

Medication disposal practices: Increasing patient and clinician education on safe methods

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Abstract

Recent research suggests that the nation's water supply is contaminated with trace pharmaceuticals that exert a negative environmental and public health impact. Incorrect medication disposal methods (e.g. flushing medications down the toilet or drain) are a significant factor contributing to the presence of medication compounds in the aquatic environment. In this commentary, we provide a summary of the existing data on pharmaceuticals in the nation's water as well as the role of improper medication disposal methods on water contamination. We discuss statistics on improper medication disposal practices among patients and clinicians as well as recent advances in proper medication disposal methods as a solution to this problem. Currently, many patients and clinicians are not aware of proper medication disposal practices. We summarize the importance of patient and clinician education in advancing environmental-safe medication disposal methods.

Keywords

Medication disposal, medication take-back programs, environmental pollution, patient education, clinician education

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Introduction: Medications in the United States water supply

In January of 2014, a study published by *Environmental Pollution* revived public attention on a problem that has been researched for decades – namely, pharmaceuticals in the water supply.¹ A study that

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measured the concentration of 56 active pharmaceutical ingredients across 50 large wastewater treatment plants found that hydrochlorothiazide, a diuretic that treats high blood pressure, was in every sample.² Other high blood pressure medications (e.g. metoprolol and atenolol) and the mood stabilizer carbamazepine were found in more than 90% of the samples.² With media outlets citing the study as the most extensive study of water coming out of wastewater treatment plants,¹ these results garnered global attention. Since the study's publication, environmental lawyers have been calling for increased tests on water supplies with the aim of determining the public health impact of these pharmaceuticals. Concern exists that even trace quantities could lead to detrimental health impacts for humans such as antibiotic resistance and abnormal hormonal effects among teenagers.^{1,3} Pharmaceutical residues may also interfere with the reproduction and growth of aquatic life.³

Drinking water treatment has a long and intricate history. For ancient civilizations, water treatment centered on aesthetics (e.g. taste, odor, and appearance).⁴ By 4000 BC, methods were noted to improve the taste and smell of drinking water. Particles in water sources were seen as problematic only in that they interfered with the water's appearance and taste.⁴ It was not until the mid to late 1800s that scientists first realized the potential hazardous impact of such particles on human health.⁴ Louis Pasteur's 'germ theory' of disease, developed in the late 1880s, established that microbes could spread disease through water.^{4,5}

Throughout the late nineteenth and early twentieth centuries, concern increased over the possibility that water particles could carry pathogens. It was not until 1914, however, that federal regulation of drinking water commenced with the US Public Health Service establishing guidelines for

drinking water quality.^{4,6} These guidelines were no longer sufficient by the late 1960s when man-made chemicals began to enter water sources through discharges from industrial sources and underground tanks (e.g. disposal and storage tanks), among other contamination mediums.⁴ This ultimately led to the passage of the Safe Drinking Water Act (SDWA) in 1974.⁴ The SDWA and its subsequent amendments have served as the primary means from which drinking water regulations are created to promote optimal drinking water treatment and delivery.^{7,8} However, though the number of water systems applying treatment to their water sources has increased since the passage of this act, water treatment still does not effectively prevent individuals from exposure to harmful toxins and chemicals in their drinking water.

Data collected supports that millions of Americans drink water that is contaminated with trace concentrations of pharmaceuticals. As more tests are conducted by state and federal agencies, a wide range of pharmaceuticals (e.g. anticonvulsants, mood stabilizers, hormones, and antibiotics) have been discovered in the drinking water supplies of at least 46 million Americans.⁹ For many years, research studies have found traces of active pharmaceutical ingredients (APIs), medicines, and synthetic hormones in surface waters.^{10,11} Research indicates that pharmaceuticals also enter underground aquifers that supply 40% of the water supply in the US.³ In one experiment conducted across 24 states that examined water from aquifers located near sources of contamination (e.g. landfills, animal feed lots), small amounts of hormones and antibiotics were discovered, among other medications.³ An examination by the US Geological Survey and the New York State Department of the water supply in upstate New York determined trace concentrations of heart medicine, estrogen,

antibiotics, a tranquilizer, anti-convulsants, and a mood stabilizer.³

Medications flushed down the toilet or in drains are one means through which chemicals pass through the sewer system and enter our streams, lakes, and rivers.¹² Indeed, pharmaceutical traces have been shown to withstand standard water treatment methods.¹³ Excretion is one route through which APIs are believed to enter wastewater systems as only a small amount of consumed medication is fully absorbed by the body.^{2,14,15} In septic systems, pharmaceutical substances enter groundwater and, in sewage systems, compounds are directed to treatment facilities that are not capable of fully degrading pharmaceutical compounds. Together, these factors contribute to wastewater that contains pharmaceutical residues.^{15,16} Bottled water and home filtration systems do not necessarily prevent exposure to these residues. Both bottlers and home filtration system companies often do not treat or test for pharmaceuticals in the manufacture of their products.³

One possible solution to the environmental impact of medications in the water supply lies in the existence, instruction, and implementation of proper medication disposal methods.

Proper medication disposal: an environmental solution

Research suggests that disposal of medications in the sink or toilet may significantly lead to the presence of pharmaceuticals in the aquatic environment.^{15,17} Thus, over the years, several surveys have been conducted to supply further insight into medication disposal practices within the US.

Overall, findings from these surveys suggest that a proportion of Americans continue to employ incorrect methods of medication disposal. However, these data

also demonstrate a trajectory towards reduced methods of improper disposal (e.g. unsafe practices such as flushing medications down the toilet or sink, discarding medications in the garbage). A survey of 500 callers to the Pittsburgh Poison Center, the state Boards of Pharmacy, the Food and Drug Administration, the Environmental Protection Agency, and community and hospital pharmacies on their disposal practices for expired medications found that 35.4% flushed their medications down the toilet or in the sink and 1.4% brought their medications back to a pharmacy.¹⁸ A survey of 301 individuals at an outpatient pharmacy about their medication disposal practices and their beliefs about medication disposal found that over 50% of the sample reported flushing their medications down the toilet.¹⁹ A study that attempted to survey 586 urology surgery patients on their disposal of prescribed narcotics post-surgery found that among the 275 survey respondents, less than 1% of patients with remaining, unused medications returned the medications to a pharmacy.²⁰ A web-based survey of medication disposal practices and beliefs that was delivered to 138 hospice home care nurses found that 55% of the nurses reported disposing of medications via the sewerage system on an 'always' or 'often' basis.²¹ Of note, the nurses expressed concern about the environmental impact of discarding medications to sewerage.²¹ Recently, a survey conducted on medication disposal practices of Medicare members found that 11% of medications were discarded through medication take-back programs and 9% of medications were flushed down the toilet.²²

Environmentally unsafe disposal practices are also common outside of the US. A survey conducted among Serbian households ($n=383$ families) on their methods of storing and discarding of expired medications found that 82.8% of survey respondents employed an incorrect medication

disposal method (e.g. disposing of expired medications in the garbage), whereas only 4.4% of respondents used a correct medication disposal method (e.g. bringing expired medications to a pharmacy).²³ Of note, though a large percentage of survey respondents used improper medication disposal methods, 66.3% of survey respondents were aware that throwing medications in the garbage could have a detrimental impact on the environment.²³ Similarly, a 2016 survey of individuals living in China found that the majority of survey respondents disposed of pharmaceuticals in the garbage.²⁴

What factors have influenced improvements in medication disposal practices? The Secure and Responsible Drug Disposal Act of 2010²⁵ allowed for an amendment of the Controlled Substances Act (CSA),²⁶ which regulates distribution, importation, manufacture, possession, and use of controlled substances. The rise in nonmedical prescription medication use in the US, especially among teenagers, as well as unintentional overdose mortalities involving prescription opioids, motivated the adoption of this amendment, among other factors.²⁷ Under this amendment, the Drug Enforcement Administration (DEA) was given authority to create regulations and propose new options for proper medication disposal. These regulations include medication take-back programs, medication mail-back programs, and collection receptacles for medication disposal. Prior to the passage of this amendment, the CSA did not supply a means for patients to discard controlled substances (e.g. unused prescription medications); pharmacies and medical facilities were legally not allowed to accept controlled substances for disposal. As a result, many individuals employed incorrect medication disposal methods, such as discarding medications in the garbage or flushing them down the toilet.²⁸ The DEA's Final Rule

on 9 October 2014 effectively implemented the Secure and Responsible Drug Disposal Act of 2010.²⁹ Under this regulation, pharmacies and healthcare facilities have the option to register as designated collection sites for any unwanted medications.³⁰

As of February 2016, options for proper medication disposal have been established in multiple community locations and pharmacies across the US with 882 DEA registrants labeled as designated collectors.³⁰ Over the last few years, published studies have suggested public interest in these programs as well as the potential of these programs to reduce nonmedical use of prescription medications and the environmental impact of improper medication disposal.³¹⁻³³ A survey was conducted to determine the level of interest patients had for participating in a community pharmacy-based medication take-back program for disposal of unused, unwanted, or expired (UUE) medications. Of the 62 survey respondents, 61% reported interest in participating in a medication take-back program, while 57% reported having no UUE medications at home.³² Of note, the authors suggest that awareness of environmental-safe methods of medication disposal remains limited.³² More recently, a study examined prescription opioids returned for disposal to a Wisconsin medication take-back program.³¹ The study found that, among returned opioid prescriptions, more than 60% of the dispensed amount was unused, suggesting that medication take-back programs could be effective in eliminating unused medications from the home environment.³¹ Another study reported the success of a medication take-back program in North Carolina that hosted more than 1395 take-back events between 2010 and 2014.³³ During this time frame, there was a 597% and 35.8% increase in the number of participating law enforcement agencies and counties, respectively.³³ Similar success was reported

for prescription medication take-back efforts based in eleven Maine cities during six DEA national medication take-back events from 2011 to 2013.³⁴ Controlled prescription medications comprised 9.1% of returned medications, over-the-counter (OTC) medications comprised 31.4% of returned medications, and non-controlled prescription medications comprised 56.4% of returned medications.³⁴ The effectiveness of an UUE collection campaign event in New Jersey was reported; the campaign event reached 60% of its intended audience and campaign exposure was associated with bringing UUE medication to a collection site for proper disposal, having conversations with other individuals about medication disposal, and instructing children on the dangers of prescription drug abuse.³⁵

Instruction on proper medication disposal: A key factor

As a result of the 2014 DEA ruling, resources for medication disposal have increased in recent years. However, data from several research studies suggest that instruction on proper disposal methods warrants further emphasis and attention. A 2006 survey of patients at an outpatient pharmacy found that under 20% of the sample had received instruction about medication disposal by their clinician.¹⁹ Of note, prior instruction on proper medication disposal was highly associated with returning medications to a pharmacy and was the factor most strongly associated with returning medications to a clinician.¹⁹ Ten years later, instruction on proper medication disposal remains an area for improvement.^{32,36–38} For instance, a survey of 300 adult cancer outpatients assessing patterns of storage, use and disposal of opioids found that 74% of the sample was not informed on proper means for disposing of opioids.³⁶ A survey study of 586 urology surgery patients found that

92% of patients reported receiving no instruction on disposal practices for extra, unused medications.²⁰ Researchers cite the important role of the pharmacist as educators for patients on proper medication disposal practices,^{32,37,38} with many noting that lack of awareness of medication take-back programs provides pharmacists with the opportunity to inform themselves and the general public on medication disposal practices.^{32,37} Indeed, pharmacist- or clinician-delivered patient instruction on proper medication disposal could further reduce the widespread environmental and public health ramifications created by unsafe disposal practices.^{32,39} However, some researchers note a barrier to this instruction – specifically, many pharmacists and clinicians may not possess knowledge on proper medication disposal. A survey of 142 pharmacists in California exploring their awareness of proper medication disposal practices as well as their intention to provide education on these practices found that, while most pharmacists indicated a positive intention to provide education, they supplied this education on an infrequent basis (e.g. once a month or less).³⁸ Further, only a small percentage of the sampled pharmacists correctly selected appropriate recommendations for disposing of controlled (10.1%) and non-controlled (15.9%) substances.³⁸ A survey on medication disposal practices among hospice care nurses found that only 16% of the surveyed sample reported learning about safe medication disposal practices in their nursing training programs.²¹ Future initiatives on medication disposal education may benefit from informing not only patients but also clinicians and pharmacists. It may also be necessary to implement improved education programs on proper medication disposal in nursing and medical education programs. Table 1 summarizes key findings across studies exploring medication disposal

Table 1 Summary of articles exploring medication disposal practices and medication take-back programs in the United States.

Authors	Sample	Primary article focus	Key findings
Kuspis et al. (1996) ¹⁸	500 callers to poison control center, 100 community/hospital pharmacies, US FDA, US EPA, and state Boards of Pharmacy	Medication disposal practices	<p>Among 500 callers:</p> <ul style="list-style-type: none"> - 35.4% reported flushing medications down sink or toilet - 7.2% reported not disposing of unused medications - 1.4% reported returning medications to pharmacy <p>Among 100 pharmacies:</p> <ul style="list-style-type: none"> - 5% reported providing consistent guidelines for consumers on medication disposal practices - 54.2% of patients reported having unused/expired medications in their household - 53.8% of patients reported flushing unused medications down a toilet, more than 35% thought that this was an appropriate means of medication disposal - 19.7% of patients reported receiving education on proper medication disposal from a clinician - 92.2% of patients (213/231) reported receiving no instruction on proper disposal of leftover pain medications from a clinician or pharmacist - 90.8% of patients (149/164) with leftover pain medication kept the medication, 6.1% (10/164) threw the medication in the garbage, 2.4% (4/164) flushed medication down the toilet, and 0.6% (1/164) returned medication to a pharmacy - 64% reported disposing of unused or expired medications by mixing them with noxious substances - 37% reported disposing of unused or expired medications by flushing them down the toilet on a 'always' or 'often' basis - 18% reported disposing of unused or expired medications by rinsing them down a sink on a 'always' or 'often' basis
Seehusen and Edwards (2006) ¹⁹	301 patients at an outpatient pharmacy	Medication disposal practices	
Bates et al. (2011) ²⁰	275 patients undergoing surgery in a urology program	Medication disposal practices	
McCullagh et al. (2012) ²¹	138 hospice home care nurses	Medication disposal practices	

(continued)

Table 1 Continued

Authors	Sample	Primary article focus	Key findings
Maeng et al. (2016) ²²	721 Medicare Advantage members with Part D prescription medication coverage	Medication disposal practices	<ul style="list-style-type: none"> - 25.2% had unused medications in their household that they did not intend to use again - 55% of unused medications remained in cabinets - 14% of unused medications were thrown out in the garbage - 11% of medications were disposed of through medication take-back programs - 74% not aware of correct opioid disposal procedures - 53% did not regularly dispose of opioids - 46% had unused opioids in their household - 38% did not recall receiving medication disposal education in pharmacy school - 67.9% supplied medication disposal recommendations once a month or less frequently - More than 80% indicated that they believed patients and health care professionals would want to receive education on proper medication disposal - Over 70% intended to include education on medication disposal as a part of patient consultations - 24.2% aware of medication take-back programs as an option for medication disposal - 61.3% willing to participate in a mail-back program for their unused, unwanted, or expired (UUE) medications - 30.6% not willing to pay to be a part of a UUE mail-back program - Current medication disposal practices: discarding in garbage (53.2%), flushing down toilet (29.0%), storing at home (17.7%) - Opioid prescriptions returned for disposal had more than 60% of the dispensed amount unused
Reddy et al. (2014) ³⁶	300 adult cancer outpatients	Medication disposal practices	
Tai et al. (2016) ³⁸	142 community-based pharmacists	Medication disposal practices	
Lystlund et al. (2014) ³²	62 patients (prior to commencing participation in an Oklahoma medication take-back program)	Medication take-back programs	
Welham et al. (2015) ³¹	761 households participating in a Wisconsin medication take-back event	Medication take-back programs	

(continued)

Table 1 Continued

Authors	Sample	Primary article focus	Key findings
Fleming et al. (2016) ³³	1395 events of a specific medication take-back program in North Carolina (Operation Medicine Drop)	Medication take-back programs	<ul style="list-style-type: none"> – 69.6 million doses of unwanted medications collected over 6-year program duration – 35.8% increase in counties participating in the program and 597% increase in law enforcement agencies participating in the program over a 4-year period
Stewart et al. (2015) ³⁴	1049 participants in 11 cities of Maine during 6 DEA national take-back events	Medication take-back programs	<ul style="list-style-type: none"> – 13 599 individual medications returned through national take-back events – 553 019 collected units of medication corresponded to 69.7% medication waste
Yanovitzky (2016) ³⁵	906 adults in New Jersey who participated in a statewide medication collection event/campaign (American Medicine Chest Challenge)	Medication take-back programs	<ul style="list-style-type: none"> – Medication return patterns: noncontrolled prescription medications (56.4%), OTC medications (31.4%), controlled prescription medications (9.1%) – 97% aware of news stories or advertisements about adolescent prescription drug abuse – 5% conducted internet search in the prior 30 days on safe disposal of unused medications – Campaign reached over 60% of its target audience

FDA, Food and Drug Administration; EPA, Environmental Protection Agency; DEA, Drug Enforcement Administration; OTC, over-the-counter.

practices and medication take-back programs in the US.^{18–22,31–36,38}

Clinical relevance of proper medication disposal methods

Enhancing the widespread application of correct medication disposal procedures will not only yield important environmental benefits but also has the potential to reduce the US's widespread problem with prescription or OTC drug abuse and misuse.⁴⁰ Misuse of prescription and OTC medications is unfortunately quite widespread; across several large samples, approximately 12–17% of American teenagers report inappropriate use or abuse of such medications (e.g. use of medications without a prescription, excessive use of medications).^{40–42} In some cases, such misuse or abuse has been linked to the presence of unused medications left in household cabinets and to the passing of unused medications to other individuals as a means of disposal (an action that can lead to drug abuse or misuse by the medication recipient).^{40,43,44} Recently, we explored the role of unsafe and/or lack of medication disposal practices in the development of prescription and OTC drug abuse and misuse in the US;⁴⁰ in our manuscript, we proposed a three-part mechanism for reducing abuse of prescription and OTC medications that integrates elimination of social stressors in the environment, continued creation and expansion of medication take-back programs, and increased education on proper medication disposal practices across patient, caregiver, and clinician communities. This model can also be applied toward reducing the environmental damage created by unsafe medication disposal practices. By increasing and improving education on medication disposal practices, enhancing existing medication take-back programs, and creating new medication-take back programs, incorrect medication disposal practices can be

significantly curtailed.⁴⁰ Reductions in improper disposal practices will, in turn, lead to a diminished presence of medications in the water supply and, thus, reduced destruction to the environment.

Conclusion

Data suggests that pharmaceuticals exist in the US water supply and that the presence of these compounds can partially be attributed to improper medication disposal practices.^{2,9,15,17} In 2014, a DEA ruling created options for proper medication disposal such as take-back programs, collection receptacles, and mail-back programs.²⁹ A 2010 manuscript noted that the impact of medication take-back programs remained to be determined.⁴⁵ In the past few years, medication disposal programs and events have been implemented and broadly utilized.^{33,34} For disposal of hospital medications, hospital-based pharmacies that accept unused medications should continue to be broadly implemented.⁴⁶ Given their widespread presence, these programs have the potential to significantly reduce the negative environmental impact caused by improper medication disposal. Future efforts should focus on the continued creation of medication disposal programs across the US as well as on overcoming barriers to program implementation. These barriers include the cost burden associated with take-back programs as well as potential difficulties in obtaining appropriate collection receptacles.⁴⁷ Of note, one recent analysis suggested that, relative to other sources of pharmaceutical excretion to the environment, incorrect medication disposal methods only minimally contribute to environmental damage.⁴⁸ Nonetheless, enhancing safe medication disposal practices is an important way to help reduce any environmental threat, regardless of the magnitude of this threat.⁴⁸

Currently, many clinicians and patients lack instruction in and awareness of proper medication disposal practices.^{21,36,38} The upcoming challenge is to disseminate widespread medication disposal education programs for both patients and caregivers into the community. Targeted sessions with a particular focus on the environmental effects of improper disposal may help eliminate pharmaceuticals and medication compounds from our water supply.

Declaration of Conflicting Interests

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Ms Gold has no conflicting interests to report.

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Medicine, CME Institute, ISCTM. He was currently or formerly on the advisory boards of Appliance Computing, Inc., Brain Cells, Inc., Eli Lilly and Company, Genentech, Johnson and Johnson, Takeda/Lundbeck, Targacept, and InfoMedic. He owns stock options in Appliance Computing, Inc., Brain Cells, Inc, and Medavante; has copyrights to the Clinical Positive Affect Scale and the MGH Structured Clinical Interview for the Montgomery Asberg Depression Scale exclusively licensed to the MGH Clinical Trials Network and Institute (CTNI).

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