

The University of Chicago



Medicating the Environment: Understanding the Challenges and Barriers of Establishing a Safe Pharmaceutical Disposal Program

By

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ABSTRACT

In the United States, we do not currently test for pharmaceutical contaminants in our water. This is extremely problematic because when pharmaceuticals are leached into the environment, the active chemical components can cause serious harm to wildlife. Furthermore, pharmaceuticals can contaminate drinking water, posing a risk to human health. Yet, one of the simplest actions to prevent pharmaceutical contamination—proper pharmaceutical disposal—is a neglected aspect of the American waste system. There are no federal disposal programs or regulations requiring consumers to safely dispose of their pharmaceuticals. As a result, pharmaceutical contamination continues to occur as many individuals dispose of their leftover medications by flushing them down the drain or throwing them away in the trash.

The lack of widespread disposal programs across the country led me to question why many institutions have not invested in creating such programs, especially institutions that have the resources to do so. This was the inspiration for my case study at the University of Chicago. In my research, I highlight the implementation challenges to establishing a safe pharmaceutical disposal program at the University of Chicago and how this reflects more broadly on how pharmaceutical disposal is scarcely utilized in the United States. My research builds from a student survey where I collected almost 200 student responses, in addition to interviews with external institutions with successful safe pharmaceutical disposal programs and extensive literature on water contamination policies and hazardous waste regulations in the United States.

Overall, I find there are both federal barriers and informal barriers that prevent widespread use of pharmaceutical disposal programs. The formal barriers I found include insufficient resources, limitations in micro-pollution policies, and fragmented enforcement. On the University of Chicago campus, the informal barriers I discovered include lack of knowledge regarding safe pharmaceutical disposal and inadequate awareness about disposal options. I ultimately recommend an implementation protocol for the University of Chicago to establish a safe pharmaceutical disposal program through three essential steps: purchase a safe pharmaceutical disposal bin, collaborate with multiple departments to educate students and spread information about the program and finally sustain the program through community involvement.

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I would also like to thank Amy Coombs who distributed my survey and ensured me through my panic that people would actually want to fill out a survey on a subject that they didn't know anything about.

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I. INTRODUCTION

Two summers ago, I worked on a research project in partnership with the Program on the Global Environment at the University of Chicago. I was examining the feasibility of establishing a site where students could safely dispose of their medication on the University of Chicago campus. The more I became involved in the project, the stranger it seemed that I had never heard of the dangers of pharmaceutical contamination. As an Environmental Studies major, I had taken many environmental-focused classes that examined the anthropogenic effects we have on the environment and the dangers that our ignorance can create, yet, I had never heard about pharmaceuticals entering our waterways nor the fundamental methods a consumer could take to prevent this contamination. Two knee surgeries from my college volleyball career had left me with a significant amount of unused prescription medication sitting in a drawer at home, so why didn't I know how to safely dispose of it?

In the last 15 years prescription drug use has increased dramatically throughout the United States. In 2000, roughly 8 percent of Americans were taking five or more medications and as of 2012, this has nearly doubled to 15 percent (Brownlee et. al, 2019). The United States has the largest market for pharmaceuticals with prescription drug sales reaching a new high at roughly \$370 billion in 2019.¹ However, these market gains are not met without severe consequences for the public and the environment. The over-prescription of pharmaceutical drugs—and the resulting increase in opioid addictions—has become an epidemic in America. A 2017 study found that roughly 18 million Americans that year, more than 6 percent of people aged 12 and older, misused prescription medications at least once (National Institute on Drug Abuse 2017).

¹ O'Brien, Jack. "Pharmaceutical Spending to Top \$370B in 2019." *HealthLeaders Media*, 28 May 2019, www.healthleadersmedia.com/finance/pharmaceutical-spending-top-370b-2019.

Results from the National Survey on Drug Use and Health found that roughly 2 million Americans misused prescription pain medication for the first time in 2017, which roughly equates to 5,480 people per day (Behavioral Health Statistics and Quality). And students are especially vulnerable to this abuse. A 2018 study found that nearly 1 in 10 students misused pharmaceuticals in the last 12 months (The Ohio State University).

But these public health ramifications are not the only consequences of the growing pharmaceutical industry. Increasing pharmaceutical use also means increasing disposal of pharmaceuticals. It is estimated that roughly 50% of Americans do not take medications as they are prescribed and roughly one third of prescriptions are not completed and become expired (Shealy, O'Day, and Eagerton 2014). However, most of these expired medications are not properly disposed creating a significant risk for these pharmaceuticals to unsafely enter the environment. When pharmaceuticals pollute water systems, they function as micro-pollutants meaning they are not eliminated with traditional wastewater treatments. With over 80,000 diverse compounds in wastewater, traditional treatment facilities are not equip to detect and eliminate pharmaceutical contaminants, so many of the pharmaceuticals remnants are not filtered out (Crawford et al. 2017). This is problematic because pharmaceutical drugs have endocrine disrupting compounds, which when ingested, can affect biological hormone regulation in animals (Crawford et al. 2017). Long-term exposure to pharmaceuticals through water consumption has been linked to cancer and destructive reproductive issues in animals (Lei et al. 2015). The continued exposure to the contaminated water means that aquatic animals are even more vulnerable to these effects. Several studies have found the change in hormone levels that fish experience can become so severe that their sexual reproduction is inhibited (Crawford et al. 2017). In several different studies, the U.S Geological Survey (USGS) has linked pharmaceutical

contamination with high levels of intersex fish and impaired reproduction function of aquatic life in watersheds throughout the United States (Vajda et al. 2008) (Ripley et al. 2008). In addition to health effects, active pharmaceutical ingredients and unfinished doses of antibiotics can also become highly concentrated and thus encourage the development of drug resistant pathogens (Nawrat, 2018).

However, even though the posed human and environmental threats from pharmaceutical contamination are prevalent, this topic is severely understudied and remains on the backburner of the prescription drug discussion (Brodin et al. 2014). Currently, there are no federal requirements for testing water supplies for pharmaceutical drugs nor is there specific standards for states and cities to follow. Furthermore, there is significant lack of knowledge on how to properly dispose of pharmaceutical drugs and why flushing them down the toilet is a serious health threat. In a 2012 telephone interview study performed to measure the awareness of pharmaceutical disposal in Cook County, researchers found that over 90% of the respondents had prescription medications in their home, and of those individuals, 80% stated they did not receive instructions on how to dispose of the drugs (Brodin et al. 2014). A majority of people claimed that flushing them down the toilet or throwing them away was their primary disposal method. This lack of a comprehensive disposal program demonstrates how pharmaceuticals are an overlooked aspect of the waste system. It is common in the United States for consumers to associate waste as a “single transaction process”. When you flush your expired medication down the toilet, the transaction is finished with no further repercussions. However, we know that the active chemicals in pharmaceutical waste does not disappear when you throw it away, so, why do we believe that it does?

In the last ten years there has been an increase in take-back events and permanent safe pharmaceutical disposal bins where consumers can drop off their unused medications. Yet, awareness and accessibility to programs like these remain relatively low, especially among college students (Ma et al. 2014). A study at University of Vermont examining the disposal practices among university students found that only 24% of the students were aware of what safe pharmaceutical take-back programs were (Vatovec, Van Wagoner, and Evans 2017). Of the 61% of students who had left over prescription medications from the last 12 months, 18% of them had disposed of the drugs and only 4% had used a safe pharmaceutical disposal program (take-back event or disposal bin) (Vatovec, Van Wagoner, and Evans 2017). Some universities, especially those with pharmacology departments, such as Ohio State University, offer disposal options, however, on-campus disposal bins or programs focused on educating students about safe pharmaceutical disposal are limited (Shealy, O'Day, and Eagerton 2014). Often, the bureaucratic red tape that occurs when attempting to establish safe pharmaceutical disposal programs negatively impacts the desire for universities and other institutions to implement their own program. This was abundantly clear in my previous research and ultimately inspired me to use University of Chicago, which currently does not have a safe pharmaceutical disposal program, as a case study to further understand what formal and informal challenges exist in establishing a disposal program on a university campus.

In my research, I examine students' awareness and knowledge about pharmaceutical disposal options. Along with this feedback, I analyze how regulations regarding pharmaceuticals has created significant limitations on establishing efficient, widespread safe disposal programs in the United States. In addition, I consult outside institutions to learn about their approach in creating their own pharmaceutical disposal programs. From these components I create a policy

recommendation for how this University and similar institutions can establish a safe pharmaceutical disposal program along with recommendations on how to increase awareness regarding pharmaceutical disposal among students. This study provides integral information on the challenges that exist in establishing a safe pharmaceutical disposal program and sheds light on why pharmaceutical disposal is an overlooked—yet pressing—issue in the United States.

i. Why the University of Chicago?

Using this university for a system analysis has several significant advantages. First, University of Chicago has a very diverse student body with individuals from across the country. Having a diverse community allowed me to assume that the data collected from the students is representative of a greater population outside of Illinois. Furthermore, the university has a fairly tight-knit social community and is contained to a designated location in Hyde Park. This allows for a development of shared values within the University of Chicago community along with an easy transfer of information which is essential for creating a safe pharmaceutical disposal program. And finally, University of Chicago has several well-established departments such as the Department of Safety and Security, Department of Environmental Health and Safety, the Office of Sustainability, and Department of Housing and Residence Life that have facilitated campus programs in the past and exhibit the shared morals and desires of the University of Chicago community. Without collaboration between various departments, enforcing the disposal program would not be possible.

ii. What is Safe Pharmaceutical Disposal?

Prior to describing my research, it is important to clarify what safe pharmaceutical disposal is and what safe pharmaceutical disposal practices entail. According to the Federal Drug Administration (FDA), safe pharmaceutical disposal is when unused, expired or unwanted

medical drugs are appropriately disposed so they no longer pose a risk to human or environmental health. A safe pharmaceutical disposal program has three essential elements: collection, destruction, and promotion. The collection involves how the drugs are collected from the consumers, destruction includes how and where the drugs are destroyed, and promotion focuses on how communities are educated about the importance of the safe disposal (Partnership for Drug-Free Kids 2015). Due to limited resources and the scope of my research, the destruction component does not play a large role in my analysis as I will primarily focus on the collection and promotion aspects of safe pharmaceutical disposal.

Although pharmaceutical contamination can occur via human excretion, inappropriate disposal methods such as flushing down the toilet or throwing the drugs in the trash, which can leach into the groundwater, pose the greatest threats. The FDA recommends the best way to dispose of pharmaceuticals is to drop the drugs off at permanent collection locations where there are safe pharmaceutical disposal bins or periodic take-back events that collect pharmaceuticals (Center for Drug Evaluation and Research 2018). If these options are not readily available, the FDA recommends flushing the medication down the toilet or throwing the medication in the trash to avoid possible risk of the medication getting in the wrong hands. However, these two aforementioned methods are problematic because the drugs still remain chemically active even if mixed with kitty litter or coffee grounds—a common myth that many individuals still believe (Partnership for Drug-Free Kids 2015).

II. LITERATURE REVIEW: A HISTORY OF PHARMACEUTICALS

To further understand the complexity of pharmaceutical contamination, my literature review includes background information on how this issue rose to prominence and why it continues to be prevalent today. I start by contextualizing pharmaceutical contamination on the

federal level by addressing hazardous waste regulations and micro-pollution policies in the United States. Because I am specifically looking at the University of Chicago for my case study, I also examine how Illinois has addressed pharmaceutical disposal. As my goal is to ultimately provide a policy recommendation for how the University of Chicago can implement a safe pharmaceutical disposal program, the final portion of my literature review explores various successful policies and programs targeted at safe pharmaceutical disposal.

i. Pharmaceutical Contamination in the United States: An Ecosystem Under Pressure

The lack of significant policy reform regarding micro-pollution would suggest that pharmaceutical contamination is not a new phenomenon, but in reality, this has been taking place in the United States since the 1980's. It was not until the early 2000's that contamination levels of pharmaceuticals and personal care products, which started being referred to as PPCPs in 2010, became widely recognized as a threat to public drinking water (Morgan 2011). Part of the reason for this delayed reaction is that chemical analysis methodologies lacked the ability to detect various forms of pharmaceutical drugs, and with no reason to believe that pharmaceuticals were leaking into the environment, the Environmental Protection Agency (EPA) did not begin conducting PPCP-specific research until the 1990's (Daughton 2003). However, when studies regarding the danger of pharmaceuticals in the water system were finally endorsed by the EPA, the findings shocked the researchers. The studies consistently showed that pharmaceutical contamination was both common and widespread. In 2002, the United States Geological Survey on Toxic Substances found that of the 139 streams they tested across the United States, 80% of the streams had various pharmaceutical contaminants (Bain 2010). These results sparked further concern when it was concluded that pharmaceutical compounds actually do "survive wastewater treatment" (Morgan 2011).

With this new information, it was expected that the government would now enforce screening for pharmaceutical chemicals, however, this was not the case. Under the Safe Drinking Water Act (SDWA), the EPA is given authority to regulate the quality of drinking water. One way they do this is by updating a Contaminant Candidate List (CCL). This list keeps track of contaminants that pose a threat to human health and are “known or anticipated to occur in public water systems” (*The Hazardous and Solid Waste Amendments of 1984*). Some pharmaceutical chemicals were added to the list in 2010, however, the list is only used as a suggestion for possible future regulations and does not guarantee systematic monitoring (*The Hazardous and Solid Waste Amendments of 1984*). Today, there are still no standards or minimum levels set for the pharmaceutical chemicals added to the list (Wu et al. 2009). In addition to the CCL, the SDWA authorizes the EPA to utilize an Endocrine Disrupter Screening Program (EDSP) to test drinking water for potential hormone disrupting chemicals. As previously mentioned, pharmaceuticals have been proven to have hormone disrupting characteristics, but after years of delay, the EPA has still not screened for any pharmaceutical chemicals (Wu et al. 2009). In 2015, it was reported that four pharmaceutical chemicals were being approved for screening, however, no report of further action has been released (Wu et al. 2009).

Along with this lack of testing, there was a significant delay in action by the federal government. Under the Controlled Substances Act (CSA), only those registered with the Drug Enforcement Administration (DEA) are permitted to handle and dispose of pharmaceuticals (*Controlled Substance Act 1971*). Pharmacies and hospitals are examples of institutions that are registered with the DEA and therefore can deal with the disposal of pharmaceuticals and hazardous medical waste. The exemption to this of course is patients—also known as ultimate users—who receive controlled substances through prescriptions. However, it was not until 2010,

when the Secure and Responsible Drug Disposal Act was passed, that the CSA allowed ultimate users to dispose of their drugs through a third party (EPA, 2010). If they wanted to dispose of their pharmaceuticals, their options were limited to throwing them away or flushing them down the toilet. With the passing of this act, ultimate users could now participate in take-back events, mail-back programs, or dropping off their medications in disposal receptacles (*Secure and Responsible Drug Disposal Act*, 2010). This act was a key component of granting states and municipalities greater autonomy to establish their own pharmaceutical disposal policies. However, these options continue to remain limited. Under the current DEA interpretation of the regulation, only law enforcement officers can be authorized to accept controlled substances, making this process of safe disposal extremely difficult for third party, non-government institutions.

This delay in action reflects a broader pattern in the United States to create environmental policies that respond to damage caused by contamination rather than policies aimed at preventing the contamination in the first place. In 1992, the concept of the precautionary principle was introduced in the United States. The principle was based off the idea that policies should be implemented to address threats of serious or irreversible environmental damage even if there lacked full scientific certainty that the harm would occur (Enick and Moore 2007). The principle has been defined in various forms, but the central concept focuses on proactive rather than retroactive action, even in the case of high uncertainty (Tickner and Geiser 2004). The approach recognizes that environmental policy often dedicates resources to the measuring, monitoring, and managing of pollutants at the expense of investigating solutions to prevent contamination levels (Enick and Moore 2007). However, the United States refused to adopt this concept, and to this

day is often implementing policies regarding hazardous waste that is aimed at mitigation rather than prevention (Campbell et al. 2016).

Other environmental micro-pollution regulations in the United States are often separated into two categories: source-directed mitigation policy, which is aimed at avoiding pollution before hazardous substances even enter the environment, or, end-of-pipe mitigation policy, which focuses on filtering the pollution after it has already entered the environment (Metz and Ingold 2014). The latter is often the path that environmental policy in the United States takes. Other theory addresses environmental policy by focusing on the context of the type of contamination rather than if it poses any threats. This theory focuses on four central principles: (Metz and Ingold 2014)

- 1) Causation, which is used to explain what is creating the problem and assessing if there are one or more sources.
- 2) Prevalence, which refers to the magnitude and number of factors that are contributing to the problem.
- 3) Effects, which is used to analyze what is being harmed along with how.
- 4) And finally scale, which reflects the scale on which the pollution is occurring.

Throughout my research, I use these four principles to further understand pharmaceutical pollution and how to address the challenges that make this type of contamination a persistent issue.

ii. Illinois Disposal Policies: A State Trying Their Best?

In 2005, Illinois debated passing a Senate Bill which would establish a planning committee and budget to develop a pilot pharmaceutical drug return program called “The Unused Medicine Disposal Act” (Herring 2008). This act was abandoned and instead in 2009,

Illinois created the Unused Medicine Task Force to create a plan for educating residents of Illinois on when and how to dispose of their unused medications (Unused Medicine Task Force 2009). The task force, however, received little funding and remains inefficient in establishing widespread awareness regarding pharmaceutical disposal plans (Shealy, O'Day, and Eagerton 2014). Later that year, Illinois established the "Safe Pharmaceutical Disposal Act," which prohibits health care institutions from flushing unused medications. This means that no health care institution, employee, staff person, or other person under the direction or supervision of a health care institution, can flush unused medication into a public wastewater collection system (*Safe Pharmaceutical Disposal Act* 2009). Although the act has had widespread success, it only focused on healthcare institutions without addressing the actual consumers of pharmaceuticals and how they dispose of their drugs at home.

In February of 2020, Illinois created the Pharmaceutical Recovery Act. This act requires covered manufacturers to participate in an approved drug take-back program or independently implement a drug take-back program (*Pharmaceutical Recovery Act* 2020). To ensure accountability, manufacturers must submit a proposal for the establishment and implementation of such a program to the EPA for review and approval. As of now, this is the most extensive step that Illinois has taken towards addressing pharmaceutical contamination and their collaborative approach seems promising. However, there are several provisions that may prevent this act from acquiring widespread success. Under this mandate, manufacturing companies are also responsible for promotional materials to educate the public about the takeback program and collection sites (*Pharmaceutical Recovery Act* 2020). This is problematic because manufacturing companies have little access to the public, especially if their products are distributed by outside marketers. Furthermore, the act only applies to "covered manufacturers" which is defined as a

manufacturer or distributor who is licensed as a wholesale drug distributor under Illinois law. A “covered manufacturer” does not include any private label distributors or pharmacies of a covered drug nor does it include a pharmacy chain that is licensed as a wholesale drug distributor (*Pharmaceutical Recovery Act 2020*). This means that the pharmacies, private companies, and other institutions that are actually distributing the pharmaceuticals to the public will have a minor role in educating consumers on how to dispose of the pharmaceuticals properly. Furthermore, they will not be responsible for creating disposal programs that their customers can utilize. As a result, significant pieces of the pharmaceutical disposal equation—educating the public and creating accessible disposal options—is not being accounted for.

iii. Implementation of Pharmaceutical Disposal Programs: The Success Stories

With the difficulties of establishing pharmaceutical disposal programs and the minimal interest in this issue, many of the disposal programs in the United States remain limited in scope and creativity. Institutions have little incentive to create disposal options and those that do are often under-utilized by the community. One example of this is the DEA’s National Prescription Take-Back Day. Many states throughout the United States participate in this bi-annual event where various health care organizations will anonymously accept pharmaceuticals and safely dispose of the drugs on the consumers behalf. Although this event can have great success, it has severe limitations as a national disposal program. First, it only occurs twice a year which makes it accessible to only a small population of consumers. Compared to the magnitude of pharmaceuticals being prescribed each year—roughly 4.38 billion in 2019 alone—the two take-back events provide a scarce contrast (Shahbandeh 2019). In addition, many consumers are unwilling to wait until the event to dispose of their drugs and instead favor immediate disposal making the event an ineffective option. But worst of all, these take-back programs are often used

as a catch-all initiative by states and municipalities to show they are addressing pharmaceutical disposal providing them with rationale to not pursue more permanent, accessible and ultimately effective pharmaceutical disposal programs.

However, there two distinct examples that exhibit how successful implementation programs can be seamlessly integrated into a community lifestyle where consumers are not only aware of their disposal options but also have the ability to access them. In 2015, San Francisco established the Safe Drug Disposal Stewardship Ordinance which required medicine manufacturers who sell their products in San Francisco, to provide all San Francisco residents with a safe and convenient way to dispose of their unwanted medicine. As of March 2015, the pilot program has collected 26 tons, or 52,000 pounds, of medication, proving that a pharmacy-based collection program works (“Safe Drug Disposal Stewardship Ordinance” 2015). The Ordinance uses an “Extended Producer Responsibility Model” in which manufacturers, retailers, consumers, and local government all play a role in managing and properly disposing of unwanted and expired medications to reduce accidental poisonings, control substance abuse, and protect the environment (“Safe Drug Disposal Stewardship Ordinance”, 2015). Stewardship Plans must be approved by the Director of the Department of the Environment and must contain detailed information on how the producers participating in that plan will provide a minimum of five collection sites per Supervisorial District to ensure convenient drop-off options for all San Francisco residents (“Safe Drug Disposal Stewardship Ordinance”, 2015).

Another successful implementation program was piloted in Maine in 2008. The EPA funded a Medicine Disposal Mail-back Program which provided postage-paid envelopes and participant surveys to interested individuals throughout Maine (Glassmeyer et al., 2009). This program relied on the cooperation from the DEA, USPS, and Federal EPA along with the state

government, and illustrated how an integrated approach to pharmaceutical disposal was achievable. The success of the program led the Senator from Maine to propose a national mail-back drug program with the hope of disposing of excess prescription drugs easier, however, no progress has been made and little information is accessible on the current efforts of such a program.

In both these examples, the increased accessibility and dedication to increase awareness about public safe pharmaceutical disposal options is what made these programs successful. Establishing permanent pharmaceutical disposal options increases the percentage of safely disposed drugs because it establishes a community where safe disposal can both be utilized and understood as an important public duty (Bain 2010). From these studies, we find that successful medication disposal programs have four essential features: they are accessible, extremely convenient, permanent and finally they are advertised immensely (Shealy, O'Day, and Eagerton 2014). These criteria are essential in the development of pharmaceutical disposal programs and will be a crucial in the creation of my policy recommendation for the University of Chicago campus.

III. METHODS

Within this section, I will explain my methods of data collection which combined both quantitative and qualitative data to analyze the challenges that exist to pharmaceutical disposal and implementing a disposal program on the University of Chicago campus. Although the majority of my analysis is focused on survey responses collected from University of Chicago students, I do consult various literature sources regarding pharmaceutical disposal in the United States, and conduct interviews with other institutions. While this research focuses on a case study

of the University of Chicago, my overall research is in service to the larger obstacles of implementing safe pharmaceutical disposal and the perceptions around this method of disposal.

i. Survey

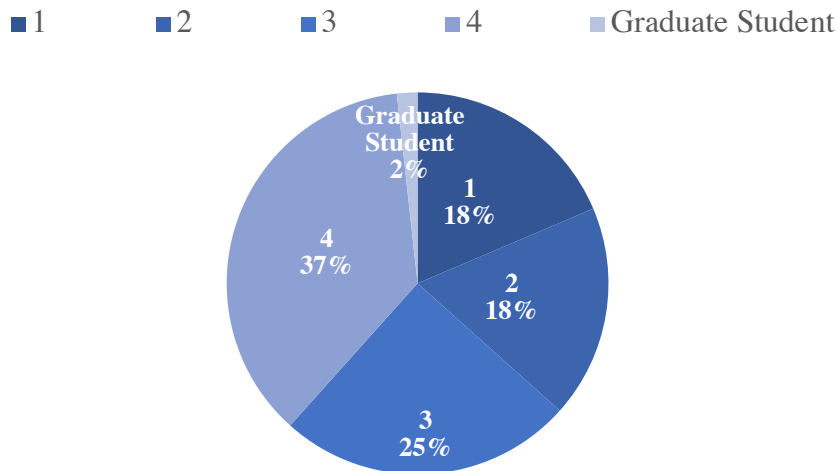
Because the aim of my research is to document how students contextualize their options for safe pharmaceutical disposal, the majority of the data collected was through a survey. My survey questions focus on three components: students' past experience of how they have previously disposed of their pharmaceuticals, students' knowledge of safe pharmaceutical disposal, and finally, students' perceived accessibility to safe pharmaceutical disposal options. Through these questions, I analyze students' awareness of safe pharmaceutical disposal and further understand how students contextualize the issue of safe pharmaceutical disposal.

To obtain my sample size for my survey, I distributed digital flyers in various Facebook groups specifically for University students. With the assistance of my preceptor, Amy Coombs, I also sent my survey through Listserv to several different groups on campus. Due to privacy reasons, I only targeted current undergraduate and graduate students and sustained from contacting faculty. I used SurveyMonkey, the survey-specific platform, to create my survey. Using this platform, my survey was completed online and could be accessed through a link. To increase response rate, I ensured that my survey was only ten questions and took roughly two to four minutes to complete. To ensure confidentiality, all surveys were automatically saved on my private account in SurveyMonkey and transferred to my account on UChicago Box. Each survey requested consent to utilize the information provided and the survey data was deleted following its use in my research.

The survey was open for two weeks and I collected 179 responses. The demographics of respondents was fairly even among first (18%), second (18%), third (25%) and fourth years

(37%), however, there were substantially fewer graduate student responses (2%). Given I am an undergraduate student and I have less accessibility to graduate forums where I could share my survey, this discrepancy in undergraduate and graduate responses was expected.

Graph 1: Respondent Breakdown by Grade



ii. Interviews

In order to further understand how a university creates a successful pharmaceutical program, I reached out to three external institutions, University of Buffalo, University of Michigan and Emerson College, which all have established their own pharmaceutical disposal programs. These interviews were semi-structured and focused on each institutions' process of implementing a safe pharmaceutical disposal program on campus, and the steps they took to do so. The purpose of these interviews was to further understand the challenges that arose when establishing these programs, and why a safe pharmaceutical disposal program was prioritized. I

also asked each institution what they would recommend to other universities who were seeking to implement their own campus program.

In addition to these external institution interviews, I also interviewed Jennifer Palombizio, the manager of Environmental, Health and Safety at the University of Chicago Medical Center to discuss how the Medical Center, which installed a public pharmaceutical disposal bin within its building a few years ago, can inform the process and possible challenges that the University of Chicago College may encounter in creating their own disposal program. The interview was also semi-structured and took place over the phone. The information gathered from this interview will be discussed primarily in my policy recommendation.

iii. Literature

In addition to the survey and interviews, I consulted various literature in the Environmental Studies field to further expand on why there lacks widespread disposal programs in the United States, as well as to identify key federal implementation challenges to creating pharmaceutical disposal programs. I specifically look at United States water contamination policies along with EPA hazardous waste protocols.

iv. Strengths and Limitations

This proposed method is essential for my topic of study because it uses both quantitative and qualitative data to analyze how University of Chicago students understand safe pharmaceutical disposal, as well as the policy challenges of implementing a safe pharmaceutical disposal program on campus. Some strengths of my choice of methods is that I will get a broad range of data between the survey, interviews, and literature that will provide me inside information on both how consumers contextualize safe pharmaceutical disposal options as well as essential information on how to overcome possible implementation challenges. However, like

any study, this method has its limitations. One being the small sample size, especially in consideration to the scope of this issue. Surveying University of Chicago residents implies that my research is contained as a case study within the campus borders and some many criticize that its applicability is limited. In addition, because I wanted to ensure I had a large response rate, I had to keep my survey fairly short. Performing more extensive interviews, rather than a ten-question survey, may have allowed for more in-depth responses, however, my focus was on receiving a greater volume of responses to more accurately reflect the opinions of the entire student body.

V. Data and Analysis

My data analysis is split into three parts. The first section focuses on qualitative findings of how and why challenges to safe pharmaceutical disposal exist on the federal level. The second section includes interviews with other institutions on how they have successfully implemented safe pharmaceutical disposal programs, and the final section examines survey data collected from University of Chicago students regarding their past experience and knowledge of safe pharmaceutical disposal, along with their accessibility to such a method.

i. Federal Barriers

The first section of my findings is based off of qualitative research analyzing the widespread implementation challenges to establishing safe pharmaceutical disposal policies. These findings indicate that there are three central barriers to successful implementation: insufficient resources to support disposal programs, fragmented standardization and enforcement of pharmaceutical disposal policies and programs, and finally, limited implementation strategies for micro-pollution policies.

a. Insufficient Resources

The EPA advises that the most efficient disposal mechanism for pharmaceutical drugs collected in drug take-back programs is incineration (United States EPA). There are currently 12 cement manufacturing plants nationally that have a permit to burn hazardous wastes, however, several years ago the EPA recognized that using these incinerators is both extremely costly and limiting, so they decided to also include large or small municipal waste combustors as an appropriate method for incineration. There are roughly 85 of these facilities across 23 states, but not all are certified hazardous waste incinerators or choose to accept pharmaceuticals (United States EPA). Crematoriums currently are not regulated units under the Clean Air Act regulations and thus the EPA does not allow pharmaceuticals from take-back events to be burned in these units.

Since no sites have the sole purpose of pharmaceutical disposal, costs increase substantially with increased safe disposal. The average cost of safe destruction of medications through an EPA-rated incinerator is approximately \$1.50 per pound (Child Fatality Task Force, 2016). Additional costs associated with the secure transportation of the drugs, permanent pharmaceutical disposal receptacles which are roughly \$700 to \$1000 per bin, and law enforcement staffing that are required to handle take-back events and oversee disposal bins, make disposal programs an expensive endeavor. In Alameda County, California, which launched the first take-back ordinance in 2015 and has become a model for other local governments, officials have estimated that it spends about \$330,000 a year to dispose of the collected drugs (Silverman 2016). Depending on the population and density of the region, costs could be even higher, making many institutions unwilling to invest in these types of programs. Furthermore, depending on the state, different drugs may require different times for how long the collected

material can be stored, how it can be transported, and how it must be incinerated (Glassmeyer et al. 2009). Organizing programs that account for all these differences requires significant time, money and human resources—barriers that some institutions are unwilling to overcome.

However, some of these costs could be absorbed by the consumer. A study in Southern California found that residents reported an annual willingness to pay about \$14 for an accessible safe pharmaceutical disposal program (Kotchen et al. 2009). They were willing to pay for a surcharge in pharmaceutical price if the pharmacy where they received the drugs would provide a disposal method for the pharmaceuticals. Another study found that a majority of respondents have favorable views about paying for medication take back programs especially on a per weight basis, meaning you pay based on how much waste you are disposing (Thach, Brown, and Pope 2013). This study also found that it is likely that consumers would place greater value on pharmacies if they provided this service (Thach, Brown, and Pope 2013). In addition, because single take-back events, unlike pharmacy take-back options which are convenient and permanent, are often inconsistent and rare (only happening once a year or every season), these types of programs can cause frustrations and thus result in low participation rates (Glassmeyer et al. 2009).

b. Fragmented Standardization and Enforcement

Federal and state agencies offer inconsistent and sometimes contradictory guidance on proper drug disposal, resulting from differences in interpretation and incompatible laws (Siler et al.). Because federal controlled substance laws and regulations were not created with pharmaceutical disposal policies in mind, it is extremely difficult for municipalities to establish safe pharmaceutical disposal policies (Lubick 2010). With no current federal regulations on contamination levels of pharmaceutical levels in the water, states are not required to perform

testing to evaluate pharmaceutical levels in drinking water, nor are they required to assess the effectiveness of their wastewater treatment systems in removing pharmaceutical drugs (Pharmaceuticals in the Water Environment). The lack of federal regulations also has trickle down effects on how states contextualize this issue and as a result, many states lack comprehensive disposal policies. Of the 62 major water districts in the United States, only 28 are known to test their water supplies for contamination by pharmaceutical drugs (Shader 2008). Major cities across the United States including New York City, Boston and Chicago were included in the list that failed to conduct tests. With no federal assistance, institutions must create disposal programs that both comply with the federal regulations of the DEA and overcome the costs of implementing a disposal program.

In addition, states must decipher how pharmaceutical waste is defined; is it a hazardous waste under The Resource Conservation and Recovery Act (RCRA), a controlled substance under the Controlled Substance Act (CSA), a medical waste, or some combination of each? Currently under the RCRA, the EPA is given the authority to manage hazardous wastes through a “cradle-to-grave” approach meaning the EPA overlooks the generation, transportation, treatment, storage and disposal of hazardous waste (*Resource Conservation and Recovery Act* 1976). However, the RCRA only classifies roughly 5-10% of pharmaceutical products as hazardous waste (“Pharmaceutical Waste Management” 2010). Because a majority of pharmaceutical waste is unregulated by federal criteria, most municipalities and industries lack comprehensive programs for managing non-hazardous waste (Wu et al. 2009). This means that many potentially harmful wastes are not being properly accounted for.

In addition to this lack of standardization, enforcement of safe pharmaceutical disposal programs is extremely fragmented. The federal regulations of the Controlled Substance Act have

created a closed distribution system where the drugs are tracked from the manufacturers to the distributors to the dispensers. The system functions to prohibit misuse and illegal activity, however, the closed system neglects an important component of the equation: the consumer. Oversight of the pharmaceuticals ends when possession is transferred to the consumer and once the drugs have left the closed system, they cannot reenter (Lystlund et al. 2014). This has severe ramifications for enforcing widespread disposal policies because it prohibits pharmaceutical manufacturing companies, hospitals, pharmacies, and other third-party stakeholders involved in the closed system from requiring participation in the collection of unused pharmaceuticals.

With these complications, regulation in the life of the pharmaceuticals once the consumer obtains them becomes voluntary for most third-party facilities. This is problematic because voluntary responsibility for water contamination is not only extremely rare, but also leads to policy implementation gaps. In a recent study investigating pharmacists' opinions on safe pharmaceutical disposal, a majority of pharmacists argued that "bringing unused drugs back into the pharmacy creates safety risks" while also suggesting that pharmacies and the pharmaceutical industry as a whole should not be involved with pharmaceutical disposal programs and instead states, counties and municipalities should take on this responsibility (Siler et al., n.d.). However, it requires a combined effort from pharmacies who are needed to identify and sort the drugs, law enforcement who must handle the drugs, and local governments who create the policies and possibly provide funding to establish pharmaceutical disposal programs. Without one complying group, successful implementation is nearly impossible (Smolen 2011).

c. Limitations of Micro-Pollution Policy

As mentioned in my Literature Review, micro-pollution policy is often multi-faceted and complex. Because micro-pollution comes from many sources it is extremely hard to take a

proactive approach. The complexity of the contamination source means research on the issue is not addressed holistically, and instead is focused on individual compounds rather than the ramifications of all pharmaceutical contaminants (Bain 2010). As a result, micro-pollution policy in the United States is approached more conservatively where scientific proof of potential threat to human or ecological health is required before action can take place (Enick and Moore 2007).

This pattern of retroactive policy has severe consequences as it makes scientists inextricably linked to environmental risk assessment and management. This makes developments to micro-pollution policies increasingly difficult because it often requires general consensus among scientists that pharmaceutical contamination poses an imminent danger; however, this consensus is rarely reached (Brodin et al. 2014). The emphasis on science has also resulted in a small body of literature focused on pharmaceutical contamination policies and its connection to larger social and economic contexts (Enick and Moore 2007). This is problematic because rather than a one-size-fits-all type of solution, micro-pollution policy requires a mix of both treating the contamination and preventing further pollution (Metz and Ingold 2014). Yet, this cannot be achieved without recognizing the intertwined scientific, economic and social contexts of pharmaceutical contamination which strengthens the dialogue between stakeholders and thus allows comprehensive solution-based policies to arise (Aslaksen and Myhr 2007).

ii. External Safe Pharmaceutical Disposal Program Interviews

To further understand how successful safe pharmaceutical disposal programs can be integrated into college campuses, I conducted interviews with Emerson College, University of Buffalo, and University of Michigan. These institutions were selected because they have implemented successful safe pharmaceutical disposal programs on their campuses within the last 5 years and were willing to speak with me about how they implemented these programs.

In the first interview, I spoke with the director of Emerson's Center for Health and Wellness, Jane Powers. I began by asking Ms. Powers if she could describe their safe pharmaceutical disposal program and what it entailed. She explained that they have one secure medication disposal bin on campus that is open to all Emerson community members.² The disposal bin, which resembles a mailbox, accepts any unused, expired or unwanted prescription drugs and over-the-counter medications in a "free, safe and environmentally friendly manner."³ The bin is accessible 24 hours a day, seven days a week and is located where both students and community members can easily access it.

An important aspect to this disposal bin that Ms. Powers made very clear is that the medication placed into the receptacle is never inventoried so it completely anonymous and discrete for the individual utilizing this disposal method. Ms. Powers explained that the idea of a safe pharmaceutical disposal program was recommended from the onsite risk mitigation evaluation completed by the JED Campus team in the Winter of 2018. Emerson college, along with over a hundred other campuses in the United States including Northwestern and Illinois State University, are a part of the JED Campus program. According to their website:

JED Campus is a signature program of The Jed Foundation (JED) aimed to guide schools through a collaborative process of comprehensive systems, program and policy development with customized support to build upon existing student mental health, substance use and suicide prevention efforts.⁴

The JED campus and their investment exhibits how a pharmaceutical disposal program can be aimed at achieving more than just environmental goals. At Emerson College, the desire for a disposal program was introduced from a student health perspective. Ms. Powers explained that it

² Jane Powers, in discussion with the author, January 8, 2020.

³ See Appendix A for an image of Emerson's Secure Medication Disposal Box.

⁴ *The Jed Foundation (JED)*, www.jedfoundation.org/.

was very important for Emerson to have an option for students to dispose left-over pharmaceuticals because it was perceived as an additional safety measure for students struggling with mental health.⁵ Following their recommendation, the JED campus constituents reached out to the Emerson Campus Police Department as a partner to develop the disposal plan. Through this partnership, an important third-party stakeholder was introduced. Given that authorized personnel such as law enforcement must oversee the disposal bins, having the support from the police department was a necessary step to continue forward. When asked about any obstacles that were faced to getting the Emerson Police Department involved, she reflected that there were “no significant challenges” and they were very willing to participate.⁶ With the support of the police department, the Center of Wellness and Health were led to pursue the Rite-Aid Foundation grant which was open to law enforcement agencies to establish a medication-disposal bin in their community. Ms. Powers acted as the liaison between the Emerson Campus Police Department Chief and the Rite-Aid contact to explore the grant process.

Ms. Powers explains that because the medication disposal box was launched in July 2019, there has not been a pick-up yet, so they are unsure how much the program has collected as of now.⁷ However, when the pharmaceuticals are collected, the Emerson College Police Department will receive a notice from the DEA a few days in advance to inform them where and when to bring the content box for disposal. Upon arrival, the DEA will weigh the box and provide a receipt.⁸

In the second interview, I spoke with Joshua Strict, the Deputy Chief of Police for Administration at the University of Buffalo. Unlike Emerson College, the program at the

⁵ Jane Powers, in discussion with the author, January 8, 2020.

⁶ Jane Powers, in discussion with the author, January 8, 2020.

⁷ Jane Powers, in discussion with the author, January 8, 2020.

⁸ Jane Powers, in discussion with the author, January 8, 2020.

University of Buffalo began from the Campus Police Department.⁹ The previous Chief made a proposal to the administration to take advantage of a program being promoted by the Department of Health. The administration decided to follow through with the suggestion. Because the site is located in the University of Buffalo Police Department, the disposal box is constantly monitored. One of the evidence custodians from the department takes the waste to be burned periodically depending on how much pharmaceuticals are collected. When asked about the success of the program, Mr. Strict stated: “We consider it [the pharmaceutical program] a success. To date this year, we have collected nearly 400 pounds of unwanted pharmaceuticals that otherwise may have been disposed of in landfills or the water system.”¹⁰ However, this success was not met without several challenges. Mr. Strict explains that early on in the development of the disposal program, there were several local businesses attempting to bring large quantities of pharmaceutical waste, mostly from elderly care facilities, to be disposed. Due to economic restraints, the police department had to reinsure that the disposal bins were for personal use only.¹¹

In the third and final interview, I spoke with Darla Bladowski, the Pharmacy Manager and Pharmacist in charge for the University of Michigan Health Service Pharmacy. Ms. Bladowski aided in the establishment of a MedSafe pharmaceutical disposal box back in August 2017 after some of her students in the pharmacy program recognized the “high level of controlled substance prescriptions prescribed to college age students,” and the resulting need for students to have a disposal option on-campus where they would “not feel intimidated about being viewed or recorded as they disposed of their medications.”¹² According to Ms. Bladowski, the goal of disposal program was equally about reducing the amount of medications in landfills and

⁹ Joshua Strict, in discussion with the author, January 10, 2020

¹⁰ Joshua Strict, in discussion with the author, January 10, 2020.

¹¹ Joshua Strict, in discussion with the author, January 10, 2020

¹² Darla Bladowski, in discussion with the author, February 2, 2020.

water systems as it was about reducing medications getting into the hands of others that were not prescribed the medication.¹³

When asked about challenges faced in establishing this program, Ms. Bladowski had a similar response to Mr. Strict in that cost was the most significant challenge they faced. She reported that they spent roughly \$1620 for the medication disposal box and \$765 for the liners that must be changed within the box every 6-8 weeks.¹⁴ Due to the expense of the program, they tried to pursue a federal or local grant, but could not find any that existed. This led them to pursue a partnership with the University of Michigan Environmental Health Safety Department who agreed and granted \$24,000 for the program. However, cost was not the only challenge they encountered. Meeting all the DEA specifications of securing the box and ensuring it is placed in a location that is supervised was also challenging. With these requirements in mind, they decided to place the box inside the Health Service building on campus where the box could be secured to the wall, consistently monitored and locked when no one was around.

Ms. Bladowski was the only interviewee that emphasized the importance of creating an advertisement campaign and utilizing campus housing along with the Department of Environmental Health Safety to spread information about the disposal box. She explained that this was an essential part of the program because it required that multiple groups on campus were involved which increased outreach to students. As a result of these efforts, the program was extremely successful, and since August 2017, they have collected over 600 pounds of pharmaceutical waste.¹⁵

¹³ Darla Bladowski, in discussion with the author, February 2, 2020.

¹⁴ Darla Bladowski, in discussion with the author, February 2, 2020.

¹⁵ Darla Bladowski, in discussion with the author, February 2, 2020.

From these interviews, two central themes emerge. First, there is no uniform process for establishing a successful safe pharmaceutical disposal program. At each university, the process for establishing a disposal program was unique through its inception and process for funding. Second, the establishment of a campus disposal program requires a collaborative approach between students, faculty and different departments. Given how costly this program can be, it is essential that more than just one organization invests time and resources into the project. Furthermore, all of these programs were sustained by having multiple “stakeholders” in different health, environmental and safety sectors across campus. Although there was usually one organization that initiated the project, a collaboration from many organizations was needed to implement and sustain the program.

iii. University of Chicago Findings and Implications

In this section I discuss the data I collected in the student survey.¹⁶ The analysis of the data has three central components. The first section focuses on past practice of how and where the respondents have previously disposed of their pharmaceuticals. The second section investigates students’ knowledge of safe pharmaceutical disposal and how students have previously been educated on the issue. The third section focuses on using spatial analysis to examine students’ perceived accessibility to safe pharmaceutical disposal options.

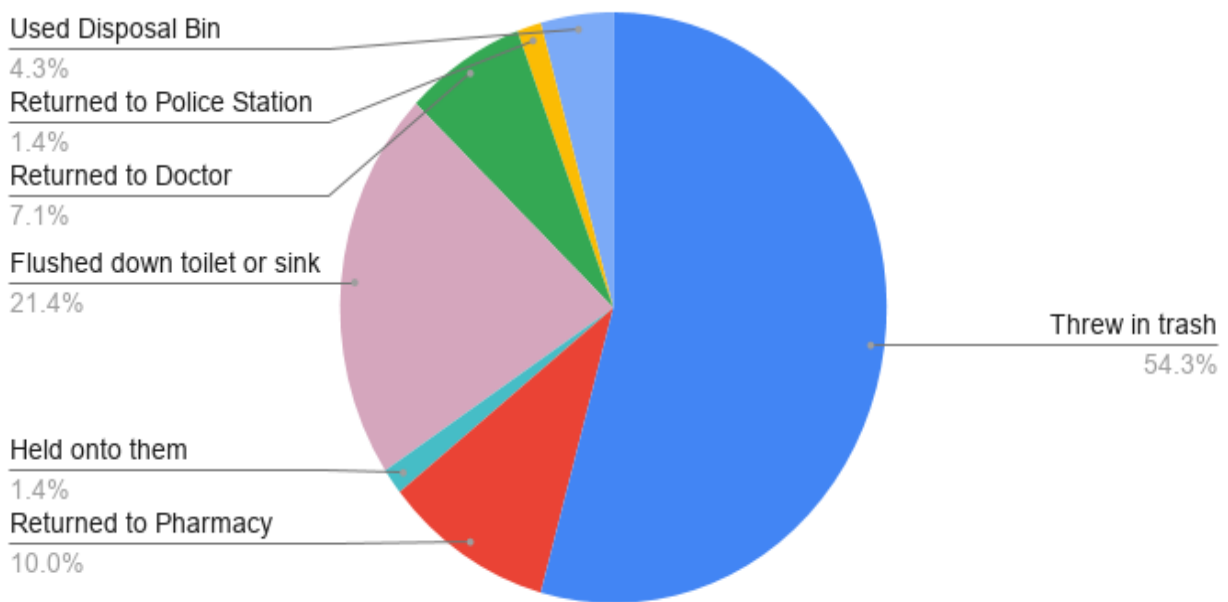
a. Past Practice

To analyze the past practice of students, I start by finding what percent of students actually have disposed of pharmaceuticals. Out of the 179 respondents, roughly 40% of students surveyed had disposed of pharmaceuticals before. *Graph 2* gives a breakdown of exactly what method was used by these students to dispose of their pharmaceuticals. The most common form

¹⁶ See Appendix C for the questions used in the survey.

of disposal was to throw the pharmaceuticals down the trash, with 54.3% of students reporting this method followed by flushing down the toilet or sink with 21.4%. These results indicate that of those who have disposed of pharmaceuticals, very few actually use what is considered safe pharmaceutical practices, which include using a disposal bin, returning the medication to a police station, returning the medication to a doctor/hospital/pharmacy, or utilizing a take-back event. Of these safe pharmaceutical practices that were reported, returning the drugs back to the pharmacy was the most common, with 10% of respondents, followed by returning to the doctor at 7.1%. Only 4.3% of students reported disposing of their drugs in a safe pharmaceutical disposal bin.

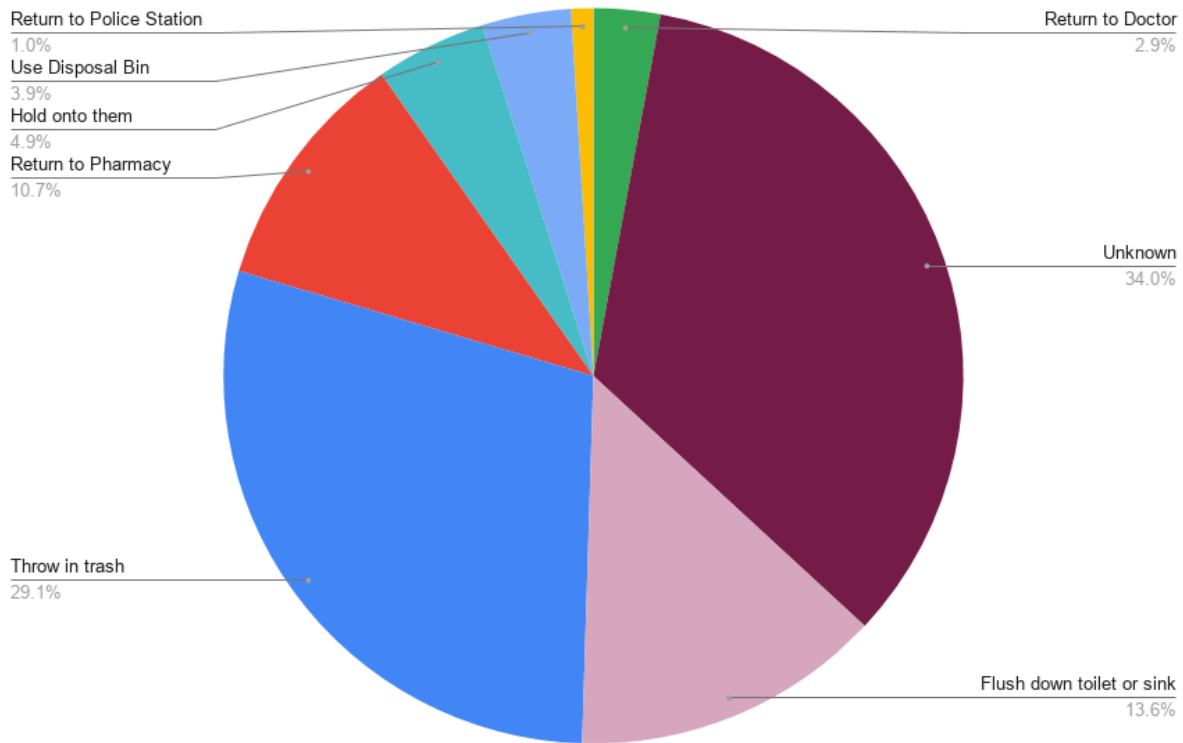
Graph 2: How have/do you dispose of pharmaceuticals?



The other 60% of respondents who were not past or active pharmaceutical disposers were asked how they would dispose of pharmaceuticals. The results are depicted in *Graph 3*. Besides answering unknown, the responses were similar to the active disposers. Throwing the pharmaceuticals in the trash was the most popular response with 29.1%, followed by flushing the

drugs down the toilet or drain with 13.6%. Utilizing a disposal bin was once again an infrequent response, with only 3.9% of students reporting this answer.

Graph 3: How would you dispose of pharmaceuticals?



Overall, the data suggests that of the students surveyed, there is little use of safe pharmaceutical disposal practices, regardless if the students are active or past disposers of pharmaceuticals.

b. Knowledge

The next part of the survey examines students' perceptions of safe pharmaceutical disposal. They were asked if they know what safe pharmaceutical disposal is and if yes, to explain it. If they claimed to not know what safe pharmaceutical disposal is, then they were asked to explain what they think it is. Because I did not want to influence responses by providing a multiple-choice answer, I left this question open ended on the survey. To analyze the results, I coded each answer into different categories depending on the parameters I was looking at.

In my first analysis, I found that 82% of respondents reported they did not know what safe pharmaceutical disposal is while only 17% answered that they did. I found this statistic to be extremely alarming given that roughly 40% of these respondents are active or past pharmaceutical disposers and the likelihood more students will become pharmaceutical users as they get older is extremely high. A 2016 study from the Centers of Disease Control and Prevention (CDC) found that only 18% of children under age 12 use prescription drugs compared to 85% of adults aged 60 and over (Martin and Ogden 2019). Although there was high response rate of individuals who answered “no,” indicating they did not know what safe pharmaceutical disposal is, I found an interesting caveat. When asked to describe what they *think* it is, a majority of these students were able to explain what this disposal method entails.¹⁷ Some were even able to cite practices such as returning the medication back to a pharmacy or using a disposal bin. I categorized these students who claimed not to know what safe pharmaceutical disposal is, yet, were able to describe it as “uninformed knowers.” *Table 1* below shows the percentages of “uninformed knowers,” “informed knowers” who both knew what safe pharmaceutical disposal is and were able to define it, and the “uninformed non-knowers” who cited they did not know what pharmaceutical disposal is and were not able to appropriately describe it.

Table 1: Defining Safe Pharmaceutical Disposal Response Breakdown

	“Informed Knowers”	“Uninformed Knowers”	“Uninformed Non-knowers”
Respondent Trends	17%	50%	33%

¹⁷ Section I, part ii for explanation of safe pharmaceutical disposal methods.

Compared to the 85% of students who claimed to not know what safe pharmaceutical disposal is, in reality, only 33% of students were not able to describe it. Although critics may argue these results are attributed to good guessing, I argue instead that students inherently understand safe disposal of pharmaceuticals, but the terminology and naming of the process is foreign, making students falsely believe they don't know what it is. The idea of safe disposal of waste is not a complex one, but the lack of education and awareness on this issue is what results in little familiarity in the process, and therefore infrequent practice utilizing this disposal method.

My next analysis takes a further look into how respondents contextualize the importance of using safe pharmaceutical disposal methods. The definition I use for safe pharmaceutical disposal is from the DEA which declares that pharmaceuticals are safely disposed when “[they] can no longer be used and is disposed of in a way that is safe for the environment” (Martin and Ogden 2019). This definition is important because it contains two essential components of safe disposal: first, the drugs are no longer a danger to other humans and, second, the disposal method will not result in drugs harming the environment. Using this definition, each answer was coded depending on if the response included preventing environmental risk (ER), preventing human risk (HR), preventing both (B) or no mention of either (N). *Table 2* below shows the results.

Table 2: Importance of Safe Pharmaceutical Disposal Response Breakdown

	ER	HR	B	N
Respondent Trends	29%	17%	21%	33%

The data indicates that students more often contextualize safe pharmaceutical disposal as an environmental risk (29%), a human risk (17%), or neither (33%) rather than both environmental and human risk (21%). Looking at the data holistically, only 1/5 of respondents were able to address pharmaceutical disposal as an issue that concerns both the environment and human

health while about 1/3 of them did not mention either environmental or human risk. These findings suggest that the importance of safe pharmaceutical disposal is often misunderstood because environmental threats are often compartmentalized from human risk.

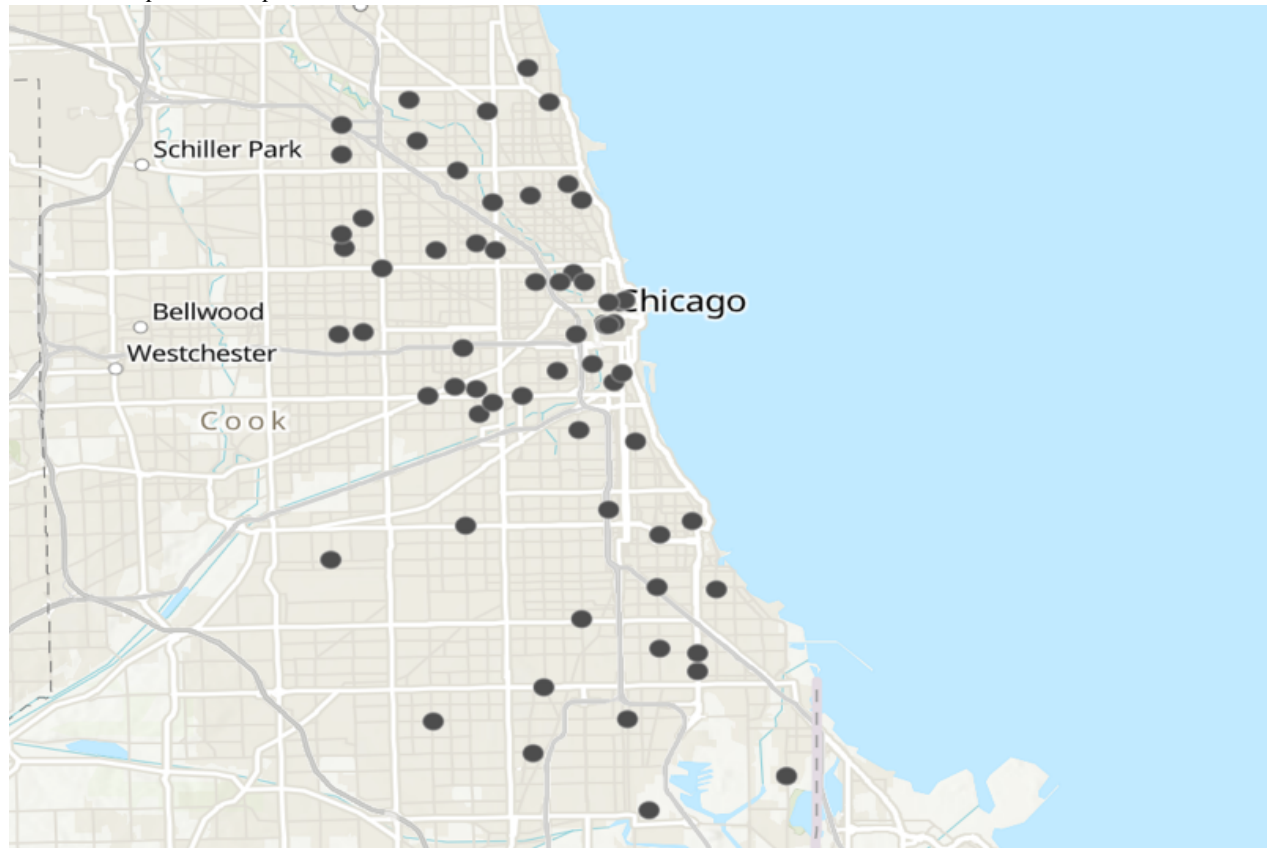
c. Accessibility

To assess student's perceptions of accessibility of safe pharmaceutical disposal bins, I asked students how far they believe the closest pharmaceutical disposal bin is to their current Chicago address, along with how many disposal bins they believe are in the city of Chicago. This data was used to run a series of analyses to examine how students physically contextualize their access to safe pharmaceutical disposal options.

Before starting any analyses, I determined how many pharmaceutical disposal bins are in the city of Chicago and entered this data into a Geographic Information System (GIS) map using the online GIS tool, ArcGIS. In total Chicago has 68 safe pharmaceutical disposal bins located throughout the city. These include police stations, drug-store pharmacies such as Walgreens and CVS, and several hospitals. It should be noted that there are more disposal sites on the north side than the south side and the downtown area has the highest density of disposal bins. *Figure 1* depicts the location of these sites.

Figure 1: Safe Pharmaceutical Disposal Bins in the City of Chicago

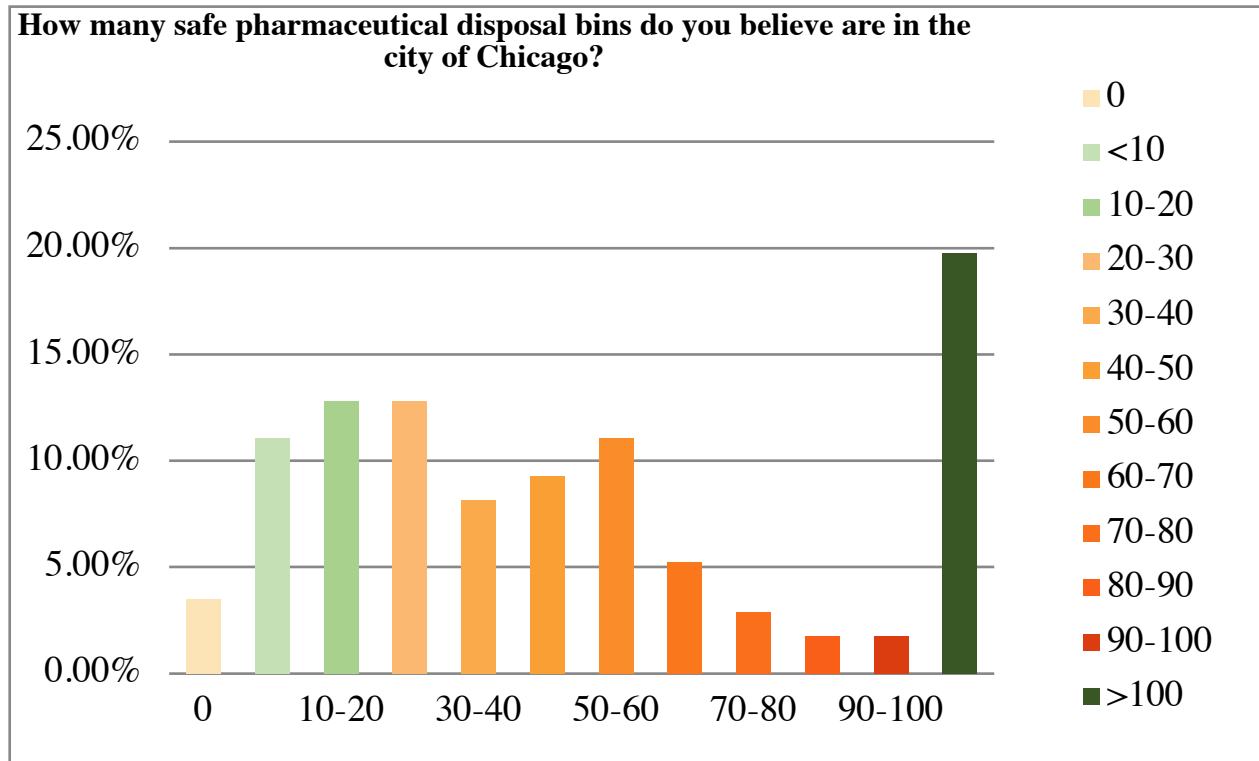
Black dots represent disposal bins.



In my first analysis, I wanted to compare how many safe pharmaceutical disposal bins are in the city of Chicago compared to student perceptions of the prevalence of these disposal bins. To make this comparison, I provided a description of safe pharmaceutical disposal bins,¹⁸ and then subsequently asked students how many disposal bins they believe are in the city of Chicago. *Graph 4* depicts the breakdown of the responses.

¹⁸ See Appendix C for description used.

Graph 4: Student Perceptions of Quantity of Safe Pharm Disposal Bins in Chicago

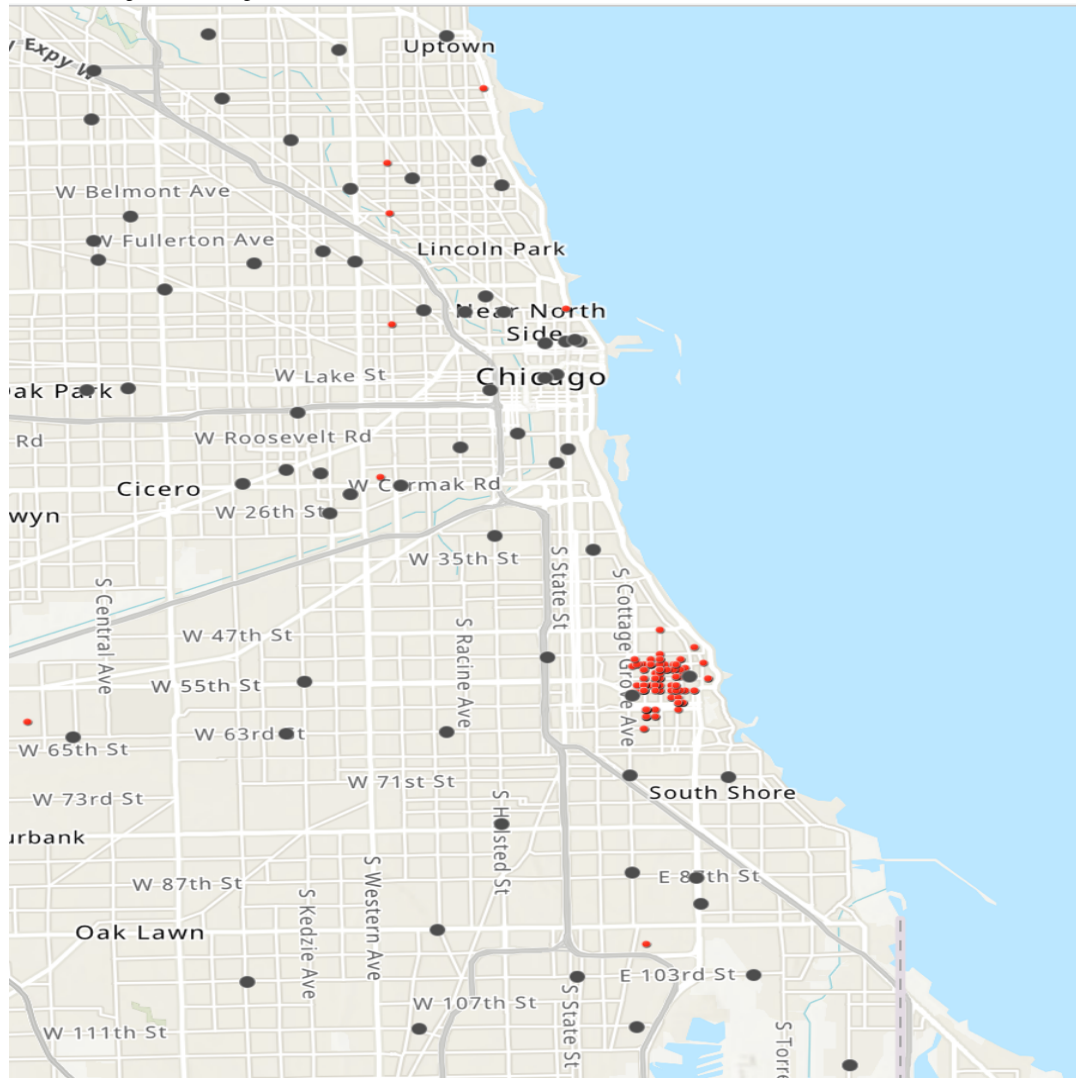


Roughly 26% of respondents overestimated the number of disposal bins in Chicago (68) with a majority of these students believing there are more than 100 disposal bins in Chicago—20% of total respondents—and about 2% responding each 70-80, 80-90, and 90-100, respectively. However, significantly more students, roughly 68%, underestimated how many disposal bins there are. Although, it is not exactly clear why more students underestimated rather than overestimated the quantity of disposal bins, I argue that because many students do not use safe pharmaceutical disposal options, as my analysis on respondents’ past experience indicated, students assume that these methods are not as abundant and available as they are.

In my second analysis, I wanted to compare students’ perceptions of where safe pharmaceutical disposal sites were located to their actual location. I started by uploading a file of the respondents’ cross-streets to the GIS map with the outlined city disposal sites. *Figure 2* depicts this map.

Figure 2: Layout of Disposal Bins in Chicago with Respondent Addresses

Black dots represent disposal bins.
Red dots represent respondent addresses.

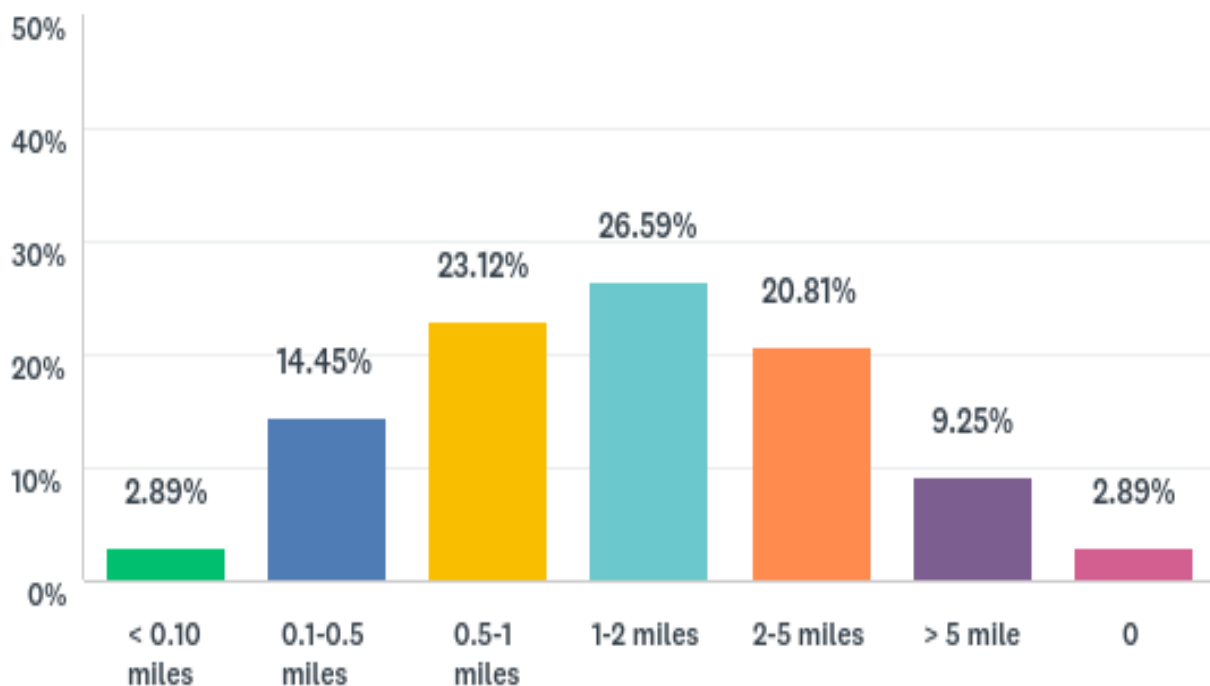


In the portion of the survey asking about how close the respondent believes a safe pharmaceutical disposal site is to their current address, they were given the option to choose “less than 0.10 miles”, “0.10 to 0.5 miles”, “1-2 miles”, “2-5 miles”, “more than 5 miles” or “there are no disposal bins in the city of Chicago”. I determined these options based on the square footage of the city and the location and quantity of the disposal sites in the area. In this analysis I am assuming that less than 0.10 miles can be considered down the block or a short

walk away, 0.1 to 0.5 miles is slightly longer but still considered within walking distance, 0.5 to 2 miles would require a long walk, a short drive or public transit trip, and more than 2 miles requires that you must drive or take public transportation. A graph of the results is illustrated in *Graph 5*. The most common response was 1-2 miles with 26.9% of respondents followed by 0.5-1 miles at 23.3% and 2-5 miles at 20.81%. These results indicate that only about 17% of respondents believe that a disposal bin is within walking distance to their current location while a majority of them believe you need another mode of transportation to reach these sites.

Graph 5: How far do you believe the closest safe pharmaceutical disposal bin is to your current Chicago address in miles?

*The option “There is no disposal bins in the city of Chicago” is represented by “0” in the graph.

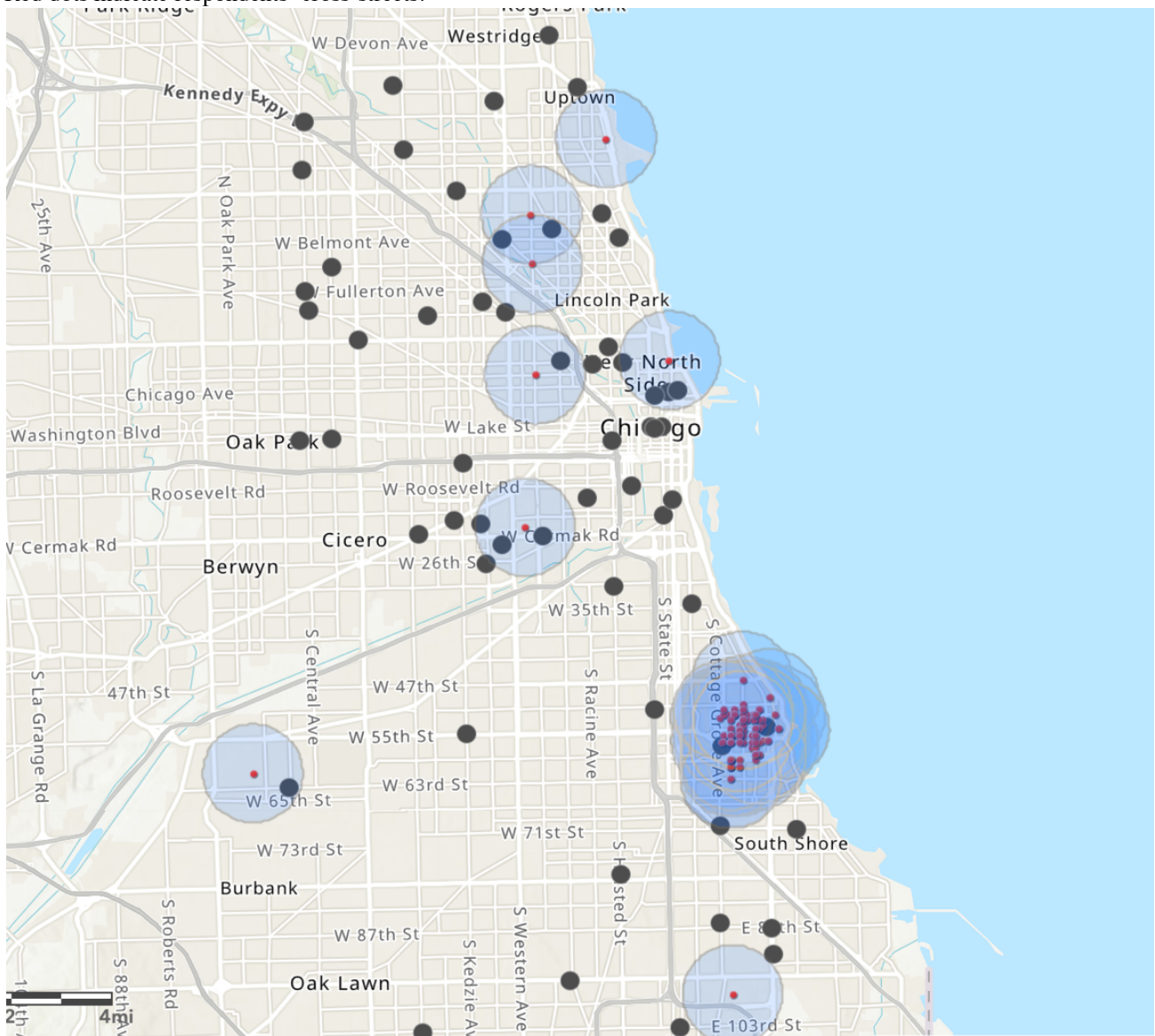


Next, I looked at where the disposal bins were actually located. I used the radius function on ArcGIS to find how many disposal sites were located within different miles radiuses of the addresses reported. The mile radiuses I used were determined from the response categories. I started with a 5-mile radius around each reported student address which can be seen in *Figure 3*.

Figure 5 illustrates the results looking at the 1-mile radius. Besides two addresses that were each short of a disposal bin by about 0.1 mile, each respondent had at least one disposal bin in their radius. The average was about 1.95 disposal bins per radius. Compared to the 2-mile radius, the average disposal bins per radius only decreased by about one third, even though the size of the radius decreased by one half.

Figure 5: 1-Mile Radius of Respondent Cross-streets

Black dots indicate disposal sites in Chicago.
Red dots indicate respondents' cross-streets.



are minimal and so the overall trends would suffice as a reasonable metric for my analysis. *Table 3* compares the breakdown of the reported responses of how close disposal bins are believed to be located compared to the percent of addresses in each radius.

Table 3: Breakdown of Student Responses

Breakdown of Student Responses	< 0.1 mile 2.89%	0.1-0.5 mile 14.45%	0.5-1 mile 23.12%	1-2 miles 26.59%	2-5 miles 20.81%	> 5 miles 9.25%
Percent of Addresses in each radius	<0.1-mile radius 0%	0.1-mile radius 2.23%	0.5-mile radius 69%	1-mile radius 98.8%	2-mile radius 100%	5-mile radius 100%

From this analysis, there are two important takeaways. First, students are underestimating how close a pharmaceutical disposal bin is to their current address. Roughly 30% of students (20.81% + 9.25%) believed that a disposal bin was more than 2 miles away when the data shows that in fact there is a disposal bin within a 2-mile radius of every address reported. Furthermore, when we look at the 1-mile radius, 98.8% of addresses had a disposal bin within 1 mile of their address but roughly 57% of students (26.59% + 20.81% + 9.25%) believed that the closest disposal bin was more than 1 mile away. The second takeaway is that more than half of students are within walking distance of a safe pharmaceutical disposal bin (69% within 0.5 mile). This is crucial to consider as a metric of accessibility. If students do not need to drive or take public transportation to access a disposal bin, then obstacles from preventing them from utilizing this option, such as limited time and financial constraints, are greatly reduced.

VI. POLICY RECOMMENDATIONS

Before proposing my policy recommendations, I want to discuss the broader limitations to addressing safe pharmaceutical disposal and why I decided not to focus my recommendations on creating a policy on the federal level. First and foremost, the bulk of this research is drawn

from University of Chicago-specific data and exploring the implementation challenges that exist on this scale. Thus, creating policy recommendations on a city, state or federal scale would be an unsupported extrapolation of my data. In addition, there are some fundamental limitations that exist on the federal level that prevent successful policy implementation from occurring. It is important that these limitations are discussed before proposing my policy recommendations as they provide nuanced background information and insight on why safe pharmaceutical disposal policy, as of now, must be approached on a local, institutional level.

i. Limitations to Safe Pharmaceutical Disposal Policies

When addressing pharmaceutical disposal on the federal level, it is extremely important to have a comprehensive approach. From my qualitative findings, I found that pharmaceutical disposal depends on the active participation of multiple stakeholders and thus a collaborative approach to pharmaceutical disposal is essential. Comprehensive participation from the government who must be willing to enforce the policies, pharmacies, doctors and medical institutions who must be willing to spread knowledge on the policies, and ultimately the consumer who must be willing to carry out these practices will produce the most effective safe pharmaceutical disposal programs. However, because of federal regulations, or in some cases lack thereof, safe pharmaceutical disposal is exponentially more difficult in the United States. In terms of actual disposal, limitations regarding how hazardous waste can be disposed has created a gap where pharmaceutical disposal is excluded from the framework. Because the RCRA is extremely limited in how it can declare hazardous waste and only hazardous wastes can be regulated by the EPA in a “cradle-to-grave” approach, there are many pharmaceuticals that pose serious environmental risks but are not regulated. However, proposing that Congress expands the definition of hazardous waste would not be sufficient in addressing this issue. Since 2016, the

FDA has approved roughly 40-50 new drugs each year, and many of these take years to test for potential environmental risks making it nearly impossible to determine what pharmaceuticals are hazardous in an efficient manner (Jarvis 2019). Furthermore, the RCRA does not include residential or household users in their regulations. This means that even if they wanted to, the EPA cannot regulate any hazardous waste disposed by individual consumers, which is what pharmaceutical waste is defined as (Wu et al. 2009).

In addition, there are fundamental issues in how accountability for safe pharmaceutical disposal is established in the United States. From the survey I performed, the data shows that very few individuals have received advice on how to dispose of their pharmaceuticals, especially from the individuals who are prescribing them. Less than one-third, about 21% of respondents, reported that they had been advised on how to safely dispose of their pharmaceuticals, but only 5% received this advice from their doctor or hospital. Yet, with the framework of pharmaceutical disposal in the United States, accountability does not lie with those that are prescribing the drugs. In fact, as my research has shown, there are no “enforcers” of safe pharmaceutical disposal and as a consequence, very few “compliers”. Yet, this fragmented enforcement of disposal methods cannot be easily fixed. Globally, there are many countries where municipalities must ensure that constituents have access to various safe pharmaceutical disposal options. For example, in Sweden, some municipalities have invested in “curbside” disposal options that function similarly to garbage and recycling pick-up (“Swedish Waste Management 2018” 2018). Households are required to separate out pharmaceutical substances from their waste which is either collected by traditional waste facilities or dropped off by the consumer at a municipal recycling center (“Swedish Waste Management 2018” 2018). However, in the United States, implementing a similar infrastructure would be extremely difficult because, as previously mentioned, household

pharmaceuticals are not regulated as hazardous waste and thus requiring additional waste management for pharmaceuticals could not be federally enforced.²⁰

Another approach to improving the pharmaceutical disposal practices in the United States is to increase transparency and awareness of the issue. In Sweden, the pharmaceutical industry has assisted in the creation of the Environmental Classification of Pharmaceutical database. This database is open to the public and provides information on how different pharmaceuticals effect the environment. The purpose of the database is to entice patients to choose medications that are less harmful to the environment with the goal of enhancing the market demand for environmentally friendly pharmaceuticals and thus enticing suppliers to create more of these eco-conscious drugs (Wennmalm and Gunnarsson 2009). With this database, information is completely transparent to the consumers informing them exactly what pharmaceuticals harm the environment and how they can make choices that reduce this harm. This is a stark contrast to America where many people today do not know that pharmaceuticals even pose a threat to the environment. However, creating a similar database in the United States that could provide this type of transparency is doubtful. As previously mentioned, the United States does not perform federal tests for pharmaceutical contamination nor do they invest in research to further understand the effect of pharmaceuticals in the environment (Wu et al. 2009). The reason for this delay in action is ultimately unknown but may be attributed to America's nearly \$370 billion pharmaceutical industry.²¹ Nevertheless, to create transparency about the issue, the United States must first address that there is an issue—something they are hesitant to do.

ii. The Future of Safe Pharmaceutical Disposal at the University of Chicago

²⁰ “Federal and State Regulations on Hazardous Waste.” *Hazardous Waste Experts*, 16 Jan. 2020, www.hazardouswasteexperts.com/federal-and-state-regulations-on-hazardous-waste/.

²¹ O'Brien, Jack. “Pharmaceutical Spending to Top \$370B in 2019.” *HealthLeaders Media*, 28 May 2019, www.healthleadersmedia.com/finance/pharmaceutical-spending-top-370b-2019.

Although my research's scope is limited to the University of Chicago and therefore does not provide seamless insight to all contexts of pharmaceutical use, it nevertheless discloses general and practical lessons about the possibilities and obstacles to collaborative policies for pharmaceutical disposal at local scales. For, indeed, local policy changes must always themselves occur in relation to larger policy frameworks, and therefore point the way to reform at multiple scales.

To curate my policy recommendations for the university, I focused on compliancy with pharmaceutical regulations while also considering how this program can maximize efficiency. My findings indicate that students on the University of Chicago campus both do not utilize safe pharmaceutical disposal methods and are largely unaware of what safe pharmaceutical disposal entails. With that in mind, implementing a disposal program at the University of Chicago with the goals of increasing awareness efforts and establishing an accessible disposal bin on campus will be my immediate policy recommendations. To do this I have outlined three central goals: establish a disposal receptacle on campus, increase awareness about the program and educate students, and sustain the program.

a. Establishing a Disposal Bin on Campus

Through my qualitative research and the findings from external interviews with outside universities, I have determined that accessibility, permanency, and anonymity are extremely important characteristics of a successful disposal program. Thus, in order to ensure the University of Chicago can create a program that has these features, I recommend installing a pharmaceutical collection receptacle on campus. Most of these receptacles are steel bins with a one-way medicine drop door that locks when not in use. The bin is secured to a permanent

structure to ensure it cannot be moved and sterilized liners are used for easy collection.²² The bin should be located in a place that is not only central to the university, but also in a known area. As Ms. Powers explained, if the bin is not accessible to students, it cannot fulfill its purpose as an amenity to the community.²³ However, the receptacle must also adhere to the regulations of the DEA which requires that the bin is managed by authorized law enforcement. This is why I propose that the receptacle is placed in the building of the University's Department of Safety and Security. With this permanent disposal receptacle, students will have 24/7 access to a disposal site that is in close proximity to their everyday activities. This will also mean that the University of Chicago Police Department must be willing to oversee the disposal bin and perform needed maintenance.

However, there are limitations to this policy recommendation. As Mr. Strict from the University of Buffalo explains, "cost is a serious limitation that is often overlooked."²⁴ In order to address the possible limitation of funding, I propose that the University applies to several institution specific grants to receive funding for the purchase of a disposal bin. Several pharmacies such as CVS, Rite-Aid, and Walgreens, along with pharmaceutical disposal bin specific companies, such as MedSafe, provide grants that universities can apply for. At Emerson College, a Rite-Aid grant was used to receive funding.²⁵ Another option is to contact the Metropolitan Water Reclamation District of Greater Chicago (MWRD). Over the last ten years, the City of Chicago has received grant funding from the MWRD to purchase collection boxes for

²² "MedSafe Medication Disposal System." *MedSafe Medication Disposal for Expired Medication*, Sharps Inc, www.sharpsinc.com/medsafe/.

²³ Jane Powers, in discussion with the author, January 8, 2020.

²⁴ Joshua Strict, in discussion with the author, January 10, 2020

²⁵ Jane Powers, in discussion with the author, January 8, 2020.

local jurisdictions and program operational costs for collection and disposal of collected drugs.²⁶ Finding, applying and receiving a grant can be a laborious process, however, it is a necessary step in establishing this disposal program.

In addition to the upfront costs of purchasing the disposal bin, there are costs attributed to the management of disposal site. As mentioned previously, authorized personnel must pick up the waste. The University Police Department can organize directly with the DEA to have someone sent to pick up the waste or depending on what pharmaceutical disposal bin is installed, officials from the given company can come to collect the waste. Jennifer Palombizio, the manager of Environmental, Health and Safety at the University of Chicago Medical Center, explained that the latter option is how pharmaceutical waste at the Medical center is collected.²⁷ She also explained that because pharmaceutical waste is public hazardous waste that is coming from a consumer and not generated by the university, it cannot be disposed of or collected with other hazardous waste that may come from the Chemistry Department or other research departments within the university. This means that the University of Chicago Department of Environmental Health and Safety, which according to the University of Chicago website, is in charge with “managing hazardous waste generated on campus or within the University of Chicago Medicine... including collection, transportation, storage, and disposal of hazardous waste” does not have the ability to finance, oversee or manage the pharmaceutical disposal bin. However, Ms. Palombizio seemed confident that students and community members will only dispose of enough pharmaceutical waste to be picked up once or twice a year which will significantly cut down on maintenance costs.

²⁶ “Medication Disposal.” *Metropolitan Water Reclamation District of Greater Chicago*, mwrld.org/medication-disposal.

²⁷ Jennifer Palombizio, in discussion with the author, February 12, 2020

b. Increasing Awareness

From the data collected in the survey, I found that many respondents lacked knowledge about “safe pharmaceutical disposal” terminology. 84% of respondents claimed to not know what safe pharmaceutical disposal was, but nevertheless a majority of these respondents were able to correctly explain what they believed the definition to be. I identified this discrepancy as an issue with how students are educated about pharmaceutical disposal rather than confusion regarding the act of actually disposing the drugs. In the interview with Jennifer Palombizio, she explained that many pharmaceutical disposal programs do not have continual promotional or educational outreach. When asked if the Medical Center continues to reach out to consumers about pharmaceutical disposal options, Jennifer explained that at first, there were newsletters to inform consumers, however, after the establishment of the program, this promotional information stopped.²⁸ In addition, doctors and pharmacists were never requested to inform consumers about the pharmaceutical disposal option in the hospital. This lack of education and commitment to continual promotion of the disposal bin is a significant flaw in many pharmaceutical disposal programs. This is why I recommend that the disposal bin installed at the University of Chicago is coupled with a program aimed to inform and educate the students on campus. I believe this can be done by marketing the disposal bin as an asset to University life and curating a community atmosphere around pharmaceutical disposal.

To do this, I suggest that the University requires on-campus dormitories to educate students through informational signs posted within the dormitory and discussions on the importance of disposing pharmaceuticals safely. Because all first-year students are required to live in on-campus housing, using the dormitories will be an effective tool to educating all new

²⁸ Jennifer Palombizio, in discussion with the author, February 12, 2020.

members of the University of Chicago community. Furthermore, educating students in the dormitories will focus on “nudging” the consumer in the right direction. In Richard Thaler and Cass Sunstein’s classic “Nudge: Improving Decisions about Health, Wealth, and Happiness”, the authors explain how the context and framing of an issue can be a powerful policy tool because it can dramatically influence consumers decision-making (Thaler and Sunstein 2008). As the survey data shows, there is a significant gap in how students understand the dangers of pharmaceutical disposal. Thus, the goal of this educational program is to use framing as tool to change perceptions. Furthermore, nudging can also create social pressure that influence people’s behavior. Studies have found that people are more likely to reduce their water consumption if they know their neighbors water consumption (Byerly et al. 2018). This is the logic for using the dormitory structure as a vessel to spread information. If one student is willing to participate, their roommates and friends are all more likely to do so as well.

c. Creating an Asset to the Community and Sustaining the Program’s Success

To sustain the program’s success, I believe that the University of Chicago should open the disposal program to the broader community in Hyde Park rather than requiring the disposal bin to be exclusively used by students. By developing a community atmosphere around this disposal program, there are greater opportunities for stakeholders outside of the university to become involved. This is essential to ensure the success and continuation of the program because without external stakeholders, the additional costs associated with a disposal program and continual need to promote information about the disposal option are not possible. The importance of stakeholders outside of the university was emphasized in both the interview with Mr. Strict from the University of Buffalo and Ms. Powers from Emerson College. Furthermore,

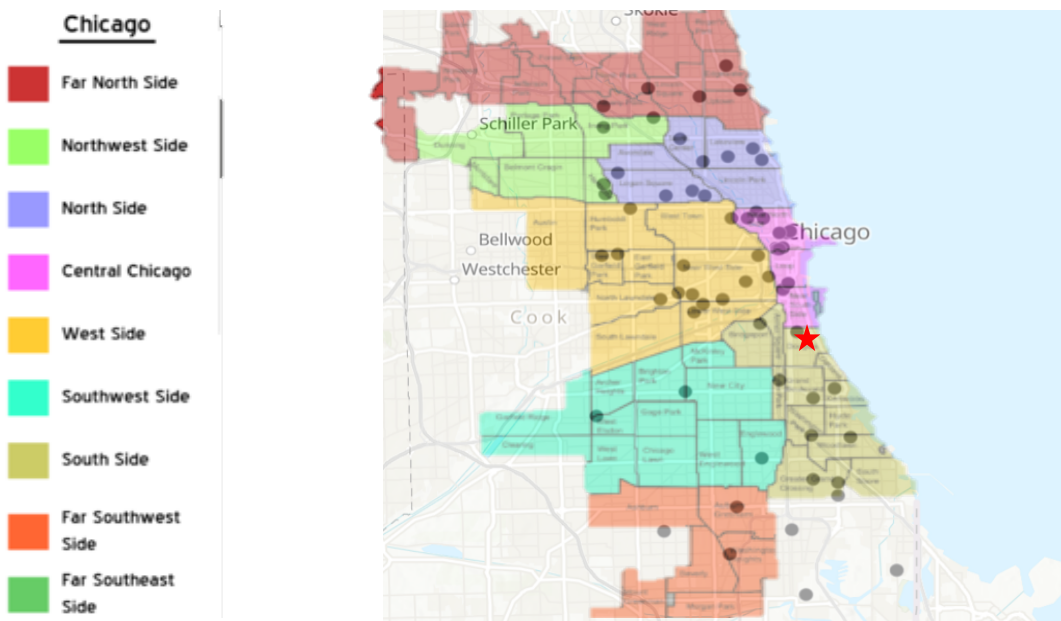
the university has an opportunity to provide a needed amenity to the surrounding community.

Ms. Palombizio spoke about the limited options for pharmaceutical disposal on the southside of Chicago compared to the north side.²⁹ My mapping of safe pharmaceutical disposal sites throughout Chicago confirms this pattern. See Figure 8 below.

Figure 8: Safe Pharmaceutical Disposal Bins in the City of Chicago

The colored map shows the neighborhoods in Chicago while a map with disposal bins in Chicago is layered on top. Black dots represent disposal bins.

The red star indicates the location of the University of Chicago in Hyde Park.



This need for disposal sites is what inspired the University of Chicago Medical Center, which is adjacent to the University of Chicago College campus in Hyde Park, to invest in their own disposal bin.³⁰ However, unlike the Medical Center where patients are usually coming from distant locations and for a one-time visit, the pharmaceutical disposal program on the University of Chicago campus will be focused on establishing a communal activity around disposal. The goal of this program is to instill safe disposal practices among students and community members

²⁹ Jennifer Palombizio, in discussion with the author, February 12, 2020.

³⁰ Jennifer Palombizio, in discussion with the author, February 12, 2020.

that they will carry with them when they eventually leave the University of Chicago campus. This program is not only about creating a waste disposal site, but also about encouraging students and community members to conceptualize safe pharmaceutical disposal as something you *are obligated* to do, rather than just something you should do. By providing this needed amenity to all community members in Hyde Park, the university will encourage stakeholder involvement and thus the continuation of the program while also reinforcing the importance of safe pharmaceutical disposal and providing an opportunity for students and community members to develop safe and healthy practices together.

VII. CONCLUSION

The purpose of pharmaceuticals is to provide medical aid to help diagnose, treat or prevent disease and restore the human body to its natural function. It might seem counterintuitive to say that pharmaceuticals are bad for our health, yet, that is precisely what this study, in a way, demonstrates. When we contextualize the danger of pharmaceuticals, we often only consider how the increasing rates of overdoses and prescription drug abuse has plagued our society disregarding how the environment and the organisms it encompasses are affected. Because American society has preconditioned us to believe that waste is no longer our responsibility once it has been disposed, there exists a significant divide between consumers and the disposal methods they use. This has resulted in a system where we are medicating the environment, yet, are taking very few precautions to change our behavior.

To further understand why pharmaceutical contamination continues to prevail in the United States, I use the University of Chicago as a case study for understanding the challenges that exist in implementing widespread pharmaceutical disposal. Through my analysis, I found that there are both formal federal barriers and informal barriers that prevent safe pharmaceutical

disposal from becoming a common practice. The formal barriers include scarce resources to safely dispose of pharmaceuticals, fragmented enforcement of safe pharmaceutical disposal, and limited federal micro-pollution policies while the informal barriers include lack of awareness, inadequate access to disposal options, and insufficient accountability. Through my survey data, I found that students find the terminology of “safe pharmaceutical disposal” problematic, but nevertheless are able to correctly define what safe pharmaceutical disposal entails. Furthermore, students underestimate where safe pharmaceutical disposal sites are located in proximity to their location indicating that students do not believe disposal options are as readily accessible as they actually are. My policy recommendations focus on how the University of Chicago as an institution can implement a disposal program and serve as an example of how to create a community that prioritizes safe pharmaceutical disposal. Furthermore, by creating this pharmaceutical disposal program, I show how the university can fulfill their educational mission as an institution that sets an example for other universities and broader society. Because universities function as closed systems where students are immersed in a network of learning and tight-knit socialization, they act as essential environments where students can foster habits of safe pharmaceutical disposal which they can then carry with them after they leave the university campus.

By performing this research, I aim to displace the assumption that “drugs” are somehow always controlled by medical authorities and instead contextualize pharmaceuticals as something that not only belongs to the consumer but also the environment. My research indicates that there are overarching themes and trends, such as lack of knowledge and insufficient resources, that make pharmaceutical disposal difficult. However, my data and subsequent policy recommendation specifically focus on the challenges at the University of Chicago and does not

indicate that these challenges exist at every institution pursuing a safe pharmaceutical disposal program. Other challenges such as lack of departments to enforce a program or fragmented communities could be prevalent at other institutions. This is why I recommend individual institutions to perform future research to examine their specific obstacles to creating a safe pharmaceutical disposal program. By understanding the challenges on the local and institutional level, we will then be able to shed light on the obstacles to widespread disposal programs which is a necessary first step to changing how pharmaceutical waste is addressed and ultimately incorporated into our state and federal waste systems.

VIII. APPENDICES

Appendix A: Image of Emerson College's Safe Medication Disposal Bin Flyer

JED
CAMPUS

NEW MEDICATION DISPOSAL DROP BOX

For all community members to anonymously and confidentially dispose of unused, expired, and unwanted prescription drugs and over-the-counter medications in a free, safe, environmentally friendly manner.

Safe Medication Disposal
Place your unwanted or expired medications in this dropbox to help prevent dangerous accidents with the children in your household.

**24 HOURS A DAY
7 DAYS A WEEK
365 DAYS A YEAR
114 BOYLSTON ST
HALLWAY**

Emerson
COLLEGE

For more information, contact
Sharon_Duffey@emerson.edu

Appendix B: Survey Questions

1. What is your home state or country?
2. What is your year in school?
3. What are the cross streets of your Chicago-based residency?
4. Have you ever disposed of pharmaceutical drugs?
 - a. If yes, how did you dispose of them?
 - b. If no, how would you dispose of them?
5. Do you know what safe pharmaceutical disposal is?
 - a. If yes, what is it?
 - b. If no, what do you think it is?
6. How would you define unsafe pharmaceutical disposal?
7. Have you ever been advised on how to dispose of your left-over pharmaceutical drugs?
 - a. If yes, what were you told?
8. Safe pharmaceutical disposal bins are locked containers where you can dispose of your pharmaceutical drugs that are expired or unused. They function similarly to a mailbox. How many safe pharmaceutical disposal bins do you believe are in the city of Chicago?
9. Roughly how far do you believe a safe pharmaceutical disposal bin is to your home address in Chicago (in miles)?

Appendix C: Description of Safe Disposal Bin on Campus

“A safe pharmaceutical disposal bin is a locked, permanent container where anyone can dispose of their left-over medications. The drugs are collected and safely disposed so they can’t pose harm to other people or the environment. The bin functions similarly to a mail-box.”

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