

**A RECENT OVERVIEW ON THE FACTORS INFLUENCING
STORAGE AND DISPOSAL OF MEDICINES****M. Ranga Priya*, A. Durga, M. Jagan, P. Kalaiselvi, G. Madhan, R. Manivannan**

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ABSTRACT

The usage of medications has grown drastically on a global scale, which has led to a rise in the number of medications kept in homes. But a large percentage of medications go unused, expire, and eventually end up in the trash. The first consumer guidelines for the appropriate disposal of prescription medicines were created by the FDA in collaboration with the White House Office of National Drug Control Policy (ONDCP) in February 2007 and revised in October 2009. Any special disposal guidelines on the medication's label or patient information must be adhered to. Improper storage conditions can reduce the effectiveness of medicines and increase the risk of accidental poisoning, drug misuse, and health hazards, especially among children. In addition, unsafe disposal practices such as throwing medicines into household waste or flushing them into water systems contribute to environmental

pollution and antimicrobial resistance. Healthcare professionals, particularly doctors and pharmacists, should actively educate patients and encourage responsible medication management. The implementation of medicine take-back programs and clear disposal guidelines can further promote safe practices and protect both public health and the environment.

KEYWORDS: disposal of medicines; storage of drugs; drug abuse; medication take back; shelf life of drugs; expiry of drugs.

INTRODUCTION

The usage of medications has grown drastically on a global scale, which has led to a rise in the number of medications kept in homes. But a large percentage of medications go unused, expire, and eventually end up in the trash.^[1]

Approximately half of patients do not take their prescription drugs as directed, according to the World Health Organization (WHO). The accumulation of pharmaceuticals in the home is caused by a high prevalence of medication non-adherence. The patient's symptoms improve, the medicine becomes ineffective, or the medication expires because of the modifications made to the treatment plan. Due to the limited supply of certain medications, patients may inadvertently lose the chance to enhance the health of others by keeping them in their homes. Additionally, patients think that if they preserve unused prescriptions, they might use them for similar diseases in the future.^[2]

Storage is important as it preserves the potency of medicines. Their photosensitive, hygroscopic and thermolabile drugs should be kept away from light, moisture-free and stored at refrigerator. The medication can become ineffective, unusable and eventually a waste if not stored in the appropriate manner.^[2]

Developed nations like Australia and the United States have set rules and regulations to enhance proper disposal and storage of leftover pharmaceuticals. The creation of guidelines is a reaction to the increasing concerns about poor drug storage and disposal methods, which have escalated to concerning proportions in industrialized nations such as the United States, Canada, and Europe. People in developing nations like Saudi Arabia, Kuwait, and Qatar have been found to store large quantities of unnecessary drugs in unsuitable settings. Similar to Jordan, these nations do not have official rules for how unwanted medications should be disposed of, and there is a clear lack of implementation of well-established pharmaceutical waste management policies, which leads to the improper handling of such trash.^[2]

STORAGE OF MEDICINES

Pattern of storage

It determined the pattern of storing the medicines in the home like the kitchen, bedroom, fridge, shelf, boxes, cupboard, depends on the label.^[3]

Reasons to store

It investigated the reasons of keeping excessive unwanted or unused and expired medicines in the home like changes in the prescription, medicine expired, self-discontinuation, expecting future need and medication didn't suit.^[3]

STORAGE CONDITIONS AND LOCATIONS

Medications stored in households are either in use, unused, unwanted or expired. Along with medication storage, they checked the temperature and humidity of six different storage locations (two bathrooms, one bedroom and three kitchens) in households.^[4]

Surveys were conducted to record medication storage locations. The bathroom, bedroom and kitchen were the most common locations to store medications.^[4]

The presence of kids in the home appears to influence how medications are stored. Life-threatening outcomes could result from kids accidentally consuming a drug owing to carelessness over the storage placement. Children under the age of twelve had the highest rate of accidental poison exposures in 2018, according to the National Capital Poison Center (NCPC). Teenagers had the largest percentage of mortality from both purposeful and accidental medicine exposures, accounting for roughly 20% of all exposures. It is believed that the drugs are kept in places where kids can easily get them.^[4]

Medicines must be kept in a secure area so that a child, teenager, pet or even a stranger does not have access to them therefore preventing accidental poisoning.

- Medicines must be kept separate from that of other family members, on different shelves or at least on a separate side of the shelf. This will make taking the wrong medication less likely.
- Medicines must be stored in the original dispensed packs, and the assigned labels should not be removed from the medication. (This ensures that the correct medication in the correct dosage is consumed.)
- Storage advice on the label should be followed to ensure that healthcare products remain effective until their use-by dates.
- Heat and dampness can badly affect some healthcare products. These products should not be stored in the bathroom, near a sink, on windowsills or in a car. Some products may need to be stored in the refrigerator.
- Lids on bottles must be kept tightly closed. A cap cannot be child or waterproof if it is not fastened properly.

- If there is cotton in the bottle when first opened, it should be removed and thrown away. The cotton can absorb moisture and affect the medicine.
- Expired medication and discontinued medication should be kept in a separate and secure area for return to the pharmacy for disposal.^[5]

DISPOSAL OF MEDICINES

The buildup of unused and expired medications (UEM) in households is an increasing public health and environmental concern, despite the evident benefits of increased pharmaceutical usage worldwide. By introducing active pharmaceutical compounds into soil and water systems, improper disposal techniques including burning, flushing, or throwing UEM into household waste contribute to ecotoxicological effects and the emergence of antimicrobial resistance (AMR). This problem is made worse by estimates from the World Health Organization (WHO) that a significant percentage of medications are prescribed, delivered, or utilized improperly globally. Unsafe disposal is still a frequent household practice, according to studies conducted in a variety of contexts.^[6]

FACTORS INFLUENCING STORAGE & DISPOSAL OF MEDICINES

Expiry date: The manufacturing and expiration dates of pharmaceuticals are important considerations for home storage. One of the key elements affecting drug storage at home was the storage environment. Variance analysis and multivariable logistic regression models show that age is the most significant factor in pharmaceutical home storage behaviour. We discovered that as people age, they pay more attention to how they store their medications at home due to the rise in illnesses and medication use.^[7]

Storage environment: Another crucial aspect that needs research is where medications are kept at home. Poor pharmaceutical storage practices include keeping several medications in the incorrect places. Unorganized medication storage in inappropriate locations within homes can result in accelerated degradation, child health risks, and resource waste.^[7]

Storage places: Most households focused on keeping medications out of kitchens and toilets and away from kids. To keep medications out of children's reach, most homes kept a medicine cabinet. Due to the possibility of exposure to high temperatures and humidity, a significant percentage of households deemed the kitchen and bathroom to be unsuitable locations for storing medications. Once more, these results are consistent with another earlier study.^[7]

Attitudes to medicine disposal: Greater access to convenient disposal locations, like community pharmacies, would help control inappropriate medicine disposal. Attitudes regarding the disposal of medicines play a crucial role in home storage, especially for expired medicines. Expired medications in the home pose a serious health and safety risk. Lack of an efficient recycling mechanism will lead to illegal medicine acquisition and environmental pollution.^[7]

SHELF LIFE AND EXPIRY DATE OF MEDICINES

The term "medication shelf life" describes how long a drug, when maintained properly, maintains its potency, efficacy, and safety. The amount of time that a pharmaceutical product is anticipated to stay within predetermined potency specifications while stored under specific conditions is known as its shelf life. useful shelf-life management guarantees that drugs continue to be therapeutically useful and do not endanger patient safety. For both patient safety and therapeutic efficacy, medicinal items must remain intact throughout their shelf life. Determining shelf life and adhering to expiration dates are essential for meeting quality requirements and complying with regulations. To guarantee the quality and safety of their products, manufacturers are required by regulatory bodies to set and verify shelf-life restrictions. In healthcare settings, optimizing shelf-life lowers waste and increases cost-effectiveness.^[8]

The end of the medication's usable life is indicated by the expiration date. The storage period ranged from 0 to 93 weeks, with an average of about 10 weeks. Adverse effects can result from expired medications. For instance, tetracycline that has expired can be poisonous and impair kidney and liver function. Taking them after they've expired could harm your kidneys and liver. It is necessary to develop strategies that explicitly target medical professionals like doctors and pharmacists to reduce wasted or expired medications. To encourage healthy lifestyles, medical providers should decrease prescribing practices by cutting back on excessive dosages and/or the usage of needless medications.^[7]

DISPOSAL OF UNUSED / EXPIRED MEDICATIONS

Disposing of unused or expired medications must be done responsibly to protect persons and the environment. Returning medications to the appropriate authorities or location and burning them under supervision are considered proper disposal methods. Throwing medications in the trash, flushing them down the sink or toilet, or burning them illegally are all considered improper disposal methods.^[9]

Returning unwanted or expired medications to donors, makers, suppliers (community pharmacies), dispensing physicians, the Food and Drug Administration (FDA), drug take-back sites, or programs is advised. Certain forms of medicines, such as solids, semisolids, powders, antineoplastics, and restricted drugs, should be immobilized by encapsulation, inertization, and high temperature burning at temperatures significantly higher than 1200 °C. When high temperature incinerators are not available, medications other than antineoplastics should be destroyed using medium temperature incineration in a two-chamber incinerator with a minimum temperature of 850 °C. However, burning medications in open containers is not advised.^[9]

Pressurized medications such as metered dose inhaler/nasal spray can be disposed in the garbage as normal waste where Ireland do not recommend disposing medicines as a household waste. According to WHO and guidelines from Ireland, Malaysia, Sri Lanka and United Kingdom, disposing medicines into the mains water drainage system is not recommended whereas in US, FDA's flush list allows some medicines to be flushed down the toilet.^[9]

Lack of awareness campaigns, insufficient information on safe disposal practices and appropriate dispensing guidance, and ignorance of safe disposal are factors associated with knowledge. Participants in studies carried out in Serbia, Nigeria, and Uganda were found to be unaware about how to properly dispose of unused medications. In Ethiopia, China, Pakistan, Lebanon, and Brazil, over 80% of participants concurred that they did not receive sufficient information or appropriate instructions for safe disposal. According to an Indian survey, all participants felt that there aren't enough awareness campaigns about appropriate disposal in their nation. In a survey conducted in Uganda, about half of the participants stated that there were insufficient awareness campaigns and unclear directions on the prescription box.^[9]

HAZARDS OF UNSAFE STORAGE AND DISPOSAL OF PRESCRIBED DRUGS POISONING

A needless health risk is created in the house when medications are kept after they are no longer needed, particularly when children are present. It is impossible to totally stop a youngster from consuming someone else's medications, even with child-resistant containers. In research that examined instances of unintentional child exposure to grandparents' medications, 45% of the incidents involved children under the age of six and medications kept in child-resistant containers. In North Carolina, over the counter and prescription medications

account for 75% of all accidental poisonings.^[10]

The American Association of Poison Control Centers' 2007 annual report details several poisoning instances, such as one in which a two-year-old boy was found not breathing after consuming the opioid medication methadone from a bottle. A 4-year-old girl overdosed and died after consuming a fentanyl patch that had been thrown in the trash.^[11]

DRUG ABUSE

The fastest-growing drug problem in the country is prescription drug usage. Over the past ten years, the prevalence of prescription drug usage in America has increased to the point where it is now referred to as an epidemic. Prescription medicines are the second most abused class of narcotics after marijuana, according to the nation's largest survey on drug use among youth. According to estimates from the National Institute on Drug Abuse, 20% of Americans will use prescription medications for non-medical purposes at some point in their lives. Nowadays, a lot of teenagers are ignorant about the risks and potential for addiction associated with prescription medicines. Because they are prescribed by a doctor, individuals mistakenly believe that prescription medications are safer and less addictive than illicit substances.^[12]

Numerous research consistently reports on the increasing prevalence of abuse. Nearly 10% of 12th graders took Vicodin9 (acetaminophen), according to the National Institute on Drug Abuse in 2007. According to the North Carolina Youth Risk Behaviour Survey (YRBS), 20.5% of high school students had used oxycontin, an opioid painkiller, at least once in their lives. The Obama Administration Strategy was expanded upon in 2011 with the Prescription Abuse Prevention Plan, which focuses on four main areas to prevent prescription drug abuse: education, drug monitoring programs, proper medical disposal, and law enforcement. Although precise statistics are unavailable, prescription drug misuse is a concern in India as well.^[13]

ENVIRONMENTAL POLLUTION

The ecosystem and our water supplies are at risk due to improper disposal of unused pharmaceuticals. Through human excretion and inappropriate drug disposal, active pharmaceutical substances are contaminating the environment and getting into our drinking water. An estimated 46 million Americans' drinking water contains dozens of pharmacological medications, including sex hormones, mood stabilizers, antibiotics, and anticonvulsants.^[11] Several locations in India have also reported similar issues. Additionally, drinking this

antibiotic-contaminated water increases the chance of developing resistance to certain drugs. Fish and other aquatic creatures are also harmed by these poisons that are present in water. Male fish may acquire female traits due to certain medications (hormones). Frequently, these "intersex fish" don't procreate.^[14]

Implementing a safer, more effective drug disposal system is therefore becoming more and more crucial due to the negative consequences associated with unused, incorrectly disposed or kept pharmaceuticals.^[14]

MEDICATION TAKE-BACK PROGRAMS

The take-back program ensures that drugs are disposed of properly and eliminates hazards to the population and environment. In the United States, this method of disposal is used. The take-back program has various modes. Law enforcement agencies have "permanent collection sites" in its lobby. Every site has steel collection containers in the lobby that are lockable. These containers are filled with unwanted drugs. Law enforcement personnel empty the bins before they are burned at facilities approved by the Department of Environmental Quality (DEQ). Additionally, DEQ promotes "Clean Out Your Medicine Cabinet" "community medication" take-back programs. Medication take-back activities are sponsored by numerous community organizations; however, they must be approved by the Drug Enforcement Agency (DEA). In the United States, the Drug Enforcement Administration organizes "one day" prescription takeback initiatives. Community-based programs have the biggest impact. Over 121 tons of unused, expired, or unwanted prescriptions were collected at the first one-day medication take-back event, which took place on September 25, 2010, and was a huge success across the United States. The date of the National Take Back Program was set for October 26, 2013. Maine's "mail-back program," which was introduced in 2007, enables citizens to securely get rid of unwanted medications by sending envelopes to the DEA.¹⁴ The take-back program's success and favourable outcomes provide compelling evidence that it is the best disposal option available in the United States.^[15]

Legal restrictions may make it impossible for pharmacies or take-back programs to accept medications that contain banned narcotics, making them difficult to locate. The "Controlled Substance Act" mandates that a law enforcement official be present while disposing of prohibited substances. Other obstacles include the expense of organizing an event or running a take-back program, as well as the cost of destroying all medications that are gathered.^[16,17]

GUIDELINES FOR PROPER STORAGE OF PRESCRIBED DRUGS

Organize your medications

Examining all your medications is the first step in organizing yourself. Conduct this kind of inventory at least once a year, or every six months. Verify the expiration date first. It is best to discard medications that have expired. Additionally, keep an eye out for medications that are crumbled, dried out, or discoloured; if you find any, throw them away. Next, search for any remaining prescription medications from a prior sickness. You should never attempt to treat yourself (or anybody else) with leftover prescription medications, so discard these as much as you can.^[18]

Where to keep the prescribed medicine

Once arranged, medications should be stored in a medicine cabinet in a dry, cool, and secure location. We frequently witness medications being stored in the refrigerator's door compartment, which ought to be discouraged. Few medications need to be refrigerated, and those that do should be stored according to the directions.^[18]

How to keep the prescribed medicine

Put your medications in a drawer or cabinet if there are kids present. Additionally, any prescribed controlled narcotics (such as painkillers and CNS stimulants) must be locked away and kept out of the hands of young people who may abuse prescription medications, which is a major issue. To avoid accidentally taking the wrong medication, keep your medications apart from those of your family. To ensure you are taking the correct medication, keep medications in well-lit areas. Keep the medication in its original bottle (certain medications are stored in amber-coloured bottles to protect them from sunlight). If necessary, you can view the information on the bottle.^[18]

Guidelines for proper disposal of prescribed drugs

A growing health concern is the proper disposal of medications. The first consumer guidelines for the appropriate disposal of prescription medicines were created by the FDA in collaboration with the White House Office of National Drug Control Policy (ONDCP) in February 2007 and revised in October 2009. Any special disposal guidelines on the medication's label or patient information must be adhered to. When your prescription medications are no longer needed, federal guidelines provide various methods for getting rid of them.^[18]

RECTIFICATIONS

Proper education to society

People in our culture need to be taught how to properly store and dispose of prescription medications. This problem is not well known in India. A number of actions at various levels must be taken before it becomes an issue. Medical students from various medical schools can conduct awareness campaigns by conducting surveys and informing the public on how to properly store and dispose of prescription medications. Pharmacology or Preventive and Social Medicine (PSM) departments may handle this.^[15]

Additionally, law enforcement and awareness campaigns should be implemented by our government to ensure that prescription medications are stored and disposed of properly. Health care providers, pharmacists, and other social groups should take the initiative to work on a prescription medication take-back program.^[15]

Doctors Role: To reduce the issue of wasted medications and their storage and disposal, doctors should refrain from overprescribing. Additionally, this could lessen societal resistance and the financial cost. Over-the-counter medications should be monitored.^[16]

Pharmacists' role: For individuals who are unsure about how to store their medications, a pharmacist is a reliable source. It's critical that other medical workers understand how to appropriately store medications. Many patients may have a nurse visit them at home to help with everyday duties like administering medicine. A nurse or caregiver should carefully check medication storage settings to make sure the medications are kept properly and don't exhibit any signs of deterioration.^[19]

Pharmacists need to step in and take a more active role in teaching patients about medication safety, storage, and disposal. Free drug disposal services at pharmacies, patient education regarding DEA (Drug Enforcement Agency) Drug Take Back Day of drug repository programs, and a list of drugs on the FDA "flush" list are some services that pharmacists could provide. Even though it could appear insignificant in comparison to drug uses, instructions, and side effects, medication storage should be a counselling topic in every session. Negative patient outcomes can still result from improper storage.^[19]

In order to prevent illness and adverse consequences, pharmacists should instruct patients on how to store their prescriptions properly and identify any signs of deterioration. According to

Gallup's annual study, pharmacists are the fourth most trusted profession in 2019 and are among the most approachable healthcare providers.^[20]

CONCLUSION

The Study highlights the storage and disposal of medicines in households is an important public health and environmental issue. Many people keep unused, expired, or unwanted medicines at home due to future expectations of use, changes in treatment, or lack of awareness about proper disposal methods. Improper storage conditions can reduce the effectiveness of medicines and increase the risk of accidental poisoning, drug misuse, and health hazards, especially among children. In addition, unsafe disposal practices such as throwing medicines into household waste or flushing them into water systems contribute to environmental pollution and antimicrobial resistance. Therefore, improving public knowledge and awareness regarding safe storage and disposal practices is essential. Healthcare professionals, particularly doctors and pharmacists, should actively educate patients and encourage responsible medication management. The implementation of medicine take-back programs and clear disposal guidelines can further promote safe practices and protect both public health and the environment.

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