

Man-Made Lead Water Disasters: Public Health Responses in Disadvantaged Communities

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Abstract

Nationally, lead drinking water crises have gained media attention in the previous years. The events that unfolded were highlighted by regulatory failures, lack of public health responses, and environmental injustice. This paper seeks to answer the following question: how can a city produce a sufficient public health response mindful of environmental justice? I will conduct comparative case study research to examine the players and roles that resulted in cases of inadequate response to concerning levels of lead in drinking water in three cities: Flint, Michigan; Washington, District of Columbia; and Newark, New Jersey. This case study will review documents researching aspects of these cases to investigate and juxtapose different solutions to improve current regulations and prevent future crises of lead contamination in water. A sufficient public health response is rooted in maintenance and prevention.

Keywords: environmental injustice, blood lead levels, public health response, water infrastructure

Introduction

Background on Lead Contamination and Public Health

Between the years 2016-2019, “nearly 40% of the U.S. population obtained their water from drinking water systems that were in violation of the law” (Faherty, 2020, p. 21 & 22). Violations remain uncorrected despite administrative actions, so how can a city produce a sufficient public health response mindful of environmental justice? Lead corrosion in drinking water is an ongoing problem in minority and low-income cities, such as Flint, Michigan; Washington, District of Columbia; and Newark, New Jersey. Lead contamination occurs when a corrosive water source is introduced into an inadequately controlled water system (Hanna-Attisha et al., 2016). The topic of lead contamination is important because “lead is a potent neurotoxin and childhood lead poisoning has an impact on many developmental and biological processes” (Hanna-Attisha et al., 2016, p. 283). The Centers for Disease Control and Prevention (CDC) defines blood lead levels as the quantity of lead in blood for children living in homes with lead service lines. The CDC analysis of blood lead levels displays higher susceptibility in the age group from 6 months to 6 years of age, “contribut[ing] about 7% of the intake of lead in the U.S. ...overall” (Guidotti et al., 2007, p. 699).

Federal Regulations and Enforcement

The U.S. Environmental Protection Agency (EPA) has strict regulations to maintain public water supplies and public health under the Safe Drinking Water Act (SDWA) and Lead and Copper Rule (LCR). The EPA has ultimate power in setting national health-based standards for lead in drinking water originating from human activity and unrefined sources. In spite of the fact that SDWA is a federal statute, “EPA establishes mandatory standards for contaminants” which are administered and enforced by the states (Butler et al., 2016, p. 94). The LCR follows

the regulations set by the SDWA, however they are legally bound to enforce a maximum contamination level as determined by the EPA. All community water suppliers are required to act when lead levels evaluated at the tap of homes attain 15 parts per billion (ppb) with corrosion control treatment, water quality parameter monitoring, and lead service line replacement.

Aging Water Infrastructure and Environmental Justice

Lead contamination in the United States has grown tremendously due to changes in water sources, infrastructures, and disinfectants. A key term primarily used in this section is water infrastructure, which is aging faucets, lead pipes, and solder in residential housing. During the 1800s-1940s, lead was “the material of choice” in service lines. As a soluble metal, lead leaches and corrodes service pipes in drinking water systems. Lead products, precisely lead service pipes, remained fully operational in communities of color despite surpassing their product life. As a result, these lead service pipes not only show a water quality and public health problem, but an environmental justice problem. The concept of environmental justice focuses on the equitable distribution of environmental health hazards on minorities and communities of color. These communities are disproportionately impacted by aging and underfunded water infrastructure “compared to their white, more affluent counterparts,” therefore it is essential to look at an environmental justice perspective to understand lead drinking water crises (Faherty, 2020, p. 21).

Case Study Outline

In order to discuss how to produce a sufficient public health response mindful of environmental justice, this comparative case study includes a literature review, methods and discussion of three cases of cities in the United States experiencing lead contamination in drinking water. In addition, the conclusion summarizes this analysis, offers recommendations, discusses limitations and biases, and provides any future research.

Literature Review

Environmental Justice

The concept of environmental justice addresses low-income and minority populations who are disproportionately impacted by environmental harms compared to their affluent white counterparts. Hanna-Attisha et al. (2016) stated that environmental injustice is “amplified by a history of racial discrimination” and susceptibility to environmental toxicants such as lead and copper in drinking water systems (p. 284). Her study used geospatial analysis to identify underprivileged neighborhoods with elevated blood lead levels in children and pregnant women after a water source change (Hanna-Attisha et al., 2016). The rising level of lead in drinking water justifies a nationwide and social justice problem that affects people of color, indigenous, and immigrant minority communities. Faherty (2020) wrote that nationwide lead crises are not solely an environmental problem, but a social justice problem that can be solved with engagement and collaboration, thus asking the following question: what are other dimensions to this problem in communities that “still are systematically adversely impacted by environmental burdens?”(p. 2). Public health responses are another dimension to address the repeated occurrence of water supply failure from lead in drinking water in communities experiencing environmental injustice (Butler et al., 2016). Butler et al. (2016) analyzes “the context of similar failures to protect vulnerable populations from lead in drinking water across the country, and actions to prevent such failure in the future” (p. 94). Future prevention is crucial to ameliorate lead contamination in drinking water burdening communities historically and geographically.

Elevated Blood Lead Levels

According to Guidotti et al. (2007), the definition of lead contamination is an abrupt rise in lead levels in drinking water attributed to consequent changes in water chemistry and

corrosivity following a change in water-disinfection treatment (p. 695). The journal of *Environmental Health Perspectives* elucidates the importance of childhood lead exposure on the human body by asking the following research question: what are the blood lead levels in children living in homes with sources of lead? In a six month study screening the blood lead levels of 6,834 residents, 2.78% of the 2,342 children from 6 months to 6 years of age had blood lead levels above “level of concern” as defined by the CDC (Guidotti et al., 2007, p. 695). Children living in homes with lead service lines “had higher blood lead levels on average than those in houses that did not...associated with other sources of exposure, particularly lead paint” (Guidotti et al., 2007, p. 695). Their research method was appropriate for finding blood lead levels in children; however, considering this is a regulatory assessment, it would have also been beneficial to measure exposure from individualized sources of lead for future regulation. The study did note sources of lead exposure in homes, but this study cannot show causation between blood lead levels and individualized sources. For the purposes of regulating lead exposure to children in this city, this study was successful in shedding light on the problem, but unable to accurately quantify the exposure of lead in children from individualized sources to develop regulations.

Guidotti et al. (2007) and Hanna-Attisha et al. (2016) found that elevated blood lead levels increased after a water source change. Both studies examined “blood lead levels for children younger than 5 years of age before and after a water source change” (Hanna-Attisha et al., 2016, p. 283). Children in utero and during infancy were not considered for water-based lead exposure — when infants and children are at the greatest risk, but have not been screened yet. By screening infants and children at younger ages, the findings in these studies would be more convincing. On the other hand, Hanna-Attisha et al. (2016) expressed that lead screening data “mandated by Medicaid and CDC-recommended” was skewed toward higher-risk children

(Hanna-Attisha et al., 2016, p. 287). Lastly, this study captured only 60% to 70% of the city's lead screening, however their errors are not too limiting (Hanna-Attisha et al., 2016).

Water Infrastructure & Regulations

Implementation of a sufficient legal framework is one-step in the right direction to mitigate aging water infrastructure. In the *Current Opinion in Environmental Science & Health*, Roy and Edwards (2019) poses the following question: what is “our current understanding of infrastructure, scientific/operational and regulatory factors that contribute to lead in water disasters” and what can we prescribe to stop lead contamination of drinking water in the future? (p. 34). Butler et al. (2016) and Roy and Edwards (2019) found dishonest claims from state government agencies “involv[ing] scientific misconduct, failure to properly implement legally mandated corrosion controls, and efforts to withhold information about elevated lead in water from the public” (p. 34 & 94). Government agencies disregarded fixing deteriorating faucets, pipes, and solder, abandoning the Safe Drinking Water Act (Roy & Edwards, 2019). The EPA counteracts these claims saying they are impossible to achieve because “there is no safe level of lead exposure” and trace lead is ubiquitous (Roy & Edwards, 2019, p. 41). It is prudent to improve our current policy, regulations, and enforcement by “relying on field and laboratory studies from the past decade, to offer scientific, regulatory, and practical advice on how to avoid the high societal and financial costs of a future water lead crisis” (Roy & Edwards, 2019, p. 36). While this study didn't introduce new information, its method exposed and amended society's flawed view of safe drinking water by discussing field and laboratory studies previously completed. The findings take a bold view on prescribing change for water infrastructure and regulations, disagreeing with reputable sources such as the EPA. Flawed assumptions such as the need to eliminate lead contamination in drinking water entirely rather than reducing lead levels

below the level of concern makes this peer-review journal article less convincing. These policies and regulations are not being followed by municipal water suppliers or enforced by the EPA, essentially nullifying them and leading to a convincing conclusion that “legislation to address this problem must be improved, strengthened, and actively enforced” (Butler et al., 2016, p. 97). By addressing this problem, cities can improve their water supply infrastructure rather than disregarding public health and the “protection of the basic right of equitable access to safe drinking water” (Butler et al., 2016, p. 97).

Whereas, Faherty (2020) and Hanna-Attisha et al. (2016) determined that water infrastructure and federal regulations have an influence on environmental injustice in low-income communities. In the American Journal of Public Health, Hanna-Attisha et al. (2016) questioned how introducing a “more corrosive water source into an aging water system without adequate corrosion control” affects blood lead levels in low-income communities (p. 283). Children and infants are the most vulnerable to lead poisoning in drinking water due to a shortfall in adequate water systems. Interpolation methods for building a preliminary risk surface are appropriate given the assumption that lead risk is spatially correlated because of the age and condition of pipes (Hanna-Attisha et al., 2016, p. 285). Faherty (2020) found a city’s sampling process had errors resulting in inaccurately low lead levels, and rising lead levels caused by increased acidity in the distribution system lead to ineffective corrosion control. This is a serious issue and it is necessary to take as many approaches as possible to research and solve it, however, this displays a “strong correlation between SDWA violations and sociodemographic factors” (Faherty, 2020, p. 24). The need for active participation in disproportionate communities is a persuasive conclusion and is willfully encouraged “to ensure safe drinking water access for all – no matter what color hand reaches for the tap” (Faherty, 2020, p. 24).

Methods

This analytical research paper will utilize comparative case study analysis and document review to understand the components of a successful public health response mindful of environmental justice to elevated blood lead levels. This paper studies and compares the players and roles that resulted in cases of inadequate response to concerning levels of lead in drinking water in three cities: Flint, Michigan; Washington, District of Columbia; and Newark, New Jersey. By qualitatively analyzing these inadequacies, this paper seeks to break down and motivate the mechanisms of a successful public health response. Herein, this paper will also review documents researching aspects of these cases to investigate and juxtapose different solutions to improve current regulations and prevent future crises of lead contamination in water. These cases were selected for this research paper because they are high-profile cases of lead contamination in drinking water covered by media that offer insight on the shortcomings that weaken a public health response. Also, these cities are in states close to each other with a high concentration of minority communities, allowing the paper to perceive the magnitude of environmental injustice occurring.

Findings

Flint, Michigan

The Flint water crisis was a man-made disaster waiting to happen. Flint was a thriving auto industry city that endured the effects of pollution predating the 1930s. Most by-products of Flint's auto industry mass-produced paints, enamels, batteries, lacquers, and gasoline, which was released into the area's water, air, and soil (Butler et al., 2016). This city has an extensive history of dumping toxic effluent into the Flint River, however a couple years ago, the Flint River was deemed unsafe to drink from due to toxicants and bacteria growth. At one time, Flint stood as "an industrial mecca and economic powerhouse," yet today this city is grappling to amend its economic deprivation and drinking water crisis (Butler et al., 2016, p. 94). Flint's economic success plummeted after its auto industry vanished, leaving behind 41.6% of 100,000 people living below the poverty line (Butler et al., 2016). According to Butler et al. (2016), the city of Flint suffered hardship to "not only [give] birth to a drinking water crisis but also [a public health crisis]" (p. 94). The state of Michigan declared the use of the Local Financial and Stability of Choice Act to take out the city's government with an Emergency Manager named Darnell Early to confront the economic deprivation of the city. The purpose of this act is to "safeguard and assure the financial accountability of the local governments...[by] removing the sense of accountability held by elected officials" (Butler et al., 2016, p. 94). The removal of elected officials was a public health and "economic-driven decision" to "protect the interests" of vulnerable communities (Butler et al., 2016, p. 94). In the days leading up to the switch of Detroit River to Flint River, residents opened their water to find a brownish color with a foul-smelling odor. As residents grew worried about their water system, the lead contamination problem became known and Darnell Early quickly dismissed allegations of water contamination.

As months passed, Flint residents complained of health problems from the Flint River water and started relying on bottled water to drink, cook, and cleanse themselves. The city of Flint, Michigan is largely an African-American community experiencing a lot of injustice from the use of lead service lines. The push to remove these lead pipes didn't come easy, Flint residents were concerned that the Former Governor switched the water supply after recent evidence of increased E.coli and related bacteria. The consideration of Flint residents was unimportant to city officials and couldn't be trusted. As residents lived through this trauma for the next few years, they fought to protect themselves since they "were failed by multiple government agencies" (Butler et al., 2016, p. 94). In the beginning of this year, the Former Governor and other state officials were accused of willfully neglecting their duty to serve and protect the Flint community. In terms of pros and cons, I believe that Flint, Michigan worked rapidly to study the effects of lead on pregnant or nursing women, and a federal emergency declaration set out to give Flint residents relief in the form of healthcare, water testing, bottled water, nutrition and educational services (Roy & Edwards, 2019). Some cons were Legionnaires Disease outbreaks that resulted in 12 deaths, all lead and galvanized iron pipes that were replaced six years after the water crisis began, criminal charges that were filed against state officials, Emergency Managers, the Former Governor, and two environmental companies (Roy & Edwards, 2019). The timeline of this crisis was prolonged and disregarded, however, in order "to protect vulnerable populations from lead in drinking water across the country,... actions [will be needed] to prevent such failure in the future" (Butler et al., 2016, p. 94).

Washington, District of Columbia

According to Guidotti et al. (2007), Washington, DC has a well-recognized lead exposure problem in older unrehabilitated homes "with residual lead paint and contaminated house dust"

(p. 695). Drinking water distribution systems found blood lead levels in children falling dramatically for a few years, yet by a population basis, older housing stocks found a correlation between childhood blood lead levels and the utilization of a disinfection agent (Guidotti et al., 2007). As time went on, the lead concentrations began to increase from the main water supplier called the District of Columbia Water and Sewer Authority (DCWASA). In 2002, the rise of lead exposure was minimal and did not surpass the EPA's lead action level, however, this was followed by a "substitution in water-disinfection treatment from chlorine to chloramines...in anticipation of the new Disinfection Byproducts Rule" (Guidotti et al., 2007, p. 695). Guidotti et al. (2007), explains that about "68% of 6,170 addresses where water was sampled exceeded the [lead action level] of 15 [parts per billion]" (p. 695). The DCWASA serves 500,000 customers in Washington, DC "with 135 million gallons... of drinking water per day at 130,000 locations"(Guidotti et al., 2007, p. 695 & 696). The city's water distribution system claimed to have no trace of lead in main lines that extend under the pavement. Guidotti et al. (2007) confirmed that changing disinfectant in tap water from chlorine to chloramines has modified and corroded the interior of the lead service lines. On the other hand, different sources of lead such as water meters, faucets, and copper pipes also leached lead into the water. The District of Columbia lead service lines are affiliated with an utility company "from the main line to the property line...and of the homeowner from the property line to the tap" (Guidotti et al., 2007, p. 696). After the discovery of the water-disinfectant treatment, almost all lead service lines were replaced years later. The DCWASA analyzed close to 7,160 homes with lead service lines on streets connected with another lead service line likely built between 1900-1950. Most homeowners paid for private segments of their lead service lines to be replaced on their property, although "lead levels are reduced proportionally to the length of pipe replaced but not

eliminated” (Guidotti et al., 2007, p. 696). An Optimal Corrosion Control Treatment (OCCT) study managed by the DCWASA looked at multiple methods of corrosion control in their water distribution system (Guidotti et al., 2007). The OCCT study found that by reducing the chlorine level, chlorine was switched to chloramines, and potentially changed the interior surface of the lead pipe. At the end of the year in 2003, the DCWASA set out an enormous program to replace all lead service lines in 92% of houses with pregnant women or children younger than 6 years of age. These replacements were a priority to the city of Washington, DC as they fixed both private and public segments of the lead service lines. The pros of this case were installations of lead filters in homes and free blood tests at clinics (Roy & Edwards, 2019). The cons of this case resulted in many miscarriages and fetal deaths from women exposed to lead, and “allegedly falsified data that downplayed harm to public health and derailed efforts to hold bad actors accountable” (Roy & Edwards, 2019, p. 35). As it still remains clear, the CDC and public health officials are watchful of lead contamination in all sources, and lowering exposure to lead in drinking water is an urgent dilemma that needs to be researched further in order to eliminate elevated childhood blood lead levels in future.

Newark, New Jersey

As mentioned by Faherty (2020), Newark, New Jersey “is the most recent city to add to the list of national lead crises” (p. 1). The city of Newark exceeded lead levels more than ten times of the federal standard in the state of New Jersey. Residents first grew aware of lead in their drinking water when thirty Newark public schools detected increased lead levels in coolers, water fountains, and bathroom faucets (Faherty, 2020). In spring 2016, Newark Mayor Ras Baraka, just like Flint, Michigan Emergency Manager Darnell Early, told residents to calm down for there was no water contamination. Around a year later, the New Jersey Department of

Environmental Protection (NJDEP) started a drinking water sampling regime for six months and lead levels started “exceed[ing] the federal action level...of 15 ppb in more than 10% of the samples in both six-month monitoring periods of 2017, with over 10% of drinking water samples exceeding 26.7 ppb throughout 2017” (Faherty, 2020, p. 11). The NJDEP quickly put a notice of noncompliance to the LCR for the year of 2017. The second drinking water samples of 2018 tested higher for lead and required the NJDEP to issue a third compliance for the city.

Throughout this year, “highest lead level yet recorded, [was] at 250 ppb,” and Mayor Baraka kept telling Newark residents that their water was safe, even though the NJDEP issued multiple notices of noncompliance. Again, this situation is very similar to when Flint city officials also disregarded and masked “the full scope of the problem to the public, stating that [t]he truth is that the water supplied by the City is safe to drink...the City’s water is not contaminated with lead...our water is safe, and that our water is some of the safest water in New Jersey” (Faherty, 2020, p. 12). According to Faherty (2020), city officials continued to spur falsified information, deny the problem, mislead the public, and refuse to enlighten residents about the public health and environmental impacts of lead in drinking water. The city’s water distribution systems, the Pequannock Watershed and the Wanaque Reservoir, treated and provided drinking water to around 300,000 residents in connection with lead service lines. Once the lead levels reached above 15 ppb, “both the Pequannock and Wanaque water treatment plants implemented corrosion control technology (CCT)” (Faherty, 2020, p. 10). The complexity of this drinking water crisis started from an ineffective corrosion inhibitor at both treatment plants, and the city’s negligence to correctly treat water to reduce corrosion from lead service lines into drinking water. Similarly to Washington, DC, New Jersey’s LCR mandated an implementation of an Optimal Corrosion Control Treatment “to help minimize the level of lead in the tap water, often by introducing

chemical additives that serve as corrosion inhibitors” (Faherty, 2020, p. 14). The prolonged lead levels explicitly indicated no optimizing corrosion control in the water distribution system (Faherty, 2020). From conducting comparative case study research, I realized the magnitude of greed and political power of state governments in these three cases. The Newark, New Jersey case is one of the worst water management and public health crises known today. For this reason, I cannot express any pros for this case, but multiple cons that stood out. First, it was truly despicable to see Mayor Baraka and state officials turn a blind eye away from residents desperate for help. Second, the level of deceit on the public, especially to residents such as the elderly, pregnant women and children was incomprehensible. Third, the city’s water distribution system wasn’t properly maintained and corroded lead metal leached into service lines reaching homes and businesses. Faherty (2020) further highlights the 2017-2018 year with “the egregious and continued exceedances” of zero compliance as a “clear violation of the SDWA’s requirements to implement and maintain optimal corrosion control, and has subsequently failed to take any measures to address the problem” (Faherty, 2020, p. 14 & 15).

Conclusion

As seen in the examined cases, an effective public health response is required to prevent, address, and resolve lead in drinking water crises. In the first case, Flint endured a preventable and prolonged disaster premised by careless disposal of harmful waste into the essential Flint River and aggravated by the disregard of the government (Butler et al., 2016). Despite Flint's rapid study of the effects of lead and relief provided to residents, Flint failed to timely address this crisis, seeing resulting public health concerns and deaths for several years due to deferred replacement of pipes and change of water source overlooking public health (Roy & Edwards, 2019). In the second case, the combination of marginalized, unrehabilitated homes and a lack of research prior to a change in water treatment by a main water supplier to follow new EPA rules resulted in the Washington, DC drinking water crisis (Guidotti et al., 2007). The Washington, DC drinking water crisis harmed numerous people rapidly due to the wide outreach of the water supplier in marginalized communities; this disaster may have been preventable with proper research and maintenance, but was addressed promptly with studies on corrosion control and inclusive efforts to replace lead service lines in homes (Roy & Edwards, 2019). According to Faherty (2020), city officials continued to deceive and deny teaching residents on how to maintain their health against lead contamination. Lastly, this man-made disaster could have been prevented with SDWA's requirements and Optimal Corrosion Control to protect against noncompliance for state governments. The key to a reliable and sufficient public health response as seen in each of these cases is rooted in maintenance and prevention. Some research utilized in this paper was funded by the EPA, making the research potentially biased. As a student who has not had experience in the field of chemistry, I am limited in understanding how preventable cases of corrosion were with proper research. For this paper, I did not have time to compare cases to

successful public health responses and research additional topics in vulnerability to poor public health responses. In the future, this research can be continued by researching successful public health responses to lead drinking water crises and public health responses to different crises.

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