



## SAFE DISPOSAL OF MEDICATION PRACTICES

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### Abstract

Unused and expired drug at home often carries the risk of accidental ingestion by children and pets moreover; it also creates confusion among geriatric patients receiving multiple drugs. Variation of disposal methods have been observed throughout the globe. Many studies throughout the world reported inappropriate disposal practices such as discard the unused medicines via the garbage, sink, and toilet. These methods ultimately have toxic effects on human and environment. Therefore, proper disposal of unused drug is paramount important. There must be some well designed disposal system for disposing of unused, unwanted, or expired drugs. Safe disposal methods as described by World Health Organization (WHO) are incinerations, inertization, returned to pharmacy or supplier, encapsulation, chemical decomposition. Therefore, these methods are required to be followed for safe disposal.

**Keywords:** Safe Disposal Methods, Disposal systems, Expired drugs, Incineration.

### Introduction

Drugs are one of the crucial requirements of today's world. Drugs are a powerful tool for eliminating the number of diseases from the human body. Numerous drugs have been identified and synthesized on regular basis (Mukherjee *et al.*, 2019; Wadhwa *et al.*, 2019). Drugs are an essential factor when it comes to improving health issues related to human beings, but the proper disposal of unused or expired drugs is equally essential. Disposal of unused prescription drugs is a significant concern. The unused drugs should be destroyed utterly to eliminate the toxic effects of on flora and fauna. The improper disposal of unused drugs could be the reason for the contamination of Surface, Ground and Drinking Water (Fick *et al.*, 2009). The EPA and the FDA want unwanted or expired drugs to dispose of completely (Cheek, 2018; Food and Drug Administration, 2017). Proper waste management system including distribution, control, and disposal not only helps the healthcare centres, but also promote environmental health (Management and disposal of healthcare waste (2013)). Even small quantities of unused or unwanted drugs except syrups should never be disposed of in the pharmaceutical bin that may be toxic to the human health and environment (Anand, 2019). There must be some proper system that principally designed for safe disposal of unused, unwanted, or expired drugs. Pharmaceutical waste is classified as hazardous and non-hazardous waste (Pharmaceutical Waste Management Best Practices (2012)). The pharmaceutical waste may consist of different forms such as strips, expired products or manufacturing wastes (Luthra *et al.*, 2015). The disposal of pharmaceutical waste isn't as straightforward as we might suspect. Hazardous pharmaceutical waste gives rise to higher risk as compared to non-hazardous pharmaceutical waste (Singh *et al.*, 2011).

The drugs that belong to hazardous waste material requires a special control regime (Halling-Sorensen *et al.*, 1998). Inappropriate disposal of medications like antineoplastic, antibiotics, and disinfectants may become hazardous to human health or the environment. Discharge of antibiotics and disinfectants in the sewage system may ruin the aquatic life or contamination of drinking water (Kümmerer, 2002). Unused prescription-oriented medication at home should never be disposed to bins or down the drains

because it also threatens the life of the children and pets (Proper use and disposal of medication. Ottawa (2012)). There are chances of accidental ingestion of unused prescription medication by the children and pets. Moreover, thrown them down the drains endanger the groundwater and wildlife. There might be a significant rise in drug pollution due to inappropriate drug disposal (Skinner *et al.*, 2017).

The volunteer for health centres must know the importance of proper drug disposal systems (Grimes *et al.*, 2018). World-leading organizations such as World Health Organization (WHO) and United Nations ICFE recommended several appropriate and safe drug disposal options and drug use prevention (World Health Organization, 1999; Abahussain *et al.*, 2006). The availability of different market products specially designed for safe disposal of controlled, uncontrolled, and over the counter medication is beneficial in the drug management system. World Health Organization (WHO) issued various guidelines concerning the safe disposal of unusable drugs. The process of disposal of pharmaceutical waste needs a lot of investment and resources. There are several methods available for the safe disposal of the drugs (World Health Organization (1999)). Several studies discovered the various options available for medication disposal in different nations around the world (Seehusen, 2006; Michael *et al.*, 2019; Braund *et al.*, 2009; Bashaar *et al.*, 2017). A cross-sectional study was conducted among twelve hundred patients to examine the attitude of consumers toward the disposal of unused and expired medications in Saudi Arabia (Al-Shareef *et al.*, 2016). It was discovered in the study that a large proportion of about 79.15% of individuals disposed of unused and expired medications via household waste whereas only 1.7% preferred returning the unusable medications to the pharmacies. About, 78.6% showed an interest in receiving information regarding appropriate disposal of unusable medication while 70.20% wanted to learn about appropriate and safe methods to dispose of unusable medication and their responsibility. The study has shown that almost 80% of individuals store unusable medication at home without concerning the possible consequences of storing medications at home (Jassal *et al.*, 2019). The author concluded that the lack of awareness regarding the appropriate method for safe

disposal among the Saudi population (Al-Shareef *et al.*, 2016).

A study was performed in Singur, Kolkata where one village was selected appropriately. This study discovered that 67.1% of the household's possessed unused medicines, similar observation was also reported by Banwat *et al.*, in Nigeria, where 65.8% of population stored the unused medicines at home. Around 34.4% of households had unused antacids followed by antipyretics (31.25%) and antibiotics (28.1%). The author concluded that recovery from illness before the prescribed duration was the common reason for storing unused medications at home. To address this problem drug take-back programs should be promoted across the country (Maharana *et al.*, (2017)).

#### Medication Disposal and Its Impacts on the Environment

Inappropriate disposal of pharmaceuticals could harm environmental health (Doerr-MacEwen *et al.*, 2006). Inappropriate disposal can lead to several consequences such as accidental childhood poisoning, antibiotic resistance, negative impacts on wildlife and environment pollution. It can seriously disturb the flora and fauna. Appropriate disposal of unusable drugs limit the number of issues related to the environment that could arise due to improper drug disposal (Srivastava, 2004). Inappropriate drug disposal can lead to severe environmental contamination problems. Besides, the concept of eco pharmacovigilance was introduced which principally focusing on "detection, assessment, understanding and prevention of adverse effects of pharmaceuticals in the environment (Medhi *et al.*, 2012). Some of the important methods of medications entering the environment are listed below

1. Medications stored at home are mostly thrown in the trash and down the drains which can enter the environment easily.
2. Unusable medications disposed of into the sewer system.
3. Humans disposed of unused home medications through sinks, toilets that can enter the water supply.
4. Throwing of unused medications on the roads, tanks, rivers, etc.

The determination of appropriate way for disposing of unused medications can predict the number of contamination problems of the environment (Chouhan and Prasad, 2016). The unintended side effects of medications on the aquatic life of animals and microorganisms have been observed in various safety and toxicology studies (Shunmugaperumal *et al.*, 2018; Boxall, 2004). Burning of unused or expired drugs in an open container released toxic contaminants into the air. There are several studies, evidence the toxic effects of medications on the environment which are disposed of inappropriately (Aalizadeh *et al.*, 2016; Ashauer *et al.*, 2010; Tim Aus der Beek *et al.*, 2016). The detection of traces of toxic compounds in the environment indicates the aquatic organisms' vulnerability to hazardous pharmaceutical waste (Miller, 2018). The high demand for antibiotics, Opium derived medications, synthetic hormones, contraceptives, and methods involved in their production can be considered as a threat to the environment.

According to the Mother Nature Network, approx. 41 million Americans have been detected with pharmaceuticals such as antibiotics, mood stabilizers, anti-convulsant and sex

hormones in their drinking water supplies. Unsafe levels of poly-fluoroalkyl and perfluoroalkyl substances (PFASs), has been in been observed in drinking water (Unsafe levels of toxic chemicals, 2016). In the United States of America, pharmaceuticals are not limited to surface water and sustained entering into underground water which includes a large part of water supply (Glassmeyer *et al.*, 2017). To resolve these alarming updates, more and more agencies, healthcare and community pharmacies are interacting with their customers appeal for the safe and eco-friendly disposal of medications. Concerning aquatic animals, a study found the presence of a significant concentration of contraceptives in fish populations due to the drugs flushed into the environment (Kolodziej *et al.*, 2004). There are certain ways where the public can dispose of medications in a safe and eco-friendly manner. Take back programs is a recommended method in which medications are collected from the designated site for safe disposal. Drug enforcement administration, health care centres, and long-term care facilities also promoting the take-back programs and pharmaceutical collection events for safe disposal (National Prescription Drug Take Back Day (2019)). The Drug Enforcement Agency (DEA) has collected approximately 4.1 million-pound medicines in only eight days by promoting the national "Take-Back Days" (National Take-Back Initiative (2019).

#### Ideal Methods for Disposal of Unused Drugs

The unusable drugs should be disposed of according to their categories (Table 1). The selection of a suitable method for safe disposal of unusable drugs makes the process easy and cost-effective. The sorting system of the material makes it less complicated and economical. The sorting of material is an essential factor to consider when selecting a suitable method of disposal. Based on the sorting of material, an unusable drug may be disposed of safely and effectively (World Health Organization (1999)). The recommended methods of disposal of unused drugs as per their sorting categories are briefly described in WHO guidelines (World Health Organization, 1999).

**Returned to Supplier:** Unusable drugs returned to the Supplier are for the safe disposal of drugs. The drugs which are about to out of date could be returned to the Supplier or manufacturer for disposal. The expired or unwanted drugs come under hazardous waste where the proper disposal system is needed (World Health Organization, 1999).

**Encapsulation:** This method is a part of waste immobilization. Encapsulation is a process where pharmaceuticals are immobilized in a solid block within a steel drum or plastic. Encapsulation offers a wide range of benefits in immobilizing pharmaceutical waste. The steel drums or plastic should be emptied and appropriately cleaned that a small quantity of previously-stored hazardous material should not be present in it. Cement or cement/lime mixture is used to immobilize solid or semi-solid pharmaceutical with a large amount of water after filling with the desired pharmaceutical of 75% of the total capacity of the drum (Guideline for Disposal of Pharmaceutical waste (2014).

**Inertization:** This process is an alternative to encapsulation and useful in the disposal of unwanted drugs. In this process, the hazard potential of the waste gets reduced by converting their adulterants into inert form. It involves solidification and stabilization of pharmaceuticals waste by

mixing it with cement or lime mixture and water. Grinder and immobilizers are the main requirements of this technique. This process does not require sophisticated equipment and comparatively cheap and safe (Guidelines for the Safe Handling and Disposal of Chemicals Used in the Illicit Manufacture of Drugs (2011)).

**Incineration:** Incineration is an inexpensive and viable alternative to expensive and sophisticated equipment. Incineration involves the breakage of chemical bonds in the drug and makes them nontoxic. Unused drugs placed in the primary combustion chamber that render the drug into ash and are disposed to specially designed landfills according to the disposal regulations (Guidelines for the Safe Handling and Disposal of Chemicals Used in the Illicit Manufacture of Drugs (2011)).

**Landfills:** Landfills involves pharmaceutical waste is to place directly into disposal land site without any treatment or preparation. Landfills are the oldest and widely used method for the disposal of solid pharmaceutical waste (Kumar *et al.*, 2016). Landfills offer three types named open, uncontrolled non-engineered dump, engineered dump, and highly engineered sanitary landfills (Bell, 1973).

**Chemical Decomposition:** Chemical method involves the usage of chemicals under the manufacturer and chemical expertise recommendation. Small quantities of drugs like antineoplastic agents can be disposed of with the help of recommended chemicals. This method can be used in the absence of a suitable incinerator, followed by Landfills (Safe disposal and Management of unused, Unwanted Contraceptives (2013)).

**Table 1:** Medication disposal practices followed in various countries are presented below:

Year of the study	Authors	Place	Study design and sample size	Participants characteristics	Ref.
2017	Bashaar <i>et al.</i>	Afganistan	Cross sectional study, 300 samples	73.4% were men and 26.6% were women, maximum respondents were more than 32 years.	(Bashaar <i>et al.</i> , 2017)
1996	Kuspis <i>et al.</i>	USA	Cross-sectional survey involving 500 participants.	500 callers to poison information center.	(Kuspis <i>et al.</i> , 1996)
2019	Michael <i>et al.</i> ,	Nigeria	Cross-sectional survey, 77 community pharmacy	77 community pharmacy	(Michael <i>et al.</i> , 2019)
2019	Sivasankaran <i>et al.</i>	India	Cross sectional study, 1000 participants from the rural and urban areas.	Females (50.9%) and males (49.1%), majority of the respondents were in between the age group of 31-50 years (44.8%).	(Sivasankaran <i>et al.</i> , 2019)
2017	Al Azmi <i>et al.</i>	Saudi Arabia	Cross sectional study among 1171 participants	Male and female person of age more than 16 years of age	(Al Azmi <i>et al.</i> , 2017)
2007	Abahussain <i>et al.</i>	Kuwait	Convenience sampling among 250 households	250 households	(Abahussain <i>et al.</i> , 2007)
2012	Kusturica <i>et al.</i>	Serbia	208 families, random sample	208 (108 urban and 100 rural)	(Kusturica <i>et al.</i> , 2012)
2017	Ahmet <i>et al.</i>	Turkey	1121 company employees, convenience sampling	multi-centered private-sector company, mean age of 28.5 ± 5.1, women (69.7%), half of the participants (49.4%) were living with <4 household members	(Ahmet <i>et al.</i> , 2017)

A study in Kabul, Afghanistan reported that 77.7% of respondents through the expired medication in trash, despite of having well awareness about its environmental impact (Bashaar *et al.*, 2017). A study in Turkey reported that 28% people keep their medicines at home (Kusturica *et al.*, 2012). Approximately one-third of respondents discarded their unused medicines via the “garbage, sink, toilet” and 34% people returned to health facility. A study in Nijeria reported that disposal methods were varied among respondents. The various methods used by the respondents were found to be junk or ordinary municipal waste, sink, toilet, NAFDAC bin, pharmaceutical distributors and burning (Hassan, 2018). About 29.6% respondents used sink for liquid dosage form, and a small proportion of respondents (23.4%) complied fully with the national guideline on disposal of expired drugs (Bala *et al.*, 2015; Michael *et al.*, 2019).

A total of 500 people interviewed in a study conducted in USA, in which 1.4% respondents returned medications to pharmacy, 54% discarded their medicines in the garbage, and 35.4% flushed medications down the toilet or sink, 7.2% did not discard their medications, and only 2% participants reported that they used all the medicines before the expiry date (Sivasankaran *et al.*, 2019). An Indian study reported that 58.3% respondents stored unwanted or unused medicines in their home and 29.3% had expired medications. Trash (78.6%) was the most common method they followed for disposal of unwanted drugs. Study from Kuwait also reported a high (97%) of the respondents stated they disposed of their medication in the garbage (Abahussain *et al.*, 2007). Similiar observation was also documented in Serbia, 85.6 % of urban and 74.5% of rural population disposed their medications in the garbage (Kusturica *et al.*, 2012). Study from Saudi Arabia also reported a high percentage of population (73%) throw

the medications in the trash while only 14% return to a pharmacy (Ahmet *et al.*, 2017).

#### 4. Actions required

The various problems due to the inappropriate disposal of unused or expired medications call for a permanent solution for promoting the public health and environment as well. Some of the safe and eco-friendly options for appropriate drug disposal are listed below

1. Take participation in the National Prescription Drug Take-Back program promoted by the Drug Enforcement Administration for safe and eco-friendly disposal (2).
2. Flush unused medication into the sink or toilets that covers FDA flush list (3).
3. Request community groups to collect unused or expired medication.
4. Dispose of unwanted medication as per the specific disposal instruction is given on prescription drug labelling or patient information.
5. Do not throw prescribed and non-prescribed in the household trash or down the drains.
6. If Take-Back service is unavailable at your location, then only dispose of medication in the trash after removing personal information on the prescription label.
7. Syrups can be disposed of into the sewer system by diluting it with a large amount of water (Singh & Sikarwar (2019)).
8. Place the unwanted drug in a sealed container or a specially designed bag for disposal after mixing with the inert substance such as coffee.

#### Conclusion

Even though Drug Enforcement Administration created several options for appropriate drug disposal such as Take-Back programs, but the detection of traces of pharmaceuticals in the environment could be attributed to inappropriate drug disposal system. The developed countries like United States, United Kingdom, Australia and Canada encouraged the pharmacies to take back unused medications from patients and educate them about the various methods available for the safe disposal. The lack of knowledge of Pharmacists and Patients about appropriate disposal of drugs which was commonly found in several Asian Regions harms the environmental health.

#### Conflicts of Interest

The authors declare no conflict of interest.

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