

REVIEW ON DISPOSAL OF EXPIRED AND UNUSED MEDICINE

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Abstract: Medicines play a very significant role for treating many diseases and conditions, but at the end of the treatment it is very important to dispose them of properly. So, the knowledge and awareness of proper drug disposal are essential for safe environment. Lack of knowledge and practice can lead to various problems like environmental pollution and various health hazards directly or indirectly. Hence, the study was aimed to assess the knowledge, practice, and awareness towards disposal of unused/expired drugs among healthcare professionals such as doctor, medical students, pharmacy students and nurses. The review aims to understand societal behaviour regarding the disposal of unused and expired medications and develop a prototype of a knowledge-based system that helps raise awareness of correct disposal methods for unused and expired medications. This review study will be an eye opener and key tool to initiate effective medical waste management programmes in India.

Keywords: Drug Disposal, Expired Medicines, unused medicines.

INTRODUCTION

A drug is a chemical substance introduced into the body to cure a disease or medical condition, relieve the symptoms of a particular disease, or simply prevent disease ^[1]. Drugs play an important role in our daily lives, but advances in the medical field have greatly contributed to the significant increase in drug waste. This is due to an increase in patient numbers and overprescribing by healthcare providers. The resulting drugs and drug waste have resulted in biological disease, ethical challenges, and negative environmental consequences ^[2, 3].

It is important to raise awareness about how to properly dispose of expired medicines and what to do with unused medicines. The pharmaceutical sector is one of the growing healthcare sectors due to the increasing consumption of pharmaceuticals worldwide.

It improves availability, accessibility and affordability, contributing significantly to the global economy. In countries such as India and China, the world's drug consumption is increasing day by day ^[4]. In the global pharmaceutical market, India ranks fifth in terms of mass production ^[5]. In India, pharmaceutical business includes pharmaceutical manufacturing, final dose manufacturing, excipient synthesis, impurity analysis, and raw material evaluation ^[6, 7]. Research indicates that many of these products will eventually be obsolete or expired ^[8-10]. According to WHO, 50% of medicines are improperly prescribed, dispensed or marketed, and half of all patients do not take them properly ^[11]. If they are not consumed, they remain unused and wasted.

Household accumulation of leftover, unused or expired drugs, and their improper disposal are also contamination hazards. Drug accumulation can be due to changes in prescriptions, changes in drug dosage, drug expiration dates, improvement from illness, etc. ^[12-15]. Another way for the general public to store drugs indoors is for future use ^[16,17].

Expired drug waste results in enormous financial losses economically. During storage, drugs can change their physicochemical properties, and storage of expired drugs can also lead to drug abuse and accidental addiction ^[16]. Studies conducted to estimate the annual economic loss of over US\$1 billion due to unused and expired medicines suffered by the US and Australian populations ^[25,26]. A similar situation has been observed in many other developed countries. Even more frustrating is the loss of expired medicines in many developing countries. The end products of expired drugs are often toxic and biologically active. It can lead to antibiotic resistance, treatment failure, carcinogenicity and is a threat to ecosystems if not disposed of properly.

According to the World Health Organization (WHO), medical waste is defined as “waste arising from the diagnosis, treatment or vaccination of humans or animals” ^[18]. Dangerous and polluting environmental risks ^[19]. Using peer-reviewed literature from 2005 to 2015, Kusturica et al. ^[20] observed that there are no guidelines or standards for the disposal of unwanted drugs.

Another review of unused drug disposal practices around the world found that the most common way to dispose of solid dosage forms at home was to throw them in the trash (24% to 89%), whereas liquid dosage forms. It turns out to be by pouring, Flush the sewer, Toilet or washbasin (2%-55%).

In addition to waste from pharmaceutical companies, the contribution to environmental pollution is dominated by unused and expired medicines from households. Some drugs, such as cocaine, oral contraceptives, carbamazepine, and iodinated contrast agents, are not completely eliminated by the treatment process and leave traces in environmental waters ^[28,29]. Apart from these, there are many other drugs found in the aquatic environment, such as fluoroquinolones, hormones, paracetamol, and diclofenac. In many developed countries, with the full support of pharmaceutical companies and governments, unused medicines are recycled and users return unwanted medicines. We are implementing a program to do this ^[22]. Community pharmacies in developed countries are responsible for collecting unused medicines and providing information on safe disposal. However, in many countries such systems are still restricted, promoting safety drug disposal practices ^[23].

In Asia, India has a population of about 1.36 billion, and both traditional medicine (Ayurveda, Siddha, Unani, herbs, naturopathy, homeopathy) and modern medicine are widely used. In most households, the drugs used do not match what the doctor prescribes and are discontinued when the condition resolves or side effects occur. These drugs are often taken without consulting a doctor. There are hidden dangers in home storage of this unused medicine. In India, standard disposal practices for unused and expired medicines include direct disposal into the environment. People are completely unaware of the consequences of unsafe drug disposal methods. Even health care professionals are clueless about drug disposal practices ^[30].

Unused and expired pharmaceuticals are considered municipal solid waste, and many local governments are also unaware of proper pharmaceutical disposal practices. Incineration is believed to be similar to burning plastic waste due to the physical appearance of the packaging. India does not have any regulatory body, monitoring system or working guidelines for the disposal of expired medicines. For generic drugs, the medicine is dispensed directly from the pharmacy. Generic drugs are purchased, stored and used in greater

volumes in the public health system than in private pharmacies. Branded medicines are taken from sellers by pharmaceutical companies and their disposal is the responsibility of the company^[31]. Pharmaceutical waste from the processing industry is disposed of in accordance with the Biomedical Waste Management Regulations 2016. However, there is a lack of awareness in India on proper disposal and provision of proper systems in each household^[19]. According to India's Central Pollution Control Board, registered health facilities generate approximately 4,057 tons of waste per day^[32].

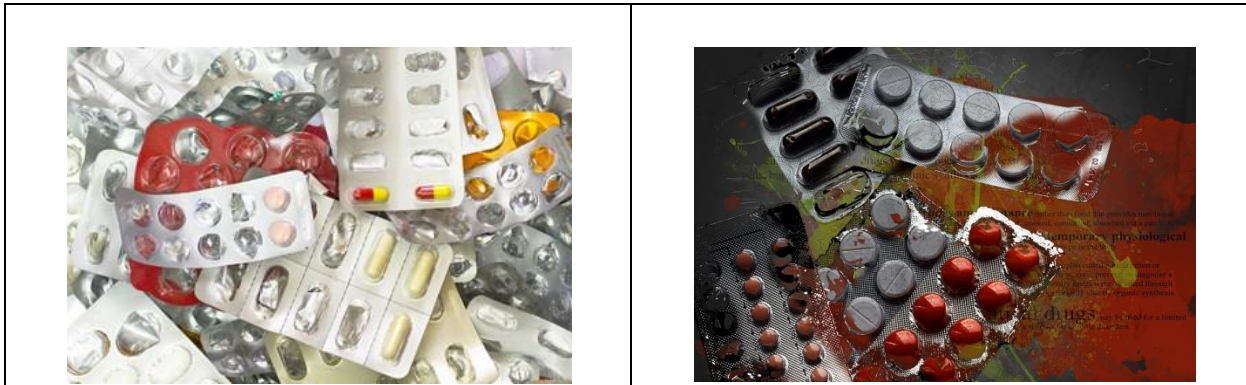


Fig 1: Pharmaceutical Waste

Aim & Objectives:

- To explore the awareness and disposal practices of unused/expired in the general public.
- Aimed to assess the disposal practices of unused and expired pharmaceuticals among the general public in Dehradun.
- To minimize the adverse impact of pharmaceutical compounds on the environment as well as the danger consequences like abuse, addiction and also death.
- The aim of this study was to know the behaviour of disposal practices of unused and expired medicines.
- To make aware on people about safe disposal.

SOURCES OF PHARMACEUTICAL WASTES AND IMPACT OF IMPROPER DISPOSAL:

Pharmaceutical waste is a wide variety of organic compounds generated from various activities. These wastes are new organic pollutants entering the environment with wide-ranging impacts on biota and global public health. Pharmaceutical waste can be broadly classified as hazardous waste. Non-hazardous and chemical waste.

SOURCES OF PHARMACEUTICAL WASTE ARE:

- Improper disposal of expired medicines.
- Disposal of unused/undesired medicines from hospitals, clinics, pharmacies, homes.
- Waste containing chemotherapeutic drug residues.
- Pharmaceutical packaging materials.
- Generation of pharmaceutical waste by pharmaceutical companies.
- Unused/unwanted medications discarded from hospitals, clinics, pharmacies, or households.



Fig 2: Sources of Pharmaceutical Waste

In India, a rapidly growing sector, the pharmaceutical industry contributes significantly to the Indian economy. Since the 1970s, these manufacturing industries have grown continuously and the patent law was amended to make medicines accessible to all citizens of India. India's generics sector has been dubbed the 'backbone' with the rapid growth of contract manufacturing and outsourcing of Indian low-cost suppliers by multinationals.

GUIDELINES FOR SAFE DISPOSAL:

1. Return to donor or manufacturer: Wherever practical the possibility of returning unusable drugs for safe disposal by the manufacturer should be explored; particularly drugs which present disposal problems, such as antineoplastics. For unwanted, unrequested donations, especially those that arrive past or unreasonably near their expiry date it may be possible to return them to the donor for disposal.

2. Landfill: To landfill means to place waste directly into a land disposal site without prior treatment or preparation. Landfill is the oldest and the most widely practiced method of disposing of solid waste. The following types are recognized:

a. Open uncontrolled non-engineered dump: Untreated waste discharged into an uncontrolled, non-engineered open dump does not protect the local environment and should not be used. They should preferably be discharged after immobilization by encapsulation or inertization.

b. Engineered landfill: An appropriate landfill consists of an evacuated pit isolated from watercourses and above the water table. Each day's solid waste is compacted and covered with soil to maintain sanitary conditions. The term 'safe sanitary landfill' refers to such a site that is adequately situated, constructed and managed.

3. Waste immobilization: Encapsulation involves immobilizing the pharmaceuticals in a solid block within a plastic or steel drum. They are filled to 75% capacity with solid and semi-solid pharmaceuticals, and the remaining space is filled by pouring in a medium such as cement or cement/lime mixture, plastic foam or bituminous sand. For ease and speed of filling, the drum lids should be cut open and bent back. Once the drums are filled to 75% capacity, the mixture of lime, cement and water in the proportions 15:15:5 (by weight) is added and the drum filled to capacity. Steel drum lids should then be bent back and sealed, ideally by seam or spot welding. The sealed drums should be placed at the base of a landfill and covered with fresh municipal solid waste. For ease of movement, the drums may be placed on pallets which can then be put on a pallet transporter. Encapsulation of antineoplastic drugs requires a slightly different technique. The drugs must be destroyed in a two-chamber incinerator, which operates at a high temperature of at least 1200°C in the secondary chamber, and is fitted with gas cleaning equipment. An after-burner (i.e. the secondary chamber) is important for the destruction of cytotoxic waste, as it is possible that antineoplastic solutions could become aerosolized following the initial combustion in the primary chamber. As a result, without a higher temperature secondary chamber, degraded antineoplastic material may be emitted from the chimney. The secondary combustion chamber consequently ensures that such antineoplastic substances are fully incinerated.

4. Waste immobilization: inertization Inertization is a variant of encapsulation and involves removing the packaging materials, paper, cardboard and plastic, from the pharmaceuticals. Pills need to be removed from their blister packs. The pharmaceuticals are then ground and a mix of water, cement and lime added to form a homogenous paste. Worker protection in the form of protective clothing and masks is required as there may be a dust hazard. The paste is then transported in the liquid state by concrete mixer truck to a landfill and decanted into the normal urban waste. The paste then sets as a solid mass dispersed within the municipal solid waste. The main requirements are a grinder or road roller to crush the pharmaceuticals, a concrete mixer, and supplies of cement, lime and water. The approximate ratios by weight used are as follows:

Pharmaceutical waste: 65%

Lime: 15% B

Cement: 15% B

Water: 5% or more to form a proper liquid consistency.

5. Sewer: Some liquid pharmaceuticals, e.g. syrups and intravenous (IV) fluids, can be diluted with water and flushed into the sewers in small quantities over a period of time without serious public health or environmental affect. Fast flowing watercourses may likewise be used to flush small quantities of well-

diluted liquid pharmaceuticals or antiseptics. The assistance of a hydrogeologist or sanitary engineer may be required in situations where sewers are in disrepair or have been war damaged.

6. Burning in open containers: Pharmaceuticals should not be destroyed by burning at low temperature in open containers, as toxic pollutants may be released into the air. Paper and cardboard packaging, if they are not to be recycled, may be burnt. Polyvinyl chloride (PVC) plastic however must not be burnt.

7. Medium temperature incineration: In emergency situations the responsible authorities may consider it acceptable to treat expired solid form pharmaceuticals using a two-chamber incinerator that operates at the minimum temperature of 850°C, with a combustion retention time of at least two seconds in the second chamber. It is recommended that the pharmaceutical waste be diluted with large quantities of municipal waste (approximately 1:1000).

8. Novel high temperature incineration: Industries which use high temperature technology, such as cement kilns, coal fired thermal power stations or foundries, usually have furnaces that operate at temperatures well in excess of 850°C, have long combustion retention times, and disperse exhaust gases via tall chimneys, often to high altitudes. During burning the cement raw materials reach temperatures of 1450°C while the combustion gases reach temperatures up to 2000°C. The gas residence time at these high temperatures is several seconds. In these conditions all organic waste components are effectively disintegrated. Incinerators conforming to these regulations may be used for the disposal of halogenated compounds, X-ray contrast media and povidone iodine; lower temperature incinerators should not be used.

9. Chemical decomposition If an appropriate incinerator is not available, the option of chemical decomposition can be used in accordance with the manufacturer's recommendations, followed by landfill. This method is not recommended unless chemical expertise is readily available. Chemical inactivation is tedious and time consuming, and stocks of the chemicals used in treatment must be made available at all times. For disposal of a small quantity of antineoplastic drugs this method may be practical. However, for large quantities, for example, more than 50 kg of antineoplastics, chemical decomposition is not practical, as even small consignments need to be treated through repeated application of this method.

COMMON PRACTICES OF GENERAL POPULATION ABOUT SAFE DISPOSAL:

The U.S. Food and Drug Administration suggests the following rules to dispose of medications:

Disposing medicines in the household trash:

Prescription and over-the-counter (OTC) drugs in pills, liquids, drops, patches, creams and inhalers can be thrown into the household trash.

Follow these steps:

1. The drugs should be removed from their original containers and mixed with something undesirable, such as used coffee grounds or dirt, thus making the medicine less appealing to children and pets as well as unrecognizable to someone looking through the trash for drugs.

2. This mixture should be then put into something that can be closed (are-sealable zipper storage bag, empty can or other containers) to prevent the drug from leaking or spilling out.
3. Throw the container in the garbage.

Disposing of Inhaler Products:

Inhalers and aerosol products could be dangerous if punctured or thrown into a fire or incinerator. These should be destroyed following local regulations and laws. You may contact your trash and recycling facility.

Flushing medicines:

Flushing could potentially harm the environment but because some medicines could be especially harmful to others, they have specific directions to immediately flush them down the sink or toilet when they are no longer needed.

Disposing of Fentanyl Patches:

Some prescription drugs like Fentanyl Patches deliver strong pain medicine through the skin. A lot of medicine remains, even after a patch is used. Such powerful narcotic pain medicines and other controlled substances should be flushed to reduce the danger of overdose from unintentional or illegal use.

DISPOSAL PRACTICES FOR EXPIRED MEDICINES:

Irrespective of whether expired medicines have desired potency or not, they are toxic or not, it is legally and ethically not favourable to use them in clinical practice. But very often reports are on the contrary. The expired medicines get recycled with a new label showing fresh manufacturing and expiry date.

While the expired medicines may not cause a serious health hazard to the public or to the environment, their improper disposal could be serious. Pilfering from a stockpile of waste drugs may result in expired drugs being diverted to the market for resale and misuse as incident described above. Expired medicines may come into the hands of scavengers and children if a landfill is insecure. Some of the issues relating to the inappropriate disposal of expired medicines are:

- Possibility of contaminating drinking water source or supply from the disposal place the leachate may get access to the water supply system.
- Disposal of non-biodegradable antibiotics, anti-neoplastics and disinfectants into the sewage system may kill bacteria necessary for treatment of sewage. Flushing of anti-neoplastics into water resource may damage aquatic life or contaminate drinking water. Discharge of large amount of undiluted disinfectants into the sewage system or water resources may too cause similar situation.
- Burning of the expired medicines at low temperature or in open containers results in release of toxic pollutants to the air. Ideally this should be avoided.

- Inefficient and insecure disposal may lead to recycling of the expired medicines. This is true especially when they are disposed in original containers.

The following disposal methods have been recommended by the international authorities:

Returning to the manufacturer: Wherever feasible this should be the first choice because the manufacturer is likely to have good disposal method at its disposal.

1. Landfill:

The waste materials are directly placed into a land disposal site without prior preparation or treatment. This is the oldest and most practiced method for solid waste disposal. Untreated waste must be rapidly covered with other municipal waste to prevent scavenging.

Care should also be taken to prevent contamination of ground water.

2. Waste immobilisation (encapsulation):

Expired drugs are immobilized in a solid block within a plastic or steel drum. After filling these substances into the drum to about 75 per cent of the capacity, the drum is filled with a mixture of lime, cement and water in appropriate proportion. The sealed drums may be placed at the base of the landfill and covered with a fresh municipal solid waste.

3. Waste immobilisation (inertisation): In this method the products are removed from the package like removing pills from blister. The products are then ground and made a paste with a mixture of water, cement and lime. Then they are taken to landfill and decanted into normal waste.

4. Sewer: Some liquid medicines like syrups, intravenous fluids can be flushed into sewer after dilution. Small quantities of liquid medicines including antiseptics can be disposed.

5. Burning in open containers: Burning of medicines in open containers at low temperature cause release of toxic pollutants to the environment. Though not a preferred method, small quantities of waste medicines can be disposed off this way.

6. Incineration: Medium and high temperature incineration devices require a capital investment, operation and maintenance budget. Medium temperature incinerators operate at a medium temperature combustible

process (800-1000°C) while high temperature incineration works at a temperature above 1000°C. Incineration of expired medicines is recommended.

7. Chemical decomposition: As the method is tedious and time consuming, it is useful only for small quantities of medicines when appropriate incineration method is not available.

CONCLUSION

In India, the improper disposal of medicines has created an environmental concern. There is lack of knowledge for disposing unused and expired medicines among the common people. Awareness programme should be initiated to educate general population about the disposal systems and also to acknowledge them regarding the harmful consequences of improper drug disposal. Proper channel systems involving drug regulatory bodies, pollution control boards, NGOs and civil society should be implemented. There is a need to create awareness under Program on Removal of Unused Drugs (PROUD), for drug take back programme including other safe disposal systems. Educating patients regarding the utilization, storage as well as proper disposal of unused / expired and unwanted medicines by the pharmacists or health professionals can play an important key role.

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