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 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 ICEF 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 disposed 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 disposed 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 (Shumugaperumal 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-fluorinated alkyl and perfluorinated alkyl 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 into 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>
<thead>
<tr>
<th>Year of the study</th>
<th>Authors</th>
<th>Place</th>
<th>Study design and sample size</th>
<th>Participants characteristics</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>Bashaar et al.</td>
<td>Afghanistan</td>
<td>Cross sectional study, 300 samples</td>
<td>73.4% were men and 80% were women, maximum respondents were more than 32 years.</td>
<td>(Bashaar et al., 2017)</td>
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<tr>
<td>1996</td>
<td>Kuspis et al.</td>
<td>USA</td>
<td>Cross-sectional survey involving 500 participants</td>
<td>500 callers to poison information center.</td>
<td>(Kuspis et al., 1996)</td>
</tr>
<tr>
<td>2019</td>
<td>Michael et al.,</td>
<td>Nigeria</td>
<td>Cross-sectional survey, 77 community pharmacy</td>
<td>77 community pharmacy</td>
<td>(Michael et al., 2019)</td>
</tr>
<tr>
<td>2019</td>
<td>Sivasankaran et al.</td>
<td>India</td>
<td>Cross sectional study, 1000 participants from the rural and urban areas.</td>
<td>Females (50.9%) and males (49.1%), majority of the respondents were in between the age group of 31-50 years (44.8%).</td>
<td>(Sivasankaran et al., 2019)</td>
</tr>
<tr>
<td>2017</td>
<td>Al Azmi et al.</td>
<td>Saudi Arabia</td>
<td>Cross sectional study among 1171 participants</td>
<td>Male and female person of age more than 16 years of age</td>
<td>(Al Azmi et al., 2017)</td>
</tr>
<tr>
<td>2007</td>
<td>Abahussain et al.</td>
<td>Kuwait</td>
<td>Convenience sampling among 250 households</td>
<td>250 households</td>
<td>(Abahussain et al., 2007)</td>
</tr>
<tr>
<td>2012</td>
<td>Kusturica et al.</td>
<td>Serbia</td>
<td>208 families, random sample</td>
<td>208 (108 urban and 100 rural)</td>
<td>(Kusturica et al., 2012)</td>
</tr>
<tr>
<td>2017</td>
<td>Ahmet et al.</td>
<td>Turkey</td>
<td>1121 company employees, convenience sampling</td>
<td>multi-centered private-sector company, mean age of 28.5 ± 5.1, women (69.7%), half of the participants (49.4%) were living with &lt;4 household members</td>
<td>(Ahmet et al., 2017)</td>
</tr>
</tbody>
</table>

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). Similar 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.

**Acknowledgement**

The authors are thankful to Lovely Professional University, Phagwara for providing the support.

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