products, such as Radithor, as physiologists realized they could market mineral water from the hot springs infused with radium to patients to treat a wide spectrum of diseases. Due to the fact that radium was considered to not be a drug, but rather a natural element, it was not regulated by the Food and Drug Administration and attributed to a large increase in demand for treatments containing radium.[18]

After the success of spas and chemotherapy began a long, and dangerous, era of science quackery involving radium. By the 1920s, radium's success in the medical fields led researchers to try to apply it to more over the counter drugs. People would genuinely believe that because medical experts used radium in major treatments that, in smaller doses, it would be safe and easily applicable to other treatments. There was a high demand for radium because of the popularity. According to a public health record, almost every type of doctor had some type of radium on hand; a practicing physician may have 25 to 50 millicuries on hand and "nearly every dermatologist has 10 millicuries or more on hand."[19] The fact that dermatologists trusted radium to be put directly on their patients face shows the faith scientists had in radium's health benefits.

Part of this allegiance to radium's effects was that in 1913 Standard Chemical, one of the largest radium distributors at the time began production on the element. They promoted it to researchers and scientists as a medicine to be used for numerous ailments from gout to cancer. Along with encouraging physicians to use radium as a medical therapy, there was pressure on medical journals to also look into the benefits of radium. The magazine, *Radium*, which was

[18] Ibid.
[19] Terrill, James G.,Jr., Samuel C. Ingraham II, and Dade W. Moeller. 1954. "Radium in the Healing Arts and in Industry: Radiation Exposure in the United States." *Public Health Reports* (1896-1970) 255-62, http://www.jstor.org/stable/4588736.

supported by the radium industry, became popular and would provide information for more famous journals, such as the *Journal of the American Medical Association*, and helped encourage even the most hesitant doctors to the element in treatments.[20] There were few who questioned radium's effectiveness after these journals publications and it would be years before there was major skepticism of radium. The perception of the element had changed from dangerous to miraculous. This was just the start of radium being used as a medical cure, as eventually the quack science would expand even further.

Once radium gained popularity, advertisers quickly realized that whatever product they were selling could become in high demand simply by placing 'radium' on the label. Radium was such a hot commodity for not only medical purposes but also for food consumables, toys, watches, makeup, etc. People realized that almost any item that could be marketed and sold, radium somehow found its way on or into it. One trendy item in the 1920's was a mixture called Undark that people marketed as a paint to apply to almost anything; dials, house numbers, flashlights, even the buckles on bedroom slippers, and pretty much anything else that could glow in the dark, Undark advertised for it.[21] Undark used radium 226 mixed with zinc and sulfide which does dilute some of the radium but not enough to be considered safe by today's standards.

Another popular item to place radium in was makeup, as can be seen by the French brand, Tho-Radia which included radium to make faces radiant with an extensive line including foundation, rouge, lipstick, and everything else that can be put on a face. This was created by Dr. Alfred Curie, who has no relation to Marie or Pierre Curie, but his name alone helped sell the product because of its correlation to radium. Some products did not even contain radium, such as

[20] Clark, C. "Radium Girls" pg. 55-57
[21] Radium Luminous Material Corp. 1921. "American Advertisement for Undark Radium Luminous Material." *The American Magazine,* Vol. 20, Frank Leslie Publishing House, 50 Pine Street New York City, NY

"Radium Brand Creamery Butter," but he still wanted to get in on the radium craze and offered that their product had the same health benefits as if radium were in it. Radium was seen as not only a cure for aches and pains, but also to bring color to faces, boost mental happiness, and overall energy to a person. Sellers of radium thrived in the 1920's by reaching every possible item and medicine by persuading the general public that radium was the newest and healthiest addition to daily lives.

With the high demand for radium induced products also came resulting tragedies, even before the dial painters. There were deaths resulting from the tonics, such as Radithor, and famous deaths, such as Eben Byers, drew some skepticism to the new craze. Most researchers investigating radium or the dial painters always feel the need to bring up Byers, and it is understandable. Despite the fact that Byers' untimely death did not happen until 1932, he is still relevant to the historical context by showing the blind trust that was placed in radium and physicians. His death is also useful as it helps to understand that it took until the 1930s for radium's safety to nationally be called into question. Eben Byers was an athlete best known for his golf championships in the early 20th century and was also a socialite. Radithor was recommended to him by his physician, William Bailey, as a supplement to help him reach top physical shape. He, along with some of his socialite friends, drank large amounts of radium for several years until 1930 when he stopped due to failing health. He died in 1932 at the age of 52. His death was attributed to radium poisoning, and sparked a national look at radium's failure as an internal medicine. Many of Byers' symptoms, such as jaw loss and abscesses in the brain, would be very similar to the symptoms of the dial painters during the same time. Byers' fame

helped promote some awareness of the lethality of radium, but it would not come until the 1930s after many of the dial painters had already come and left the business.[22]

The Legislation and Industry of the Times

As the studies on radium changed the public's perception of the element and use in the medical field, the industry of dial painting began to emerge. Prior to World War I, radium was extracted mainly for curative purposes. In 1913, Sabin von Sochocky, one of the founders of United States Radium Corporation, created his famous luminous paint that would later be used by the radium girls. The change in demand happened with the onset of the war when the need for luminous watches rose as soldiers required them, especially since they were more visible on the battlefield than regular watches. On top of the demand for luminous watches, the military needed luminous airplane instruments that the dial painting factories produced. During the height of demand, the plants were producing paint for compasses and gun sights for the military while making a large profit from the war. The factories that had been set up in Orange and Newark, New Jersey before the war would eventually have young, female workers in the factory seven days a week and had night shifts just to meet the demand from the military.[23]

By World War I, the luminous watches and the painting involved became the major source for radium products, rather than for medicines. By 1918, almost 95 percent of the radium produced was shipped to the dial painting factories for the watches.[24] After the end of World War

[22] Evans, Robley D. (1933). "Radium Poisoning a Review of Present Knowledge," *American Journal of Public Health and the Nation's Health.* 23 (10): 1017. doi:10.2105/AJPH.23.10.1017-b
[23] Moore, K. "The Radium Girls", pg. 7
[24] Clark, C. "Radium Girls" pg. 61

I, demand for luminous watches still remained high, but there was a decrease from the previous success of the business. Throughout the war and after, the Waterbury Clock Company did experience a high demand for luminous watches resulting in the company's switch to manufacturing glow in the dark watches for the average customer. Both companies had a steady business through the interwar years, but eventually, another company with similar practices opened up in the Midwest.

The third major dial painting company in the nation was located in Ottawa, Illinois, and operated under a rival company called Radium Dial Company. A division of the Standard Chemical Company, Radium Dial opened towards the end of World War I and operated near Westclox Clock Company, their largest client for luminous watches. Similar to the Orange and Waterbury plants, the Ottawa plant hired young women, from late teens to women in their mid-twenties, to paint dial numbers onto the clock faces, with radium induced paint. These factories would put out thousands of products each day with hundreds of dial painters working. The Ottawa plant differed from the Orange and Waterbury plants as the women worked in the local high school compared to the factories that the New England dial painters worked in. All three of these plants made up the majority of production for luminous dial painting for the country throughout the 1920s and into the 1930s. At the same time that these factories were being set up and their businesses were booming, there were larger events taking place that would shape the outcome of the dial painters' cases.

All three factories were located in different areas, but they all had the same training for the dial painters and each used the same techniques. Each painter would sit at a desk with a tray

of either twenty-two or forty-four dial faces, depending on size, and a slim camel-hair brush.[25] The brushes had an incredibly fine point but after a few strokes the brush would become larger and would need to be made into a fine point again. The smallest dial face that the women painted was only 3½ centimeters and the dial painters' work was closely inspected; the women were paid not by hours but by each dial painted. If there were mistakes on a dial they either had to go back and fix it or forfeit pay for it. On top of that, radium was still astonishingly expensive, and the women were reprimanded if they wasted too much radium on mistakes. Some workers were fired if they wasted too much of the element on their mistakes. In order to avoid making those detrimental mistakes, and instead get a finer point, the dial painters used the method of 'lip-pointing.' Since the women were paid based on how many dials they painted, rather than by the hour, they worked fast and would lick their brushes more in order to get through more dials. In theory, the dial painters with minimal skills could go home with a large paycheck; the top workers took home $375 a week in today's money. The large salaries that the women could make encouraged them to work faster and to utilize the lip-pointing technique more.[26]

The dial painters were instructed to also dip their brushes into a water dish to clean off the paint. After repeatedly dipping the brush into the same water, most of the radium paint would end up staying on the brush and entered the women's mouths by ingestion. The women also contracted radium by playing with it during their breaks. The next step after they had painted their dial faces was to send the dials to the 'dark room' where another girl would inspect the work of the painting and correct any minor mistakes. The dark room was kept dark to inspect the glow of the dials and make sure that they shone bright enough. However, during breaks or after

[25] La Porte v. United States Radium Corporation, 1935 New Jersey. 13 F. Supp. 263
[26] Moore, K. "The Radium Girls" pg. 8

work shifts, they would collect together in the darkroom and paint themselves with the radium paint. Undeterred by the rarity of the radium, the women snuck into the dark room, hiding from their supervisors, and played with the luminous paint. They would paint their faces, hands, nails, hair, with the radium to watch themselves glow in the dark. Often, if the women went out for the night, they would paint the radium onto their teeth to give them an extra glow. Not only did they ingest the radium via their lip pointing routine, but also by playing with it. They were assured numerous times by their superiors that the radium was safe for them. Along with the quack science craze that promoted radium as the miracle tonic, the women believed that radium was good for them and saw the applying of the radium as a similar way to taking vitamins. They believed because of the science of the day, and the assurance of their supervisors that they were in glowing health when working in the factories. Along with poor ventilation, the women would eventually become sick from their time at the dial painting factories.[27]

During the time that the dial painting factories were starting to boom, there were changes happening in industrial legislation. One of the major changes would be the rise of the Consumers' League, which would become a major influence on the dial painter's trials later. Founded in 1899 by Jane Addams and Josephine Lowell, the group's main goals were to make safe work environments for employees and a fair marketplace so that shoppers could consume products responsibly. As General Secretary of the Consumer's League from 1898 to the 1930s, Florence Kelley, once said, "to live means to buy, to buy means to have power, to have power means to have responsibility", which sums up the goals and aspirations of the league overall.[28] In 1900, New Jersey founded their own branch of the Consumers' League with the goal of pushing

[27] Ibid.
[28] Patricia Chappine "The Consumers' League of New Jersey: Major Campaigns and Activism of the Twentieth Century," *Saber and Scroll*: Vol. 2: Iss. 4, Article 5, 2013. pg. 24

through industrial hygiene reforms. The mission of the workers for the New Jersey Consumers' League came as a result of the Progressive reforms at the time. In the early years of the state's league, the main focus was on child labor and pushing legislation through so that New Jersey children could have shorter hours and higher wages as compared to other states. On top of that, the Consumers' League fought to get safer working conditions and balanced nutrition for the children workers. When the trials of the radium dial painters came up, the Consumers' League kept them in the same demographic as children because they were still young women. The ages of the young women, anywhere from fifteen to thirty, were what caught the attention of the New Jersey Consumers' League, who also sent agents out to help in Waterbury because it was close by, and the youth of the women first brought attention to the dangers of their workplace. As a result of the popularity of the Progressive reforms, the Consumers' League became a more prominent activist group. With the new acclaim, the Consumers' League began looking into the New Jersey dial painters' their safety and would later become an ally in their court proceedings.

One of the major players in the Consumers' League who had influence over the dial painters' investigation was Alice Hamilton. Hamilton's career began in the Hull-House started by Jane Addams and she had a reputable education with degrees for medicine from the University of Michigan, Universities of Leipzig and Munich, eventually switching to pathology at Johns Hopkins University. Eventually, she went to work on the Occupational Disease Act in Illinois in the early 1910s but became better known for her pioneer work in industrial toxicology. In 1910 she became part of a commission in Illinois that studied various industrial poisonings such as lead, rubber, and painting industries. She was later asked to conduct a similar study for all the states and she reported on the high mortality rates of workers in various industries. Her

focus would be on lead industries, but she still made her career on investigating industrial hygiene of all fields. She later joined Harvard University's Department of Industrial Hygiene, becoming the first female faculty member, and combined efforts between Harvard's team and the Consumers' League, and she accomplished this through Katherine Wiley.[29]

In order to tell the history of the dial painters, it is necessary to discuss Katherine Wiley. The executive secretary for the New Jersey Consumers' League, Wiley was one of the first to champion the fight for the dial painters and one of the first to take up the dial painter's cases. Coming from a settlement house before she worked for the Consumers' League, Wiley was one of the first, in 1924, to investigate the dial painters' working conditions. Throughout her career, she often looked into cases of poor occupational conditions involving female workers. Often during the early decades of the 20th century, there were few unions for female employees to turn to in the case of workplace hazards or unfair treatment. As seen later when the dial painters did not have a union to help them through their fights in court, many occupations for women did not have a union to help either research the dangers of the workplace or to fight for compensation later if an issue did arise.[30]

In 1923, Wiley wrote to Hamilton after attending different speeches from her for advice on various issues in the industrial hygiene field. Through their correspondence, Wiley and Hamilton learned more about the dial painters' plight and began formulating ways to investigate the factories of the dial painters. Hamilton would go on to give advice to Wiley throughout the entire investigation and lawsuits even when other leading professionals in occupational safety,

[29] "Alice Hamilton and the Development of Occupational Medicine" *American Chemistry Society* https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/alicehamilton.html#early-hazards-industrial-workplace

[30] Clark, C. "Radium Girls" pg. 80-82

such as the famous statistician, Frederick Hoffman, would end up hindering Wiley's fight for the dial painters. In 1924, after Wiley began her correspondence with Hamilton, she also reached out to John Roach, a part of the Bureau of Sanitation and Hygiene in New Jersey's Department of Labor, along with Frederick Hoffman. Hoffman was well known for his work in combating public health issues through his career as a statistician. He was of use to Wiley as he began to look into the conditions of the New England factories at her request. In 1924, Hoffman and Wiley would attempt to begin their investigation a year after one of the New Jersey dial painters, Irene Rudolph, passed away and her physician filed a complaint but found difficulties. Wiley appealed multiple times to the New Jersey Department of Labor to gain clearance for a full investigation but was consistently denied, usually on the basis that a full investigation had already been conducted and negative results were found, in defiance of being true. Wiley continued to try and appeal to the Department of Labor for clearance and eventually turned to the U. S. Public Health Service for help but still was rejected. This was due to the resistance from the radium companies every time a federal agency attempted to conduct an investigation.[31]

Eventually, it was not Wiley, Hoffman, or Hamilton who was the first to actually get in and conduct a full investigation of the dial painters, but rather a team from Harvard led by Dr. Cecil Drinker. Along with his wife, Dr. Katherine Drinker, and a colleague, Dr. William Castle, the three began their research in 1924 by visiting the dial painting factory in Orange. Requested by U. S. Radium Corporation to have some type of investigation conducted on the effects of radium on employees, Drinker and his colleagues began their investigation in 1924 and published their report in 1925. The reason that U. S. Radium Corporation finally allowed for an

[31] Ibid.

investigation was to quell the fear from workers about the possible dangers from the radium. After the families of Irene Rudolph and Marguerite Carlough filed claims against the company for compensation, there were large numbers of dial painters who quit or threatened to quit, out of fear of falling ill. On top of that, the company was trying to avoid a large class action lawsuit for compensation and wanted to put any fears about radium being hazardous to rest. They turned to Drinker and his team to begin an investigation that would help end the fear.[32]

When the Drinkers and Castle began their report they were more concerned with the ventilation of the factory rather than the actual lip-pointing methods implemented there. Due to previous studies conducted by Drinker and his colleagues, they thought that the ventilation, or lack thereof, would be the source of the problem for industrial workers, more so than other causes. However, as Drinker and his team found out, there were a multitude of problems. They were correct about the poor ventilation, so poor that the entire factory was covered by dust that had been contaminated by radium. But it was the technique of lip-pointing that was determined to be the most problematic. The constant repetition of the lip-pointing, along with the practices of the women playing with the radium and the coating of radium dust, caused major health defects to the female workers there. Many developed unusual sarcomas, but very often in different spots from the other dial painters. As documented in Drinker's report, most women complained of pain in their jaws, where they would eventually have tumors in their gums, but others also had hip or leg problems, which again would later become develop into sarcomas. Drinker and his colleagues came to the conclusion that the radium being ingested through the

[32] Clark, C. "Radium Girls" pg. 89.

paint and air was the cause of the dial painter's ailments, and wanted U. S. Radium Corporation to report the problems.[33]

The Drinkers and Castle wanted to publish their results immediately and to send a report to the Department of Labor. Yet, despite being asked by the treasurer of U. S. Radium Corporation, Arthur Roeder, to investigate the effects of radium on the Orange workers, Roeder threatened to sue if Drinker published his report. When the results of Drinker's report confirmed the fears of the dial painters, Roeder and other executives at U. S. Radium Corporation were unwilling to allow the report to be published. Already the perception of U. S. Radium Corporation was shaky and deteriorating. The last thing it needed was for a report confirming all the fears about working there. Drinker agreed not to publish the report in order to avoid being sued. However, he did provide suggestions to Roeder and USRC to prevent any further illnesses. Alice Hamilton heard about Roeder's refusal to allow Drinker to publish and put pressure on Drinker to publish it regardless of a lawsuit. It was later discovered that Roeder had submitted a version of Drinker's report to the Department of Labor but altered to make U. S. Radium Corporation appear more flattering. When Hamilton told Drinker of Roeder's actions, Drinker decided to publish his report, despite the possible legal repercussions.[34]

The women in both New Jersey and Connecticut had a state organization looking out for them, the women in Ottawa, on the other hand, had to rely on legislation. The Illinois Occupational Act, drafted in 1911, was one of the steps Illinois was taking during the Progressive Era to bring industrial legislation up to speed with other states. Illinois had struggled with industrial issues such as putting a limit on how many hours workers could work. In the late

[33] Castle, William B., Katherine R. Drinker, and Cecil K. Drinker. "Necrosis of the Jaw in Workers Employed in Applying a Luminous Paint Containing Radium." *Journal of Industrial Hygiene* 7 (1925): 371-82.
[34] Ibid.

19th century Illinois was considered to be progressive in making sure that workers were being paid well, and were safe while working. Jane Addams, one of the key reformers in the Progressive Age, was from Illinois and worked towards helping immigrants, women, children, generally anyone who was disenfranchised at the time, in the workplace. Attention was paid to the lack of quality care for workers under the leadership of Addams and the Hull House.[35]

By the 20th century, Illinois had fallen behind the rest of the country in industrial hygiene, and the Occupational Act was desperately needed. The reason that Illinois had lost its momentum in leading the country with occupational reforms was due to politically savvy manufacturers, who did not want to have to pay workers more for fewer hours. They played a game with reformers and instead of fighting them, they cooperated to an extent and were able to control regulation by challenging laws in court. For example, in 1909, reformers such as Addams lobbied for the Ten-Hour Law, requiring workers only work ten hours, but faced harsh opposition from manufacturers in court. Eventually the law passed. However, it is an example of the decline of Illinois's concern for occupational safety and health in the early 20th century as it became more difficult to fight big corporations in courts.[36]

By 1911, Illinois had hoped to return to its progressive roots by drafting the Occupational Disease Act. The Commission on Occupational Diseases had previously worked on a bill to pass in the Illinois State Legislature in 1911 that would expand existing requirements for sanitation, cleanliness, special protection of women and children, and regulations for dangerous industries, such as radium dial painting. It "was designed to ameliorate harmful and dangerous working

[35] Clark, C. "Radium Girls"
[36] Bruce, Andrew Alexander. 1909. "The Illinois Ten-Hour Labor Law for Women." *Michigan Law Review* 8 (1) (Nov.): 1-24, http://www.jstor.org/stable/1271580.

conditions and was humanitarian in purpose."[37] Due to unknown reasons though, the most likely being that the commission realized the manufacturers would never let their politicians pass the bill, it was switched. It eventually was switched to what would be the Occupational Disease Act. This act was meant to help compensate workers who suffered ill health at the hands of their employers, and the act specifies that the "aggravation shall arise out of a risk peculiar to….the employment."[38] The act was meant to help workers by forcing employers to focus on limiting exposure to dangerous chemicals for workers, administering medical exams to employees that work in at-risk jobs, and reporting any illnesses that arose amongst workers to the Department of Factory Inspection. Alice Hamilton fought to maintain most of the legislation that made employers accountable for their workers. Thus, the legislation then laid out that proper ventilation needed to be applied and that workers had to be notified that they were working with poisonous or harmful substances.[39]

The context surrounding the legislation that existed during the dial painters' lives helps to explain the obstacles they would later have to overcome in their court cases. Industrial hygiene was a relatively new area of study when the dial painters began working and the legislation needed to properly protect workers were not in place. There were reform movements that had made large strides to protect workers, but the laws that came, as a result, were either not applied everywhere or did not cover enough types of workplaces. Acts, such as the Occupational Disease Act, did not cover enough different types of work and did not allow for enough time to file for

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[37] Vallet v. Radium Dial 1935

[38] Occupational Diseases Act. 820. ILCS 310/1 sess.(1936): Chap. 48. http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2431&ChapterID=68

[39] "Alice Hamilton and the Development of Occupational Medicine" *American Chemistry Society* https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/alicehamilton.html#early-hazards-industrial-workplace

compensation. It would take investigators and reformers to advocate for change in the legislation surrounding industrialization, along with the legal action from the dial painters.

The Towns They Lived In

To truly understand how these events happened, it is necessary to look at the makeups of the towns that were homes to the dial painters. Each town and its demographics were different from the rest and shaped the outcomes of the dial painters' lives. The history behind the towns shaped not only the industries there, but also the legislation influencing them. The two New England towns had different populations of immigrants than Ottawa and had different work ethics because of this. There also was a different emphasis on industrial hygiene in the New England towns than in Ottawa and the industrial legislations in both areas reflected theses differences. There were also different attitudes about the dial painters and their court cases because of the history of union rights in both areas. The history of each town is in important aspect to the dial painter's histories and help to explain some of the key differences between each set of dial painters' stories.

The first town was Orange, New Jersey, where the beginning of the radium dial painters' stories originated. Orange, a part of Essex County, was established in 1806 as part of the Newark Township. A moderately sized town with populations ranging from thirty thousand throughout the twentieth century, it covered roughly a little over two square miles, Orange was more highly concentrated than the other cities. In 1910, Orange had twenty-nine thousand citizens and the

population rose throughout the twentieth century.[40] Orange was a small sized town, but there were many notable people that came from Orange and was in constant communication with the rest of the state. Orange, as a city, stayed in touch with state and national politics while still managing to keep up with current events and reforms, something that other cities, like Ottawa, struggled to do.

Orange has had a long history of industrialization and trying to keep up with reforms throughout the Progressive Era. Going back to when New Jersey was just a colony in the 18th century, the beaver trade conducted by the Huguenots led to the demand for hatting business. During the late 18th century, Orange became the town for hat manufacturing, especially for fur hats that resulted from the fur trading. The Protestant ideology of work ethic, the mountain stream that supplied water directly to the town, and the fur trade all led to Orange becoming industrial even before they were an established city. Whereas other cities in this study, such as Ottawa, took well into the late 19th and even early 20th centuries to industrialize, the concept of industrialization had been a part of Orange's history since the beginning.

The importance of Orange's early businesses impacts the narrative of the dial painters because there were very different reactions to their court cases, depending on which city they worked in. The fact that Orange had a long history of industrialization, and eventually unions, provided a much more sympathetic audience to the dial painters' plights. The women in Orange received far more coverage, especially positive, about their stories and were able to speak out about their illnesses without stigma, in turn affecting the outcome of their cases.[41]

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[40]United States. Bureau of the Census. 1912. Thirteenth Census of the United States, 1910: Population by Counties and Minor Civil Divisions, 1910, 1900, 1890. https://books.google.com/books?id=T9HrAAAAMAAJ&pg=PA336#v=onepage&q&f=false

[41] Moore, K. "The Radium Girls"

Orange was a fitting place for the luminous dial painting factory and U.S. Radium Corporation sought to open another facility in the New England area to increase production. Waterbury, Connecticut was the chosen location.

Waterbury was added to the Connecticut colony in 1686 and was established near the Naugatuck River.[42] It would not be until 1853 that Waterbury would be established as a city after it had survived several major floodings and began to manufacture brass. During the 1830s there was an increase of brass businesses and manufacturers that turned Waterbury into an industrious city.[43] After the establishment of Waterbury as a city and the brass industry had boomed, Robert H. Ingersoll's business of dollar-priced pocket watches continued to contribute to the economy of the town. While Ingersoll did not discover the pocket watch, his business made large profits as his plants produced over twenty thousand pocket watches a day in Waterbury.[44] With these two industries fueling Waterbury's economy, the town became a blue-collar area with legislation to protect those employed in the factories and plants there. The town's strong watchmaking industry influenced U.S. Radium Corporation's placement of their dial painting plant in the town. United States Radium opened another plant of dial painting in Waterbury in order to meet the demand of watches and technology for World War I.[45]

At the time the dial painting industry was established in Illinois, the small town of Ottawa was oblivious to the dangers of radium that were being discussed in New England. It is easier to

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[42] Henry Bronson, *History of Waterbury, Connecticut, 1804-1893*, 1858, pg. 3-4 https://babel.hathitrust.org/cgi/pt?id=njp.32101073810093;view=1up;seq=32

[43] Joseph Anderson, *The Town and City of Waterbury, Connecticut, from the Aboriginal Period to the Year Eighteen Hundred and Ninety-Five,* 1896, pg. Xix https://babel.hathitrust.org/cgi/pt?id=hvd.32044025023904;view=1up;seq=390

[44] Henry C. Bearly, *Time Telling Through the Ages*, 1919, pg. 201 https://babel.hathitrust.org/cgi/pt?id=loc.ark:/13960/t6zw28n0p;view=1up;seq=286

[45] Clark, C. "Radium Girls".

understand how Ottawa was out of touch on the major scientific discussions going on halfway across the country when the demographics of the town are considered. Compared to Waterbury and Orange, which were both larger and industrious cities, Ottawa was a much smaller and rural town. Since the first census conducted there in 1870, the town has never reached above twenty thousand in population, and roughly covers 12.8 square miles.[46]

By the 1920's Ottawa had gained two factories and brought some industry to the rural city. The Libbey Owens Ford Glass factory and the Peltier glass factory both brought in jobs and revenue for the city that provided an alternative to workers that did not farm. The reason that Ottawa only had two glass factories is because Ottawa has sat on top of one of the largest reservoirs of silica sand which helps make quality glass. While these jobs in the glass factories provided many workers with a suitable lifestyle and paid well enough, they were incredibly labor intensive and required long hours working with heavy machinery. They were excellent jobs for men but did not provide many other jobs for women, teenagers, or disabled workers.

Ottawa did provide some options for women looking for a job that did not require heavy lifting, or working on a family farm, but they were difficult to obtain. In the 1920's, the possibilities for working women were limited to either teaching or nursing. However, most young women in Ottawa could not afford the extra schooling that was required for either nursing or schooling. Few teenagers in the town could afford to finish high school, let alone spend money for the extra schooling after to become a nurse or teacher. To drop out of school to begin work was more of the norm for most teenagers there; to completely finish high school was not unheard of in 1920's Ottawa, but the far more frugal, and common, option was to help out the

[46] County of La Salle. 2015. Street Map and Corporate Limits City of Ottawa. Vol. 1 in=1,000 ft. La Salle County, IL: Parcel Lines.

family by going to work either on the farm or in a factory. Most citizens of Ottawa learned a trade rather than continue the path of education because it was too expensive. When the Radium Dial Company eventually came to Ottawa and provide a good paying and non-labor intensive job, many teenage girls finally found a way to make their money.[47]

Their Judicial Legacies

In each city, the dial painters realized that the common denominator between their illnesses was the place of their employment. In Orange, Waterbury, and Ottawa, each set of dial painters came together to make a demand for compensation after their fellow co-workers died or became seriously ill. Each set of dial painters' trials had different results but they all had a major impact on industrial reform. Some of the women sued the respective companies individually, but in this paper, the focus is on the major trials that involved class action lawsuits from groups of dial painters.

Waterbury, Connecticut

Waterbury, Connecticut was where the first court actions occurred. No major trials happened, but between 1926 and 1936 the Waterbury Clock Company, partnered with U.S. Radium Corporations, issued over $90,000 in medical settlements.[48] By 1927 the company changed its qualifications for filing compensation. Prior to 1927 dial painters had a five year grace period before they had to file for compensation. If they filed within that time period they could be considered for a settlement but any requests made after were disregarded. After 1927, the company changed the period from five to three years, making it even more difficult for the

[47] United States Census Bureau. 2013. Census Explorer: Ottawa, IL. Census Explorer.US Census Bureau.
[48]Clark, C. "Radium Girls". Pg. 145

dial painters to collect on their compensation. The problem with radium poisoning, as the women found out, is that it takes several years for it to set in before any major symptoms show. The previous five year grace period was already a small window of opportunity for the dial painters to gather the resources to demand compensation, but three years really made it difficult for any of them that did not develop cancer quickly after their employment.

As the dial painters struggled to fight the difficult compensation law, it would not be until 1941 when the Waterbury Clock Company agreed to the Union's demands of raising wages by two cents.[49] A small victory and for those willing to continue working at the Waterbury company it was a bonus, but the Waterbury case studies are the least documented out of all of the three locations. This is most likely because the dial painters in Waterbury did not press for any other action other than compensation for those who developed cancer and could trace it back to the company and higher wages for those still working there. The other two cities attracted large media attention, both positive and negative, and were much longer ordeals. The Connecticut dial painters settled rather quickly probably due to the lack of their resources and inability to get around the legislation.

Orange, New Jersey

Meanwhile, in Orange, the New Jersey dial painters were next in going to the courts to try and gain compensation for their illnesses. There, the women received far more media attention than the Connecticut dial painters. Part of this was because the Connecticut dial painters went first to lawyers and were the first to try and sue the U.S. Radium Corporation, and the New Jersey dial painters were following in their footsteps. In 1927, after at least seven dial

[49] Ibid.

painters had died of abnormal cancers and numerous others had gotten sick, the New Jersey dial painters were encouraged by their colleague, Grace Fryer, to find a lawyer.[50] Recommended by their shared doctor, Dr. Martland, to reach out to Raymond H. Berry, a young lawyer barely out of law school, the dial painters found someone willing to take on their case. Berry's argument was that there was no possible way for the women to have brought a lawsuit forward if they did not know it was the U.S. Radium Corporation's fault for their illnesses. Since the company did not provide the proper safety instructions and misled them about how sick they were, the women would not have thought to have brought forward a lawsuit against them. Until 1925, when Martland formally diagnosed them with radium cancer as a direct result from working at the dial painting factory, the women did not have any evidence to suggest that their workplace was the reason for their cancers. In New Jersey, workers had up to two years to file for compensation from their employers, and Berry believed that the two-year clock for the formal complaint filing should not have started until 1925 when Martland gave a formal diagnosis. Grace Fryer filed a formal complaint on May 18th, 1927 and sued the U.S. Radium Corporation for $250,000 in compensation.[51] Fryer's complaint launched the start of several New Jersey dial painters filing complaints and an eventual class action lawsuit against their former employers.

After Grace Fryer began her lawsuit, other New Jersey dial painters, their husbands, and families, came to Berry to also file for compensation. Eventually, Berry decided to take on four other dial painters' cases. Edna Bolz, Quinta Maggia, Albina Maggia, and Katherine Schaub joined Fryer's case to file a class action lawsuit against U.S. Radium Corporation for their

[50] "Radium Killed Woman, Relatives Declare; She is Seventh Watch Dial Painter to Die." *New York Times* June 19, 1925.
http://ezproxy.hamline.edu:2048/login?url=https://search.proquest.com/docview/103598141?accountid=28109
[51] Moore, K. "The Radium Girls," pg. 175

abnormal sarcomas developed after their employment. Their case rested on two major arguments: challenging the statute of limitations for not allowing enough time to file suit and proving the radium companies hid vital information from the women about their illnesses. Berry argued that the statute of limitations on the number of time workers in New Jersey had to file a claim was unfair to the dial painters because the prescribed period should not have been counted until they knew that they had a "cause of action".[52] Their lawyer argued that the women should not have had to file suit until they were diagnosed with radium poisoning by a medical professional, and only then should the clock on the time frame start. The second major argument that Berry was going to use was proving that U. S. Radium deceptively concealed the dangers of their workplace and the source of their illnesses from the dial painters while preventing them from earning compensation by preventing them from filing suit in a timely matter. Not only did they have to prove that their jobs at the dial painting factory were the source of their cancers, but also that the company had been blatantly negligent in protecting its workers. They had to prove that they had been harmed and that it was a direct result of their employers or workplace.[53]

Meanwhile, U.S. Radium Company defense team argued that radium poisoning was a new disease and prior to this case there had been no studies previously done on it. They saw themselves as unaware of the dangers as well because there was no precedence on it. They attacked the doctors that had determined radium necrosis as the cause for the girl's ailments. Their lawyers questioned how the doctors could have prescribed radium necrosis as the main cause of the dial painters' cancer if there had been no case of it previously. When Hoffman, the statistician who helped Katherine Wiley begin the investigation into the Orange dial painters

[52] Moore, K. "The Radium Girls," pg. 120
[53] Moore, K. "The Radium Girls," pg. 120-121

illnesses, took the stand, he was questioned how he could have suspected radium necrosis if there had never been a case of it before. The company's argument was that if medical professionals had no previous knowledge of radium necrosis, then there was no way the company could have prevented it in the first place. This did little to help their case as Berry pointed out that regardless of the knowledge of the necrosis, the dial painters were becoming sick as a result of working at the company and in turn should have received their compensation. As a result, the company's second tactic was to delay the rest of the trial as long as possible. Most of the five dial painters that were suing did not have much time left as their types of sarcomas were fast acting and their doctors did not give them a long life expectancy. If the dial painters died before the completion of their trial it would severely complicate the lawsuit and possibly terminate the case. Numerous times the case was delayed and adjourned. After the pre-hearings, the trial itself was set four months later. There was also a delay in the trial after Berry rested his case and the defense did not feel they had enough time to present their case and instead opted to adjourn when there was enough time in the court calendar, another five months later. There were more delays until eventually there was enough pressure on the defense to reschedule for a May date to begin the rest of the trial. The defense's abilities to focus on the lack of medical knowledge on radium necrosis and delay trials were their main tactics in the trial. The combination of the two led to advance their case but also gave the media ample material to work with.[54]

The main difference between New Jersey dial painters' case and Connecticut's dial painter's cases was not the arguments or the pace of the trial, but the presence of the media. In Waterbury, the dial painters case was seen as an anomaly and was quietly settled out of court.

[54] Moore, K. "The Radium Girls," chapters 29-31

The media did not report on it very much and it quickly went away. However, in Orange, the newspapers created a romanticized account of the dial painters' trial. The young age and gender of the dial painters amplified sensitivities about their mistreatment. Many cases of radium poisoning made the women infertile or made the women give birth to children with deformities. Journalists sensationalized this aspect of the radium poisoning to create an outrage that these women were stripped of their womanhood. Much of the rage that readers felt about this tragic situation came from these types of stories where the women's lives were seen as all but over. In many interviews, the women came across as tragic and wronged victims that were just trying to obtain justice despite this horrible loss of life. One reporter commented that, "During previous days of the hearing they had heard physicians and technicians testify they were...facing certain death. They have maintained an attitude of almost cheerful resignation all through the trial."[55] Since the women were portrayed as the victims just trying to get justice, they never came across as outraged at the companies. These types of interviews led the newspapers to sensationalize the dial painters' story but kept from blaming the companies directly.[56]

The reason that the media's coverage of these dial painters' stories is relevant is that the journalists had a major influence on how the public reacted to the case. This, in turn, impacted the case because according to the media, the villain in this story was not the companies, but rather radium itself. The whole story reads as a tragedy that had no way of being prevented. There was a public outcry for the victimized women, but it was seen more as the dial painters were innocent victims while the companies were just tragic bystanders. This also impacted the

[55]"5 POISONED WOMEN FACE COURT DELAY." *New York Times.* Apr 28, 1928. http://ezproxy.hamline.edu:2048/login?url=https://search-proquest-com.ezproxy.hamline.edu/docview/104578696?accountid=28109.
[56] Ibid.

number of dial painters that came forward. When searching for women to testify against U. S. Radium Corporation, Berry had his dial painters reach out to their fellow colleagues to come forward. After the sensational newspapers were printed though, many women who had previously not been diagnosed were now terrified of discovering they had radium poisoning and refused to have any contact with the doctors, lawyers, or their former coworkers. Along with the ones scared to find out if they had cancer or not were the ones that were afraid they would be socially rejected for having cancer that made them infertile or deformed. Many women were afraid of not being able to find a husband or start a family if they came forward. Katherine Schaub once discussed how "so many of the girls I know won't own up...they say they are alright...they're afraid of losing their boyfriends."[57] The portrayal of the dial painters in the newspapers ended up impacting the number of people willing to testify and the feelings of the judges involved.

The trial of the five Orange dial painters was incredibly dramatic. From von Sochocky, the inventor of the radium paint who changed his testimony on the stand, to Drinker refusing to come forward, the trials were sensational. Von Sochocky had promised to help the women's case by testifying about his prior knowledge of the danger of radium along with his, and the company's, negligence to properly protect the workers. However, once on the stand, von Sochocky changed his story and claimed ignorance of the danger of radium.[58] He denied warning any dial painters about the dangers of lip pointing and claimed he never knew the dangers of radium, despite suffering from radium necrosis himself.[59] His testimony set the dial painters'

[57] Clark, C. "Radium Girls," pg. 132
[58] Moore, K. "The Radium Girls," pg. 127
[59] DENIES RADIUM AILMENT. (1928, Sep 08). *New York Times*
http://ezproxy.hamline.edu:2048/login?url=https://search.proquest.com/docview/104466005?accountid=28109

case back as he affirmed the defense's position. Meanwhile, Drinker, who had conducted the research that condemned U.S. Radium Corporation after he and his team found poor ventilation and negligence to be the cause of the dial painters' illnesses, refused to testify. Drinker reported that he did not typically testify in these types of cases and felt no need to testify publicly.[60] Berry had to order a subpoena to bring Drinker forward to testify. Without Drinker's testimony, the dial painters would have lost all credibility. After Drinker, the dial painter doctor, Martland, testified and showed the measurements he took of the radium found in the dial painters' bones by wrapping x-ray film around their legs, thus confirming the amounts of radium in them. Eventually, combined with Drinker's and Martland's testimony, the dial painters and U.S. Radium Corporation were able to reach a settlement.

The settlement reached was considered a win for the dial painters, yet it came with many compromises. The judge ruled that each of the dial painters in the case would receive $15,000 as a lump sum along with an extra $600 a year for life to pay for medical expenses.[61] These amounts sufficed for the women's medical expenses and did constitute a win for the dial painters, albeit with conditions. The first one was that US Radium Corporation did not have to admit fault and did not have to acknowledge radium poisoning as a disease. The second condition was that a committee of physicians had to be created in order to examine the women and monitor their health. The status of their health would determine whether they were eligible for their yearly pension. If the physicians determined that the women no longer had radium poisoning or sarcomas related to U.S. Radium Corporation, then they were no longer eligible. The board was set up of three physicians, one the dial painters chose, one the company chose,

[60] Clark, C. "Radium Girls," pg. 126
[61] Clark, C. "Radium Girls" pg. 135

and a third party they agreed upon. The women would keep their compensation until they died, but it put an unnecessary stress on them. They constantly had to fight for their compensation as the doctors had their own biases, which were reflected in their diagnoses. Berry would take on several other cases for the Orange dial painters and would win small compensations for them, but ultimately his case surrounding the five dial painters was his most successful and had the most impact on the Orange dial painter story. The compensations were small, though they were helpful to not only the dial painters but future workers. By the end of the five women's case, sixteen dial painters had died because of radium necrosis.[62] The publicity of the Orange dial painters' case helped to bring attention to the danger of working in the dial painting industry and helped to prevent more workers from applying to U.S. Radium Corporation.

Ottawa, Illinois

Even though the Orange dial painters were able to win in their settlement, the Ottawa women struggled to get lawyers and hearings. By the end of Orange dial painters' trial in 1928, one dial painter in Ottawa had already died and several others had developed illnesses similar to what their New England counterparts were suffering from. It was not until 1926 that the dial painters in Ottawa became ill with pains in their jaws, hips, and legs, similar to what the New England dial painters suffered from. Mary Ellen "Ella" Cruse was the first Ottawa dial painter to die in 1927; the same year that the Orange dial painters reached a settlement with U.S. Radium Corporation. Between Kjaer's investigation and the company placing an ad as an attempt to alleviate any fears about working in the Ottawa plant, Cruse's family felt that Radium Dial Company was attempting to cover their tracks regarding Cruse's death. The doctors had

[62]"16TH RADIUM VICTIM DIES." *New York Times* Sep 14, 1930, http://ezproxy.hamline.edu:2048/login?url=https://search.proquest.com/docview/98831584?accountid=28109

diagnosed Cruse with Streptococcic Poisoning, which her family questioned as the cause of death. In that same year, another Ottawa dial painter, Margaret Looney, passed away prompting Cruse's family to look into Ella's workplace. In turn, they made the connection between her illness and her work place and sued Radium Dial Company in 1929. Cruse's family sued for $3,750 in compensation but received $250 in a settlement.[63] Looney's family also sued but did not receive any compensation because according to her death certificate she died of diphtheria and pneumonia. The reason these two cases are relevant is that they occurred during the same year as the New Jersey dial painters' trials and yet received significantly less coverage. This would also be true when more Ottawa dial painters sued and were the main difference between the two sets of workers.

After the two families tried to sue Radium Dial Company in 1929, at least nine more dial painters became ill and at least five died by 1934. In that time period, the Orange dial painters continued to see their respective physicians in order to continue to receive compensation, and some had begun to be tested by research clinics. It would not be until 1934 that more dial painters would sue Radium Dial Company. Nine women diagnosed with cancers that affected their bones notified Radium Dial of their illnesses and applied for compensation. In the same year another dial painting company, Luminous Processes, set up in Ottawa and took over Radium Dial's employees and business. It even saw Radium Dial's CEO Joseph Kelly and his son Joseph Kelly Jr. leave to take over at Luminous Process. This allowed for Radium Dial to cease operations and was an attempt to protect the radium company heads in Illinois from

[63] Swenson, J. "Memo to File". March 3rd, 1970. Argonne National Laboratory.

financial loss. With Radium Dial shutting down, its official's plan was that the company would be unable to pay back workers filing for compensation.[64]

The ceasing of operation of Radium Dial did not deter the dial painters from filing for compensation as they were still the party to be held responsible under the Occupational Disease Act. In 1935, another ill dial painter, Inez Vallat, filed suit against the company for $50,000 in damages.[65] Vallat claimed that her work at the plant caused her to become sick and that Radium Dial was in violation of the Occupational Disease Act of 1911. She charged that the company "carelessly and negligently failed to provide reasonable and approved devices, means or methods for the prevention of such occupational diseases incident to the work in hand, but permitted air surrounding the plaintiff while at work to be impregnated and saturated with dust containing radium" and as a result she contracted anemia, rarefaction of the bones, and alveoli of the jaw.[66] In their defense, Radium Dial argued that she was not an employee of theirs when she became sick and that she did not file the suit within the necessary two years after working for them.

The same issue that had plagued the Orange dial painters during their trials also gave the Ottawa workers issues. However, the Ottawa dial painters' case came after 1933 when the case, Raymond v. Industrial Commission decided that employees could only file for compensation after they had discovered they were ill. The Raymond v. Industrial Commission case changed the statutes of limitations on when workers could apply for compensation and did not penalize them for not applying for said compensation when they did not know they were ill.[67] This case changed the provisions previously made in the Occupational Disease Act and allowed workers,

[64] Clark, C. "Radium Girls," pg. 190
[65] Vallat v. Radium Dial Co., 196 N.E. 485 (Ill. 1935)
[66] Ibid.
[67] Raymond v. Industrial Commission

including the dial painters, the time needed to be diagnosed and prevented Radium Dial Company from withholding compensation due to time limitations, a privilege not granted to the Orange women. However, the Vallat family still had its legal obstacles to overcome.

Vallat was the first of the Ottawa dial painters to go to court she was in the worst condition out of the dial painters. By 1935, her case had been dismissed but was appealed and eventually reached the Illinois Supreme Court where she argued that she was eligible for compensation under the new amendments to the Occupational Disease Act resulting from the *Raymond v. Industrial Commission* case. In the appellate court, Radium Dial responded by arguing that the Occupational Disease Act was actually unconstitutional in the first place. Radium Dial's argument was that the legislation "fails to set up an intelligible standard of duty and violates the due process clauses of the State and Federal constitutions..., it unlawfully confers legislative powers upon the State Department of Factory Inspection".[68] The issue at hand was whether the wording of the Occupational Disease Act was too vague for parties to understand and if so, which party was at fault. The court affirmed that the act was too ambiguous for Radium Dial to understand what precautions it needed to take. The court decided that "In order that a statute may be held valid the duty imposed by it must be prescribed in terms definite enough to serve as a guide to those who have the duty imposed upon them" however, "if the duty is imposed by statute through the use of words which have not yet acquired definiteness or certainty and which are so general and indefinite that they furnish no such guide the statute must be declared to be invalid".[69] As reviewed in the case of People v. Yonker, it was determined that any act that did not use definitions commonly understood, then an "unwarranted delegation" of

[68]Vallat v. Radium Dial
[69] Ibid.

legislative power was distributed, which left employers with a larger sense of power than constitutionally allowed and also a lack of unity and clarity on how employers were to handle compensation.[70] Inez Vallat's case for compensation was denied as section 1 of the Illinois Occupational Disease Act was determined to be unconstitutional and was dismissed. This was devastating for the Vallat family, but also for the other Illinois dial painters as their cases were also dismissed for want of prosecution.

The state legislature did revisit the Occupational Disease Act in 1936 after the state supreme court deemed the act to be unconstitutional, to revise it so that all industrial diseases were worthy of compensation.[71] It also was edited to have clearer language that outlined precisely what employers needed to do to protect their employees and what the standards for compensation were. In 1938 fifteen dial painters filed for compensation again, with the exception of Inez Vallat who had passed away earlier that year and were granted hearings in front of the Illinois Industrial Commission. Catherine Donohue was the sickest dial painter at the time, she was significantly smaller than her colleagues as she weighed only 71 pounds, was the first to be heard before the Industrial Commission.[72] She was asking to be compensated for her medical expenses that totaled over $2,500.[73] After collapsing in the courtroom, the hearings took place the next day on February 11th in Donohue's home where she testified about her experiences at the dial painting factory and the consequences of working there. With the revisions to the Occupational Disease Act in place, the commission ruled that Donohue was to be awarded

[70] People v. Yonker
[71] *Victim Faints at Death Query in Radium Suit,* McKenna, Helen http://www.lgrossman.com/pics/radium/slides/radium%20dial48-orig.html
[72] Newspaper *Victim of Radium Poisoning Faces Death, Asks Pay* from Fond du Lac *http://www.lgrossman.com/pics/radium/slides/radium%20dial39-orig.html*
[73] Ottawa Republican Times http://www.lgrossman.com/pics/radium/slides/radium%20dial104-orig.html

compensation $5,661 from Radium Dial.[74] Her trial marked the first success for the Ottawa dial painters, yet for Donohue and the other dial painters receiving compensation would be difficult as the company that owed them the money had ceased operations.

With Radium Dial having closed, there was little money to pay Donohue her awarded money, let alone any of the other dial painters planning to file for compensation. Radium Dial wanted to appeal the Donohue award, yet the law required it to post a $10,000 bond. The company claimed it was unable to post the bond as their remaining assets were not sufficient enough after shutting down. In June of 1938, they issued a writ of mandamus against Edward Ryan, a clerk of the circuit court of LaSalle county to have him issue a writ of certiorari and writs of scire facias.[75] In People Ex Rel. Radium Dial Co. V. Ryan, the radium company wanted the court to review the award from the Industrial Commission to Donohue as a way to prevent paying the bond until they could appeal. Despite this, the Illinois Supreme Court denied them the writ of mandamus and they were forced to post the $10,000 bond. Radium Dial appealed the Industrial Commission's award all the way up to the Supreme Court where the justices declined to hear the case, affirming the lower courts' rulings. Radium Dial had to post the bond, but the $10,000 was all that would be given to any remaining dial painters and had to be split between them.[76]

Although Radium Dial was forced to pay the $10,000 bond for the dial painters, the remaining women had to split what was left of the company's money, with less than $667 each.

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[74]21 N.E.2D 749 (ILL. 1939), 24935, PEOPLE EX REL. RADIUM DIAL CO. V. RYAN

[75] *Writ of mandamus* is an order by a court to a corporation or person to perform a specific action. *Writ of certiorari* refers to a court order to review the decisions made in a lower court in case of any irregularities. *Writ of scire facias* is a writ that requires the defendant to appear in court and attempt to prove why an existing judgement should not be carried out on them.

[76] Main, John "15 Walking Ghosts Jilted by Justice" *Chicago Times*, 1937

Although the Ottawa dial painters received very little in the settlement, they were lucky to even be granted any hearings. According to one newspaper, the lawyer they did have, J. S. Cook, took the case practically pro bono as no "Ottawa lawyer...would touch them. Ottawa bitterly resented...these poor women's charges as giving a 'black eye' to the community."[77] The lack of willing lawyers, the shadiness of Radium Dial's closing, and the previously insufficient Occupational Disease Act, all led to the incredibly small award for the Ottawa dial painters, but they did at least obtain some victory in the court. Their cases also were what influenced the necessary changes to the Illinois Occupational Disease Act that has protected all workers in Illinois throughout the twentieth century.

Although they were able to influence major labor legislation in Illinois, the journalists covering the dial painters' stories focused more on their appearances than the court cases. Whereas the people who lived in Orange were very sympathetic to the dial painters, the Ottawa media ostracized the women by focusing on their malformities. In Orange, the people saw the women as victims that were unjustly harmed. In Ottawa, though, the media reflected the town's opinion that the women were a black spot on their community. One reason for this was the actual appearances of the women. The town often shunned these women as the radium seeped into their systems causing deformities, such as when Charlotte Purcell had to have an arm amputated. There was also Catherine Donahue, who was not only 71 pounds but also missing her jaw and parts of her hip, looked more like a walking corpse than human. The papers dubbed them the 'Living Dead' and focused heavily on their appearances rather than any changes they helped create for industrial hygienics. Although the Ottawa women helped further Illinois labor

[77] Ibid.

legislation, the main focus in the newspapers was their disfigurement and their 'living dead' status.[78]

Each dial painters' trial had different outcomes and each city responded to their plight in distinct ways. The women of Waterbury were the first to demand compensation and received the least amount of attention in the media. The Orange dial painters instead had a large media presence and used that to fight for better compensation. The Orange women had a better lawyer and were able to use their media presences to create outrage at the company. While their compensation came with many conditions, they were able to reach a larger settlement than the women in Waterbury. In Ottawa, the media actually hurt the dial painters as it presented the dial painters in a negative light. They cast a bad image on the town and the women struggled to get the necessary legal aid they needed because of their malformities. In the end, the Ottawa dial painters received a small amount of compensation that did not help them enough. Yet, their court cases did help workers in industrial fields as their cases prompted changes in legislations and helped to make compensation more obtainable.

Subjects to Scientific Research

The court cases of the dial painters left a significant impact on industrial history. However, they should also be acknowledged for the major influence they left behind on the scientific community. After the court cases had ended, the remaining dial painters began a decades long process of scientific testing. The period of researching done on the women can be broken up into three different eras based on the locations: MIT testing, Atomic Energy

[78] Griffin, Frederick. "Society of the Living Dead". *The Star Weekly*. April 23rd, 1938.

Committee testing, and Argonne testing.[79] Each lasted several decades and were located in different parts of the United States. Altogether the testing conducted on the dial painters had an impact on their story that is very often neglected; the testing done on the dial painters lasted longer than any of their trials or time of employment and had the biggest influence on science compared to any other aspect of their story. By 1961, over 200 former dial painters had volunteered to be studied by researchers in order to better understand the internal effects of radium in a human.[80] This section breaks down each era of the experiments done on the women and examines the impact on the knowledge of internally deposited radium.

MIT

As previously stated, the New England dial painters were tested at the Massachusetts Institute of Technology by Robley D. Evans from the 1930s throughout the 1950s. The first period of testing aimed to study the long-term effects of internally deposited radium in human beings. In the beginning, Evans sought out to find a cure to radium poisoning as there were still some physicians and patients that bought into the radium craze. In the 1930s, tonic water containing radium was still being sold in large numbers to the public. This was a result of the radium craze in previous decades and there was not a universal consensus on the healing abilities of the element. Evans' mission was to find a cure for the radium poisoning as he understood that "every case of radium poisoning has been fatal, but there is no *a priori* reason for believing that a satisfactory cure will never be found."[81] Since radium water was not banned at this time, Evans sought to find a cure to cure anyone that fell victim to the quack science. After failed

[79] Rentezi, M. "The Women Dial Painters as Experimental Subjects (1920-1990)", pg. 240-242
[80] Letter from Dr. Finkel from Argonne to Dr. Dahlin from Mayo Clinic, October 3, 1961
[81] Evans, Robley D. "Radium Poisoning". *American Journal of Public Health*, October 1933. Pg. 1.

experiments on rats proved to be ineffective, he turned to the large population of former radium dial painters for subjects to study.

Evans and his team reached out to Martland from Orange for references on how to get a hold of any dial painters willing to be subjected to testing. Martland, in turn, sent Evans the largest existing list of the women at the time. Already the list was not as complete as Evans had hoped as Martland only had names of women who had come directly to him, leaving numerous dial painters unaccounted for. Evans worked with the few former dial painters he could contact and began taking measurements of the women. The painters consented and were willing to help, but the conduct of the experiments was inefficient and slow. Since Evans was the first to attempt to measure the quantities of radium in the living dial painters, all he had available were rudimentary practices. His testing consisted of having the women sit in a chair while he and his team circled them with Geiger counters to get readings. According to a researcher, the studies would take all day and involved many repetitions of entering data from the Geiger counters' readings.[82] Eventually Evans would develop technology to take breath samples and became more efficient as they took less time to take measurements.

As the national interest in atomic energy continued, Evans was eventually approached by a committee for radiation standards from the Manhattan Project to study the dial painters to determine safe amounts of luminous material in humans. Plutonium, the main radioactive element in the nuclear bombs, had very similar biological effects on humans compared to radium.[83] Since the dial painters were the largest group of people that had ever been exposed to

[82] Renzetti, M. "The Women Radium Dial Painters as Experimental Subjects (1920-1990) Or What Counts as Human Experimentation" pg. 241
[83] Ibid.

radium internally, they became valuable subjects in studying radioactive materials and setting health standards for the employees working in the Manhattan Project.[84]

In 1940, Evans, along with an advisory committee, took measurements on 27 subjects and came to the conclusion that the tolerance level for a residual body count of radium in a human should not exceed more than 0.1 μCi and would be referred to as the 'maximum permissible body burden' for future research.[85] This would be an improvement on the former tolerance level which had previously been anywhere between 1 μCi and 10 μCi. Evans was able to narrow down what was an appropriate amount of luminous material in a human and changed the level to a much smaller amount than previously allowed. This new standard was a result of the research done on the dial painters and was the standard used by the Atomic Energy Commission.

Atomic Energy Commission

After the completion of the Manhattan Project in 1946, the Atomic Energy Commission, or AEC, was formed and looked to Evans' testing to continue studying the effects of radium on workers. The AEC backed Evans' work and helped to expand the experiments. Evans still struggled to find more subjects as many had moved away from the area, typically in an attempt to move on from their past trauma, and resorted to using photos, marriage records, voter's registration lists, reporters, and a detective. There are reports of reporters calling upon the women in their homes and interviewing them about their medical past and asking them to participate in experiments for Evans and his team.[86] It was during this time that an employment

[84] Ibid.
[85] Rowland, R.E. "Radium in Humans," pg. 29
[86] Rentetzi, M. "The Women Radium Dial Painters as Experimental Subjects (1920-1990) Or What Counts as Human Experimentation", pg. 242

list from the Waterbury Clock Company was eventually discovered and the MIT team was able to expand from what was previously just under 40 test subjects to over 1,000. Not only was there more funding for these experiments but also more subjects to be tested. Evans was able to create an entire facility dedicated to measuring the quantities of radium in the women.[87] In a report by Rowland, he explains why the dial painters were so valuable and why there could never be any similar studies conducted like the ones done by Evans. One of the major reasons that the women were important was because "there is no prospect of duplication of this experimental material" and because they had a "moral obligation to future generations requires that all possible information be obtained by this generation of investigators, on these humans."[88] While the dial painters suffered through tragedies because of their employment, it was that very unfortunate circumstance that MIT was able to take advantage of and positively use for scientific advancements. Evans realized this and that is why his study expanded decades, until 1957 when he had started to look to retirement, in order to make use of the dial painters' situation. When Evans' experiments came to a close, his data was sent to Illinois as a second, and larger, experimental operation was being set up.

Argonne

For several decades, the dial painters from Ottawa, Illinois were used as test subjects for the Argonne National Laboratory, located just seventy-five miles away from the town. When Evans retired, he worked with the Atomic Energy Commission to set up an entire center dedicated to continuing the investigation of the impact of radium on human bodies. Within Argonne National Laboratory the Center of Human Radiobiology was established and became

[87] Rowland, R.E. "Radium in Humans," pg. 31
[88] Rowland, R.E. "Radium in Humans," pg. 34

the lab that conducted the most research on the dial painters. For decades, the women volunteered their bodies to these studies at the laboratory. Argonne also contacted some of the families of the deceased dial painters and asked to perform exhumations on the bodies.[89] Within Argonne, the Center for Human Radiobiology specifically wanted to understand which types of radium and radon were the most dangerous and also what was the safest amount for a human to consume. This began as research started in the context of the Cold War as more atomic tests were being conducted and more workers were needed to work on radioactive weapons for the arms race. The studying of radiobiology became more relevant as researchers were finding new ways to add to the atomic industry.

In order to find the answers to their questions, Argonne researchers reached out to the former dial painters in Ottawa. They used employers' records from both Radium Dial Corporation and Luminous Processes, while also using other dial painters to reach out to their former colleagues. For a time, researchers had to rely on a photograph of a company picnic to find other dial painters. Charlotte Purcell, a former dial painter, was sent the photograph in 1978 and was asked by Argonne to help track any of the remaining dial painters down.[90]

Argonne researchers requested permission to conduct tests on the women to determine the long-term effects of radium. Deceased dial painters were also of interest to Argonne and they sent out letters to the families requesting for exhumations.[91] Argonne conducted several tests on these bodies to determine the amount of radium in their bodies. Peg Looney's body, for example, had 19,500 microcuries of radium in her bones, which was more than 1,000 times the safest

[89] Hamilton, G. J. "Proposal for Exhumation on Inez Vallat", 1975. Argonne National Laboratory.
[90] Letter from Charlotte Purcell to Argonne Researcher, April 3rd, 1978.
[91] Letter from Robert A. Schlenker to Mr. & Mrs. Reavy, November 9th, 1984.

amount.[92] To compare, another former dial painter named Catherine Reavy was tested by Argonne to determine the levels of radium in her body. Her body count of radium had only four microcuries which were still "a considerable amount and would have conferred on her a substantial risk of bone cancer."[93] Argonne's research did help to settle any debates left over of whether or not the dial painters died of radium poisoning or another disease such as syphilis. On the living dial painters, Argonne conducted numerous tests that included bone marrow probing and biopsies.[94] As Charlotte Purcell's doctor promised her and the other dial painters, the biopsies and X-ray studies that they conducted would "be of value to not only to us but will be of real benefit to you and your physician."[95] There was an assumption that if the women consented to these tests, then the results from the experiments could help alleviate any pain they had or even help cure them.

To the disappointment of the women, Argonne rarely revealed any results from the tests to them. One of the reasons the women agreed to help in the experiments was because they believed that Argonne might be able to help them out with their illness. They had hoped that if Argonne could study them, then they might be able to alleviate their pain. For example, Argonne doctors encouraged Charlotte Purcell to have an operation on her hip, something that they felt "otherwise [would] be giving her trouble."[96] That surgery did happen, but Charlotte Purcell never received her full results. In a letter from 1980 from a new doctor, whose name has been removed from the records, he apologized that she never received her results from three years prior and that

[92] Moore, K. "The Radium Girls," pg. 392
[93] Letter from Robert A. Schlenker to Mr. & Mrs. Reavy, November 9th, 1984.
[94] Langer, C. *Radium City*, 45:44
[95] Letter from the Director of the Health Division, "Letter to Purcell", September 10, 1963. Argonne National Laboratory.
[96] Letter from Medical Director, "Letter to an Unnamed Argonne Doctor", July 28, 1977. Argonne National Laboratory.

they "checked into the matter, and [found] that small amounts of radium were found. This was to be expected, in view of [her] work history" and stated nothing more.[97] For something even as routine as a hip surgery, the women had to continually ask for their results and if they did receive them, they were as curt, yet still vague, as the response from Purcell's doctor. The doctors did not specify exactly how much radium was in them and they did not reveal what that meant for them. Despite the frustrating and infuriating experiences, the women still continued to keep going in the hopes that their predicament could help make further scientific discoveries in regards to radium.

While several of the dial painters visited Argonne for decades, during the 1980s there appeared to be a decline in willing participation from the women. After a little over a decade of submitting themselves to tests and helping Argonne, the dial painters felt they received little in return. In a memo from a researcher at Argonne, they recall what happened when they reached out to Charlotte Purcell and asked her to come in for more tests. Reportedly, Purcell "Hung up" and told them that she had not "been feeling well but 'why should I discuss it-you people don't help me-I don't get anything out of it-I don't even have any money to go to the doctors'".[98] This memo was written on August 30, 1985, and came after several other correspondences where Purcell showed reservations about being subjected to more X-ray testings. The hostile memo from 1985 seemed to be a reaction to the five years of Argonne pressuring Purcell to receive more X-ray testings after she had started to lose interest in aiding the research facility after it did little to help her condition. In a memo from 1980, Purcell already showed signs of disinterest in

[97] Ibid.
[98] Report on call to Charlotte Purcell, "Case 03-455", Argonne National Laboratory, August 30, 1985.

helping Argonne as she cancelled another appointment because she felt "there were too many forms to fill out, too many x-rays, too little benefit to her."[99]

Charlotte Purcell and her family were not the only ones that Argonne worried about losing cooperation in the 1980s. V. Lloyd Vallat who was the husband of Inez Corcoran Vallat, the first Ottawa dial painter to sue Radium Dial Co., received numerous letters from Argonne asking him for permission to examine his wife. Vallat first received a letter from Argonne asking for permission on February 10, 1984 and proceeded to mail him on numerous occasions. In a letter from a senior staff assistant at Argonne to Vallat, they mention that they had been attempting to contact him without success, "(letters 2/10/84, 5/20/84, and 5/15/84)".[100] Mr. Vallat appeared to have not responded in 1984 and there was a decline in Argonne's correspondence to, not only, Vallat but also other dial painters' families. In the later part of the decade there was a decrease in correspondence between the research facility and the women, and fewer requests were made of the families. Part of this may be due to the release of Carole Langer's *Radium City* in 1987 that showed not only the maltreatment of the women as dial painters but also as subjects to Argonne's testing. Marie Rossiter's testimony of Argonne's poor treatment correlated with a decrease in testing on dial painters as Argonne's credibility was questioned. In a letter responding to a Joan Wiegers of Missouri, who wrote to Argonne asking if her tumors were related to the radium episodes of the dial painters, an Argonne researcher had to acknowledge the impact of *Radium City*'s portrayal of the events. The researcher wrote back to her, "There is no chance that the exposures you mentioned in your letters could have had anything to do with your condition...Although an emotionally accurate portrayal of the original horrendous episode, the

[99] Memo to CHR Records, "Note on Charlotte Purcell", Argonne National Laboratory, May 20, 1980.
[100] Letter from G. June Hamilton, "To V. Lloyd Vallat", Argonne National Laboratory, July 17, 1984.

later parts of the film 'Radium City' were grossly irresponsible: disturbing persons like yourself is part of its unfortunate effects".[101] *Radium City*'s portrayed Argonne in a very negative light and while Weigers wrote to the research facility in an attempt to cure her cancer, the rest of the former dial painters ceased to come back to Argonne for research. Argonne would continue attempting to reach out to the women until the early 1990s when the program ran out of money.

Argonne National Laboratory still continues to operate in Illinois but no longer has any program related to the dial painters. Researchers at Argonne's Center for Human Radiobiology in the 1990s were unable to complete their goal of following and collecting data from the dial painters throughout their entire lives until they died. Even so, the research and data they were able to collect constitutes "the total available human radium experience" and continues to remain the largest experiment done to understand the impact of radium on the human body.[102]

The decades long process of scientific testing on the dial painters was another chapter of difficulty in their histories. For the scientific community, however, it was a time that helped to enlighten researchers on the science behind radium as an element. The research done on the dial painters helped to confirm the harmful effects of over the counter radium therapies and the need to discontinue any manufacturing of the false remedies. Their scientific contributions also helped to set a limit of acceptable quantities of radium in a human body which helped to provide safety standards for workers on nuclear projects. The knowledge on radium toxicity was expanded greatly due to the large population of the female dial painters.

[101] Letter from James H. Stebbings, "Letter to Joan Wiegers", Argonne National Laboratory, October 14, 1988.
[102] Rowland, R.E. "Radium in Humans", pg. 2

Conclusion

While the histories of the radium dial painters can be read simply as tragedies, they should be better remembered for the significant roles they played in advancing legislative labor and research on radium. The radium companies' negligence led to shorter lives for many of their employees and should be a reminder of the importance labor regulations play in workers' safety, yet their stories fit into a contextual narrative that is a result of the times. In the early twentieth century, many reformers across the United States were striving to better protect workers and advocated for unions of all demographics, including women. Yet many states, such as Illinois, struggled to keep up with its progressive contemporaries and did not have effective legislation in place to properly protect its industrial workers. The radium dial painters' cases helped to affirm that acts, such as the Occupational Disease Act, were indeed constitutional and need to be upheld. Their cases also set precedents for class action lawsuits regarding labor groups; allowing for future workers to have better opportunities to file for compensation. Their cases allowed for the courts to reevaluate rules, such as how long a worker had to file for compensation after they realized they were ill, and provided a way for other disenfranchised workers to gain compensation.

Along with the impact these women had on legislation, they also contributed to the scientific understanding of radium. This substantial group of women helped to answer questions about the effects of radium internally deposited in human beings. The large subject population that consisted of these women and their bodies helped researchers not only understand the ill effects of the former miracle cure but also establish safety standards for programs like the Manhattan Project. For decades, radium was believed to be the solution to any patients' ailment.

After the cases of the dial painters, though, the scientific community reconsidered their acceptance of the radioactive element. With the knowledge that digesting radium in any capacity was actually harmful to patients, researchers actively advocated against radium therapies.

Along with understanding the functions of radium, the dial painters' contribution to government programs, such as the Manhattan Project, helped established health standards for employees. The dial painters helped to set safety regulations for government employees, allowing for them to continue working on radioactive materials throughout the Cold War while still protecting workers. Although they did not receive the proper protection from their own companies, the dial painters helped to prevent future cases such as theirs from happening. Their histories are a tragedy, but they are also a reminder of the importance of industry regulations and humane treatment. Throughout the Progressive Era, when the dial painters' histories begin, reformers were making strides in advancing in the field of industrial hygiene. As the decades continued on, and the dial painters' cases were needed to reaffirm the constitutionality of new industrial acts, state legislatures worked to revise outdated statute in favor of workers. Although the dial painters' histories were dismal, their legacies allowed for advancements in workers' compensation and the understanding of an unpredictable element.

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