

Pharmaceutical Wastes and their disposal practice in routine

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Abstract

Variety of pharmaceuticals in surface, ground, and drinking waters around the country is raising concerns about the potentially adverse environmental consequences of these contaminants. The consistent increase in the use of potent pharmaceuticals, driven by both drug development and our aging population, is creating a corresponding increase in the amount of pharmaceutical waste generated. Pharmaceutical waste is any waste which contains medicinal drugs that are expired, unused, contaminated damaged or no long needed. Improper disposal of pharmaceutical waste such as expired drugs, used test strips and unused medication are ending up in landfills, some of these eventually polluting water bodies around the landfills. In the past, health care facilities would routinely flush waste pharmaceuticals down the drain. As a society we didn't know how detrimental these drugs would be to the environment. Now biologists have found residual pharmaceuticals in fish and the aquatic ecology and we understand how bad the untreated disposal of drugs is. As responsible citizens and waste managers, we need to keep the Precautionary Principle in mind. Disposing of pharmaceutical and other chemical waste such as lab waste can be highly problematic where there are no established treatment facilities. Waste can be minimized by careful stock keeping. Keep a record of the amount of each medicine that is needed and avoid ordering too much to prevent it going out of date. Establish a "first in first out" system in the pharmacy so that the packages which are going to expire first are dispensed first. In this paper we will briefly unfold the various disposal methods for Pharmaceutical wastes in practice.

Key words: Pharmaceutical wastes, pollution, Environment.

Introduction

Pharmaceuticals are produced and used in large volumes increasingly every year throughout the world. With this growth comes concern about the fate and effects of these compounds on the environment. The identification of pharmaceuticals in the aquatic environment has been a hot topic of research from the last decade^{1,2}. A wide varieties of pharmaceuticals have been detected in fresh and marine water of various countries³, the presence of pharmaceuticals in our water bodies raises issues beyond concerns about their potential impact on humans and studies are been shown that even small quantities of these pharmaceuticals in environment have the potential to cause harm^{4,5}. Pharmaceutical wastes include expired, unused (rejected by the patient), spilt, contaminated, prescribed, proprietary drugs, vaccines and sera that no longer required and due to their chemical or biological nature, need to be disposed of carefully. This pharmaceutical waste can be in the form a pill, an oral liquid, an intravenous liquid or in any other form that is intended for a patient to consume⁶. Medicines are produced and prescribed in increasing volume every year. The sale of prescribed and over the counter drug is been increasing from last two decades. With these episodic increase comes, concern about the fate and effects of the unused/ left out or expired compounds in the environment. Recent studies have identified a wide range of pharmaceutical chemicals in rivers, streams and groundwater internationally^{7,8} and it has also been shown that some of these compounds are potentially harmful to aquatic organisms, affecting reproduction and development even at very low concentrations in some cases⁹. The fate of unused medicines is a rapidly emerging concern that spans a broad range of issues including environmental and human health, water quality, solid waste management, law enforcement and the health care industry. Substances of concern include both prescription & non-prescription medicines and this category are sometimes expanded to include cleansing agents, cosmetics, nutritional supplements and skin care products. A common term used for this suite of compounds is pharmaceuticals and personal care products (PPCPs). There are thousands of products that fall into this classification; all of these substances are specifically designed to interact with biological processes and are widely used around the world⁸. Medicines are produced and prescribed in increasing volume every year. The sale of prescribed and over the counter drug is been increasing from last two decades. With these episodic increase comes, concern about the fate and effects of the unused/ left out or expired compounds in the environment. Recent studies have identified a wide range of pharmaceutical chemicals in rivers,

streams and groundwater internationally ^{7, 8} and it has also been shown that some of these compounds are potentially harmful to aquatic organisms, affecting reproduction and development even at very low concentrations in some cases ⁹. The fate of unused medicines is a rapidly emerging concern that spans a broad range of issues including environmental and human health, water quality, solid waste management, law enforcement and the health care industry. Substances of concern include both prescription & non-prescription medicines and this category are sometimes expanded to include cleansing agents, cosmetics, nutritional supplements and skin care products. A common term used for this suite of compounds is pharmaceuticals and personal care products (PPCPs). There are thousands of products that fall into this classification; all of these substances are specifically designed to interact with biological processes and are widely used around the world ⁸. Traces of pharmaceuticals are being detected in the environment, primarily in water (surface water, coastal water, groundwater and drinking water) and soil. There is growing evidence that throwing pharmaceuticals (prescription drugs and non-prescription/over-the-counter drugs) and other personal care products in the garbage or flushing them down the toilet or the sink is contributing to this issue and consequently may have a harmful effect on the environment and human health ^{7, 10}.

Pharmaceuticals have been found primarily in discharge from wastewater treatment plants and surface waters. Pharmaceuticals are also released into waterways from commercial animal feeding operations and aquaculture and from fields where manure and bio solids have been used. Sewage treatment plants are not designed to remove these drugs and these chemicals are directly released into streams, lakes and groundwater and affect fish and other aquatic wildlife. A study by Daughton identified the presence of human and animal pharmaceutical chemicals in water bodies and these include hormones, antibiotics, blood lipid regulators, analgesics and anti-inflammatories, beta-blockers, retinoids, tranquilizers, antidepressants, anti-epileptics and antineoplastics ⁹. Several worldwide studies demonstrated the adverse effects of improper drug disposal and raised concern about consequences that may occur if appropriate action not taken ^{7, 10}. In March 2008, The Associated press reported that drinking water supplies of 24 metropolitan areas across U.S. had pharmaceutical residues of mood stabilizers, anti convulsants and antibiotics ¹¹. In 2002, United States Geological Survey found pharmaceuticals in 80% of the samples they tested ¹². The samples taken from the Ohio River contained *Escherichia coli* showed resistance to penicillins, tetracyclines and vancomycin ². Presences of these

pharmaceuticals in waste system have a potential impact due to continuous exposure in wildlife ecosystem, the life span rate get reduced and endangered. Drinking of water with these pharmaceuticals can lead to ill effects ^{13, 14}.

Treatment of contaminated water

Disposing of unwanted or expired medicines by environmental unfriendly routes is becoming a big issue and can be a challenge for households. A few guidelines are available for individual consumer's medicine disposal, but unfortunately it is less in practice not only in developing countries but also in developed countries and consequently left out and expired drugs are making their way into septic tanks, sewers or landfills ¹⁵. Septic systems represent another source of unwanted medicines to groundwater and ponds as these are also not equipped to break down pharmaceutical chemicals. Researchers have discovered some estrogenic chemicals in groundwater down-gradient of residential septic systems and new research indicates higher levels of these chemicals in ponds near areas of higher residential density ^{16, 17}. In general, wastewater treatment plants are not designed to remove dissolved medicines from water. They were designed to remove solids, organic materials and some nutrients such as phosphorus and nitrogen. At wastewater treatment plants, water goes through one, two or three stages of treatment, depending on the sophistication of the plant and the needs of the community served ¹⁸. Primary treatment removes solids, which are either applied to land as fertilizer or sent to a landfill. The treated water still can contain dissolved and colloid organics and bacteria. If the treatment plant does no more than primary treatment, then the water is chlorinated to kill the remaining bacteria and discharged. During secondary treatment, organic materials and nutrients are removed with the aid of bacteria in aerated tanks. After the bacteria are added, the wastewater flows to settling tanks where the bacteria settle out. Various types of tertiary treatments are possible depending on the composition of the wastewater. Typically, tertiary treatment uses chemicals to remove phosphorous and nitrogen from the water, but may also include filter beds and other types of treatment. Chlorine added to the water kills any remaining bacteria and the water is discharged ¹⁸.

Disposal methods

A large portion of the pharmaceuticals in our water come from the improper disposal of unused or unwanted drugs by households and medical facilities. Most people either flush them down the toilet or throw them in the trash. The best method of disposal “take back” programs in which drugs are returned to concerned authority, but is not commonly available in all the places, leaving people with few options ^{19,20}.

Disposal methods by patients

It was previously believed that the best way to prevent accidental consumption of prescription medications was to dispose of any unused or expired medications in the toilet or down the drain, as opposed to discarding them in the trash, where animals or humans more likely to encounter them. However, as awareness of the possible ecological and public health effects of medication flushing spread, recommendations for medication disposal practices began to shift ²¹. The White House Office of National Drug Control Policy (ONDCP) released an official guidance in 2007 (updated in 2009) for proper medication disposal that advises people not to flush their medications down the toilet or wash them down the drain and provides explicit directions for how to dispose of medications safely in the trash as solid wastes ²². Researches indicate that consumers lack guidance on how to dispose of their leftover medication. A 2006 survey of 301 patients at an outpatient pharmacy found that fewer than 20 percent had ever been given advice from a healthcare provider about medication disposal (Table 1.1). The same survey found that more than half of patients reported storing unused and expired medications in their homes, while more than half flushed unused medication down the toilet, and only 22.9 percent reported returning unused medication to the pharmacy for disposal ²³.

Table 1.1: Respondents prior practices and beliefs connecting unused and expired medication disposal²³

Patients who have disposed of medications Number (%)	
by number	
Rinsing down a sink (301)	
Yes	106 (35.2)
No	195 (64.8)
Storing in the house (301)	
Yes	163 (54.2)
No	138 (45.8)
Returning to Pharmacy (301)	
Yes	69(22.9)
No	232 (77.1)
Flushed down a toilet (301)	
Yes	162 (53.8)
No	139 (46.2)
Giving to friends or family (301)	
Yes	33 (11.0)
No	266 (89.0)
Returning to a health care provider (301)	
Yes	42 (14.0)
No	258 (86.0)

In a survey of Southern California residents a similar trend was found, with 45 percent disposing of their pharmaceuticals in the trash and 28 percent disposing of them down the toilet or sink. A

random survey in King County, Washington showed that 52 percent of respondents disposed of pharmaceuticals in the trash, 20 percent flushed them down the toilet or sink and only 1 percent returned them to a pharmacy or doctor ²⁴. Earlier research yielded similar findings. A 1996 survey of 500 callers to a U.S. poison information center found that only 1.4 percent of callers returned medications to a pharmacy, while 54 percent reported disposing of medications in the garbage, 35.4 percent reported flushing medications down the toilet or sink, 7.2 percent reported that they did not dispose of medications and only 2 percent said they used all medications before expiration ²⁵. A survey in India among 200 households, majority of respondents disposed medicines in trash (67%) followed by hoarding in the house (20%). Solid dosage forms were most commonly disposed by trashing. Returning to pharmacy and storing in house were the other ways adopted for dispose the solid drugs (8%). For liquid medications, rinsing in sink (18%) and flushing in toilet were also employed (5%). Semisolid medications (ointments and gels) were disposed in garbage (91%), stockpiled or shared with others (9%). 59% of respondents strongly agreed that drugs pose a threat to environment. Self-medication with over the counter drugs was cited as the most common reason for possession of expired medications in households (58%) (Table 1.2). Majority of the respondents did not receive any advice on drug disposal technique (89%). Fifty five percent believed that a system of returning drugs to pharmacies for safe disposal would be favourable ²⁶.

Medicine procurement	Frequency of procurement	N (%)
On prescription (N= 308)	Never	37 (12)
	1-3	104 (34)
	> 3	166 (54)
Without prescription (N= 468)	Never	107 (23)
	1-3	262 (56)
	> 3	98 (21)

Table 1.2: Frequency of obtaining medicines by respondents in past six months²⁶**Health care professionals – Physicians (HCWs)**

Prescription medications and the recommendation for use of over-the-counter (OTC) medications are commonly encountered in most ambulatory settings. According to 2006 statistics released by the Centers for Disease Control and Prevention, 2.6 billion prescriptions are written per year for walk-in patients in the United States alone²⁷. Ideally, patients will consider the recommendation of their physician and use said prescribed medication appropriately. However, many patients will experience at least one to two medication changes at one time or another, whether a change in dosage or the initiation of a new medication^{28, 29}. Health care professionals are the role models for the patients and public in connection with the health issues. Hence it is very important not only to instruct how to take medicines and also how to dispose them in case of left outs and expired medicines. One should have knowledge about safe disposal practices. A study by Teshina, in 2011 to determine the level of knowledge physicians possess regarding proper medication. Majority of them (75%) indicated they had no formal training regarding disposal guidelines and 67% of respondents indicated no knowledge of any current drug disposal guidelines. Sixty-one percent reported that they recognized the environmental impact of improper disposal practices and of those, 58% felt that this influenced their prescribing practices. In terms of the establishment of a medication disposal program, 64% of respondents indicated some interest in such a program and 61% reported that they had encountered patients inquiring about drug disposal options. Respondents view for potential barriers to the initiation of a disposal program were Safety (15%), time (54%), logistics of disposal site (69%), cost (71%) and interest level of consumers (71%)³⁰.

Disposal methods by students

Initiating the education regarding safe disposal practice from school level is appreciable and well needed to change the current scenario. Disposal Practice for Unused Medications among the Students of the International Islamic University Malaysia reported that maximum of them were not known about medication waste. On the other hand, a large portion of the respondents did not know about drug-take-back system (n=828). The most common reasons given by respondents for

having leftover or unwanted medications was changed to other treatment (n=354), passed expiry date (n=389), medical condition improved or resolved (n=398), excess quantity supplied(n=478), side-effect of medication (n=187), medicine labels had unclear instructions(n=44), unsure why medication was prescribed (n=123), inconvenience or difficulty in following instructions (n=34) and patient deceased (n=35) and other category respondents (n=158). Disposal practices of medication formulation by Abul Kalam study stated that about 62% (n=547) of the respondents dispose of unwanted liquid medications into the domestic water system via the toilet or sink ³¹ (Table 1.3).

Table 1.3: Respondents method of disposal depending on medication formulation type ³¹

Response	Medication formulation type		
	Liquid	Tablet/ capsule	Ointment/ cream
Down the toilet	169	157	7
Down the sink	378	51	6
With household rubbish	223	563	689
Take it to the tip	14	17	46
Burn	15	11	9
Return to the pharmacy	53	75	110
Give away	12	3	7
No answer	21	8	11

A study in INDIA on Safe medication disposal defined the need to sensitize undergraduate students, out of 236 respondents participation, majority of the respondents (72%) reported the possession of up to five medicines at home (Table 1.4) and the qualitative analysis of expired

medications at home revealed antipyretics (54%), analgesics (64%), followed by antihistamines (35%) to be hoarded in home pharmacies/medicine chests. Other drugs were antibiotics (26%), antacids (23%), topical drugs (39%) and supplements (vitamins) (41%). Excessive buying of over-the counter (OTC) drugs (53%); self-discontinuation (17%) and expiration of drugs (24%) resulted in possession of unused/leftover medications at home (Table 3.5). Majority of students disposed medications in trash (94%). Rinsing down the sink (32%), flushing down the toilet (12%) and returning to pharmacy (3%) and storing in house (28%) were the other ways adopted to dispose the drugs. Solids (92%), liquids (74%) and semi-solid medications (94%) were disposed of in garbage. For liquid medications, rinsing in sink (18%) and flushing in toilet were also employed (3%). Semi solid medications (ointments and gels) were disposed in garbage (94%). Most students thought that municipality collection from home (43%) or returning to pharmacist (48%) were acceptable ways to dispose leftover expired drugs³².

Table 1.4: Number of unused/ left out drugs at students home³²

S. No	Number of unused/ left out medication	N (%)
1	0	11 (5%)
2	1-5	171 (72%)
3	6-10	44 (19%)
4	11-25	8 (3%)
5	> 25	2 (1%)

Table 1.5: Reasons for possession of unused/ leftout medication at home³²

S.No.	Reason	N (%)
1	Doctor changed treatment	12 (5%)
2	Doctor prescribed more than needed	21 (9%)
3	Self-discontinuation after condition resolved	33 (14%)

4	Leftover from previous over the counter drug purchase	126 (53%)
5	Passed expiry date	56 (24%)
6	Adverse effect to prescribed drug	9 (4%)
7	Others	7 (3%)

Disposal methods by Pharmacists

Pharmacist's knowledge and awareness towards safe medicine disposal is much needed and has to stand in front. A study on opinion of pharmacists towards disposal of unwanted medication in Kuwait, throwing unwanted medicines (UM) in the trash was the main method of disposal by majority of the respondents (73%). Only 23 pharmacists disposed according to the guidelines of Ministry of Health, Kuwait (MOH). However, about 82% were aware that improper disposal causes damage to the environment and 97% agree that it was their responsibility to protect the environment. About 86–88% of the pharmacists agree to have government hospital pharmacies and polyclinics as collection points for future take-back programs³³. A study by Kuspis in the same community found that only 5 percent of the pharmacies had consistent recommendations for their customers on drug disposal. In addition, 25 percent of the pharmacies said questions on drug disposal were handled by individual pharmacists only on consumer request²⁵. A survey on minimizing pharmaceutical waste, the role of the pharmacist in INDIA, one-fourth of pharmacists who underwent the survey admitted that they trashed the solid dosage forms (Table 1.6). Eighty nine percent of pharmacists stated that they were not taught about proper drug disposal in pharmacy schools. Many pharmacists were not clear (21-37%) as to how the pharmaceutical distributors dispose of drugs, though more than half of the respondents were confident that incineration was done for solid dosage forms, controlled and hazardous drugs. Most of the pharmacists took help of journals or workshops to get update information. However, knowledge about drug disposal and environmental impact of pharmaceutical waste was found to be inadequate. 58% admitted that drug disposal was linked to environmental pollution. 69%

could logically deduce that incineration was the best way to dispose unused/expired drugs. Most of the respondents (73%) agreed that drug-take backs should be regular events to manage unwanted medications. More than half of respondents acknowledged that redistributing usable drugs, short-term dispensing and educating public were good options to minimize wastage ³⁴.

Table 1.6: Method of disposal of expired/ leftover medication by pharmacists

Type of preparation	option was marked) ³⁴				
	Garbage (%)	Sink/ toilet (%)	Incineration (%)	Return to distributor (%)	Others (%)
Solids	24 (29)	-	-	58 (69)	2 (2)
Semi solids	13 (15)	-	-	71 (84)	-
Liquids	4 (5)	4 (5)	-	72 (86)	4 (5)
Controlled drugs	1 (1)	2 (2)	-	79 (94)	2 (2)
P-listed drugs	3 (4)	-	2 (2)	78 (93)	1 (1)

The best form of preventing unintentional poisoning and minimizing hazardous impact to environment can be achieved by practicing proper disposal of unused drug. Drug take back programmes afford proper drug disposal and these programmes were well implemented in many countries ¹⁸.

Conclusion

Hazardous pharmaceutical waste is a growing concern for all types of healthcare facilities, including pharmacies, hospitals, and clinics. It isn't limited to expired pharmaceuticals, either; vials and bags containing trace quantities of toxic substances, protective gear, spilled liquids and pills, and even packaging can be classified as pharmaceutical waste. As the global health care system expands, reaching more people and offering ever more sophisticated treatments, a silent and largely neglected crisis is unfolding. The ever growing amount of waste that is generated by

these lifesaving advances is not being treated properly, causing enormous suffering, pollution, unnecessary carbon emission, and waste of resources. Globally, health care waste management is underfunded and poorly implemented. The combined toxic infectious and other hazardous properties of medical waste represent a significant environmental and public health threat. By reducing and segregating health care waste, health care facilities can reduce their operational costs, eliminate risks to their staff, enhance the local environment and improve community relations. There are many options for the treatment and disposal of medical waste. Some work best in large facilities appropriate to major hospitals or centralized facilities, and others are best for low to middle income countries, small facilities and resource constrained settings.

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