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Pharmaceutical Waste Management: Sustainable Practices in Pharmacy Setting

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Abstract: *The problem of medication disposal is concerning today and is becoming more and more recognized by both consumers and healthcare professionals. Since they work in the healthcare industry and are in a unique position to inform patients about safe drug disposal, pharmacists have the ability to lead this movement. Appropriate patient counseling regarding the proper disposal of medications can have a big impact on the environment and public health. Understanding how to properly dispose of leftover medications is just as crucial as understanding how to use medications..*

Keywords: Pharmaceutical Waste Management, Medication disposal, Environmental health, biomedical waste, chemo waste, P & U listed waste, pharmacist

I. INTRODUCTION

Medications that are contaminated, unwanted or discontinued medications that have been dispensed, and expired goods are all included in the pharmaceutical waste. Merely a fraction of the active ingredient in medications recommended for prophylactic purposes or in reaction to acute or chronic illnesses gets metabolized. Waste discharges into receiving streams carry both the non-metabolized parent material and its metabolites into the natural aquatic environment.

This can contaminate recreational lakes or even the intakes of drinking water treatment plants[1] The biochemical activity of pharmaceutical substances is intended to occur in target species at comparatively low concentrations. Thus, there is worry that some of these chemicals may have an impact on the environment and human health at low parts per trillion levels.

Despite the fact that biological and physical processes compounds, traces of pharmaceutical chemicals and metabolites used by humans and animals have been found in drinking water, groundwater, and surface water.[1] High consumption rates are always associated with higher drug waste, according to a cross-sectional study done on the older population. The study projected that drug waste accounted for 2-3% of all drug costs, or more than $1 billion in drug waste in the US.[2 3]

As per the Central Pollution Control Board of India, 4,057 tonnes of garbage are generated daily by licensed healthcare establishments[3]

A chemical component with pharmacological action and a beneficial impact on the identification, mitigation, treatment, or prevention of disease, or one that modifies the anatomy or physiology of the body, is called an active pharmaceutical ingredient (API).Six APIs for small molecules are formed into Eventually, these APIs end up in drinking waters, groundwater, marine ecosystems, sewage sludge and bio-solids, animal tissues, and food chains. Both the biotic and abiotic systems are impacted by APIs[4 1] Drug use is growing daily in both the veterinary and human populations.

One estimate puts the annual consumption of antimicrobials at 100,000 tons.[5]

The Drinking Water Contaminant Candidate List now includes many estrogenic hormones used in medicine formulations as well as the antibiotic erythromycin, according to the US Environmental Protection Agenccy.[6]

In response to a Washington Times article, wastewater samples were gathered from South Indian industrial zones, where the bulk of Indian medicine manufacturers dispose of their leftover materials. It was discovered that 45 kg of ciprofloxacin, a single, potent antibiotic, was being discharged daily, and that amounts of other antibiotics, such as lomifloxacin, ofloxacin, and norfloxacin, that are hazardous even to plants and algae, had also been observed. Waste water downstream from the Indian plants contained 150 times highest levels than those detected in the United States of America.11

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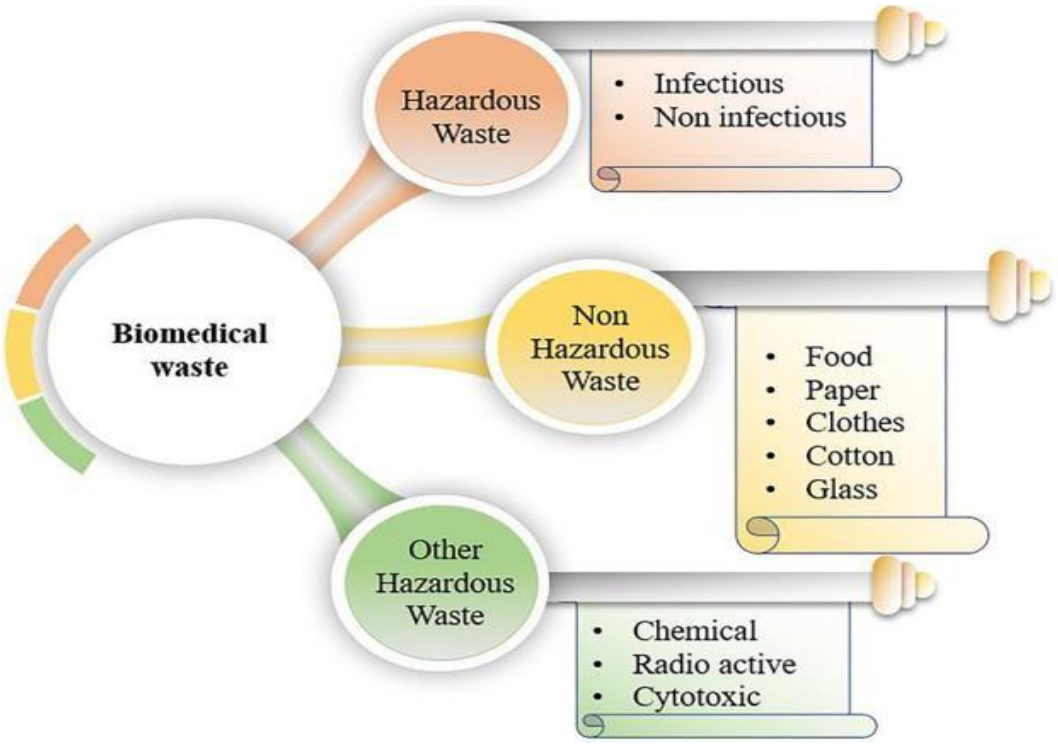

Hazardous waste:

Hazardous waste is defined as waste that poses a risk to public health or the environment. It may consist of sludges, liquids, solids, or trapped gasses.[7]

Hazardous waste are classified in two categories:

- Listed wastes
- Characteristic waste

One of the four categories of hazardous waste (F, K, P, and U) contains listed wastes .Two of these lists, the P and U lists, both contain commercial chemical items, and pharmaceuticals are listed on them. Because they have particular hazardous qualities, such as ignitability, corrosivity, reactivity, and toxicity, characteristic wastes are subject to regulations.

Solid waste is defined as wastes that are not on the list and do not fit any particular description. Requirements for regulated medical waste disposal, as well as state and/or local laws, should be followed when disposing of solid waste.[4]

Listed hazardous wastes:

P-Listed Pharmaceutical waste

P-Listed Drug Manufacturers Commercial chemical compounds that are classified as acutely hazardous under RCRA are known as P-listed wastes, as table No. 1 illustrates. A medicine must meet several requirements in order to be classified as acutely dangerous on the P-list, one of which is an oral lethal dose of 50 mg/kg (LD50) or less. The term "LD50" refers to the total amount of a substance that, when administered to a group of test animals, results in 50% of them dying. Because of their toxicity, even little doses can result in death or permanent sickness.

If two requirements are met, drug waste that contains a P-listed ingredient of concern and is disposed of or planned for disposal must be handled as hazardous waste:

1. Only one active ingredient (54 FR 31335) that is on the P list is present in the discarded drug waste, and it hasn't been used for the intended purpose (54 FR 31336).

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2. (40 CFR Part 261.7(b)(3)) Empty Containers of P-Listed Wastes:-A container is not deemed "RCRA empty" after holding P-listed waste unless it has
3. Triple rinsed, and
4. The rinsate is managed as hazardous waste

All vials, IVs, and other containers that have carried a P-listed substance must be handled as hazardous waste, regardless of whether or not all of the contents have been removed, as triple rinsing is impractical in healthcare settings.[8] Certain states have opted to loosen their interpretation of "used" when referring to solid dosage forms like tablets and capsules, and they are also not enforcing regulations on "empty" warfarin stock bottles or unit-dose containers.

Table No 1: P-listed drugs with waste code

P-listed pharmaceutical	waste code
Arsenic trioxide	P012
Epinephrine	P042
Nicotine	P075
Nitroglycerin	P081
Physostigmine	P204
Physostigmine salicylate	P188
Warfarin	>0.3% P001

U-Listed Pharmaceutical Wastes:

A wider variety of medications are included in the U-listed chemicals category, and they once more need to be the only active ingredient subject to regulation. If disposed of, these products technically wouldn't be considered hazardous waste because none of the U-listed ingredients is the only active ingredient. Table 2 lists some of the 21 medications that are on the U-list. If the following criteria are met, these substances are listed:

mostly due to their toxicity. Like a trash that is P-listed, when one of these compounds is present in a drug waste that is disposed of, it needs to be handled like hazardous material if two[9]

1. Only one active ingredient, which is on the U list, is present in the discarded drug waste, and it hasn't been used for the intended purpose.
2. Empty U-Listed Waste Containers (40 CFR Part 261.7(b)(1)):- If two requirements are satisfied, a container that has stored U-listed garbage is deemed "RCRA empty":

- Everything that can be taken out with a syringe or other standard method has been taken out.
- No more than 3% by weight remains[10]

The container needs to be handled as hazardous waste if either of these requirements is not satisfied. It is necessary to handle any leftovers that are taken out of the empty container as hazardous trash.[11]

Table no 2: U-Listed drugs with waste code

U-listed pharmaceutical	Waste code
Chloral hydrate	U034
Paraldehyde	U182
Chlorambucil	U035
Phenol	U188
Cyclophosphamide	U058
Reserpine	U200
Daunomycin	U059
Resorcinol	U201
Dichlorodifluoromethane	U075
Saccharin	U202
Diethylstilbestrol	U089
Selenium sulfide	U205
Hexachlorophene	U132
Streptozotocin	U206
Lindane	U129
Trichloromonofluromethane	U121
Melphalan	U150

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Nonhazardous wastes:

This group of materials is thought to contain no materially harmful qualities. It is important to remember, though, that this does not mean that there are no potentially harmful substances present; rather, it just means that the concentration of any such substances is below the level that could be harmful to human health. Crucially, this non-hazardous status may change at any time, and the treatment options could vary dramatically if certain components were added or removed from the waste stream

Pharmaceutically inert: Some medications, such as sodium chloride or dextrose solutions, have no pharmaceutical qualities yet are nevertheless managed and given by medical professionals. However, these goods may become contaminated or mixed with other substances during use, therefore it is necessary to evaluate them for any dangerous qualities before disposing of them.

Chemo waste:

Chemo wastes are further divided into bulk and trace chemotherapeutic waste categories.

Trace chemotherapy waste:

The topic of trace chemotherapeutic waste is not covered by the federal RCRA laws. Since there is no lower concentration limit below which P- and U-listed hazardous wastes can be released from the regulatory system, there is no acknowledged distinction between bulk and trace chemotherapeutic contamination. The majority of state-regulated medical waste regulations either don't define trace chemotherapeutic waste or define it vaguely. The National Institutes of Health's pharmacy staff, who were instrumental in implementing the RCRA requirements for antineoplastic wastes, first mentioned the practice of isolating trace chemotherapeutic waste in a 1984 publication. Thirteen The Medical Waste Management Act of California and the Medical Waste Rules of Wisconsin define trace chemotherapeutic waste and mandate its cremation in a controlled medical waste facility or through another authorized treatment technique. If there has been a chance of chemotherapy contamination, all chemotherapy accessories ought to be handled as trace chemotherapy waste. The following products should be managed as trace chemotherapeutic waste:

vials, syringes, IV bags, and tubing marked as "RCRA empty";

gowns, gloves, wipes, and additional supplies needed for the regular handling, preparing, and administering of chemotherapy; and,

#Wipes and additional supplies needed for a biological system's regular cleaning and disinfection

#Glove box or safety cabinet (unless alcohols, phenols, or other dangerous compounds are being employed)

Bulk chemotherapy waste:

Eight chemotherapy medicines are U-listed, while one chemotherapy agent is a P-listed ingredient of concern. For a long time, listed chemotherapy drug waste that needs to be handled as hazardous waste has been disposed of in trace chemotherapy containers. Given that hazardous waste incinerators and RMW incinerators burn trace chemotherapeutic waste, this is not only against the law but also inappropriate. RMW incinerators are subject to less stringent permit requirements and emissions limitations. Adding "bulk" P- or U-listed chemotherapeutic drugs to your trace chemotherapy waste should be your first step in improving your pharmaceutical waste management program. This practice has resulted in significant enforcement actions and fines.

Sources of Entry of Pharmaceuticals into Environment[12 13]

There are several ways that pharmaceutical compounds can get into the environment, including

- From low-cost pharmaceutical manufacturing sectors in emerging nations like China and India
- Direct and inappropriate disposal by patients or people, who throw away leftover or expired drugs in the garbage or excrete urine or feces
- Discharge from hospital trash/waste
- Pharmacy disposal
- Added to animal diet and used by veterinarians as medication; discharged into surface waterways or soil.
- Getting rid of dairy waste

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- Domestic wastewater and water, solid waste combined with excess drugs
- Seeping from faulty disposal sites
- Release from aquaculture that has been fed medicated feed and excreted into the environment
- Discharge from pesticides and molecular farming
- Getting rid of animal carcasses that have been medicated or put to sleep
- Medical representatives receive physician samples from corporations for the aim of promoting sales, even in underdeveloped nations like India. We frequently read in the local newspaper about drug goods that have expired or are unused that are discovered by the side of the road.[1]

The most typical pathways via which medications reach the environment are depicted in Figure 1.

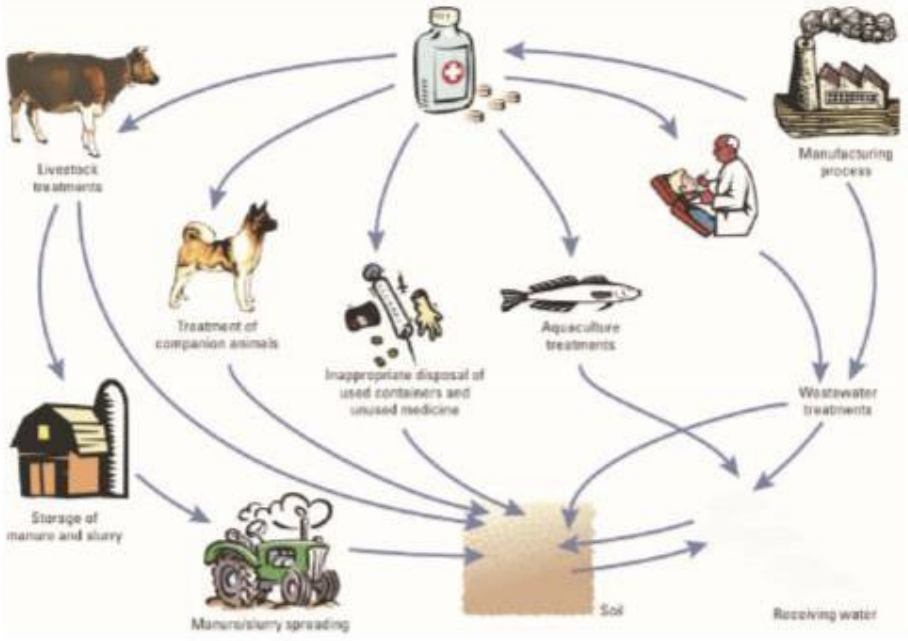

Figure 1: Routes of pharmaceuticals entering the environment 'Reproduced with the permission of Alistair Boxall.'[12]

Types of Healthcare Wastes or Pharmaceutical Wastes:

The terms "general health care wastes" and "hazardous health care wastes," also referred to as "healthcare risk wastes" or "special wastes," are used to describe biomedical and communal wastes, respectively.

The following categories apply to biomedical wastes as well:[3 1]

1. Infectious waste
2. Pathological waste
3. Genotoxic waste
4. Chemical waste
5. Wastes with high content of heavy metals
6. Radioactive waste
7. Pharmaceutical waste

Infectious Waste

When present in sample concentrations, pathogens such as bacteria, viruses, parasites, or fungi are thought to be present in infectious wastes that cause diseases in susceptible hosts. They also consist of:

- Microbial cultures, infectious agent stocks from pathology labs, and wastes generated from treating sick patients (disposable towels, gowns, aprons, gloves, etc.)

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- Tissues, materials, or equipment utilized in operations and autopsy on individuals with infectious illnesses.

Pathological Waste:
Pathological wastes include tissues, human corpses, blood and bodily fluids, body parts, human fetuses, etc. They go by the name "anatomical wastes" as well and are typically classified as an infectious waste subclass.
Items that have the potential to produce cuts or wounds, such as broken glasses, knives, hypodermic needles, scalpels, etc., are considered sharps. Whether they are afflicted or not, they are regarded as extremely dangerous.

Genotoxic Waste:
Items that can cause mutagenicity, carcinogenicity, or teratogenicity are typically included in genotoxic wastes and typically result in serious issues. Such garbage need to be disposed of carefully and decisively. The majority of the medications in this category are cytotoxic ones. These medications are used in cancer chemotherapy. The departments that use these medications are radiation and oncology units, and the use of these medications has been rising daily. The following is a list of some of the genotoxic medications. Certain medications are known to cause cancer, such as chlorambucil, azathioprine, cyclosporin, etc.; other drugs that are likely to cause cancer include carmustine, lomustine, daunocin, doxorubicin, phenobarbital, phenytoin, chlornaphazine, niridazole, oxyazepam, and phenacetin.

Chemical Waste:
Chemical wastes include things like liquid, solid, and gaseous chemicals that are thrown away from labs and other experimental facilities. If a chemical waste has even one of the following characteristics, it is deemed dangerous:

- Toxic
- corrosive
- flammable
- Reactive genotoxic

Chemical wastes that lack any of the aforementioned characteristics, such as sugars, amino acids, and specific organic and inorganic salts, are also regarded as nonhazardous. The following are some instances of hazardous chemical wastes that are frequently utilized in hospitals and healthcare facilities:

- Solvents including formaldehyde, acetone, methanol, acetonitrile, and chloroform, among others.
- Photographic chemicals, including potassium hydroxide (1–5%), acetic acid (5–10%), 45% glutaraldehyde, etc.
- Inorganic chemicals like acids and alkalis like sodium hydroxide, hydrochloric acid, sulfuric acid, ammonia solutions, oxidizing agents like potassium permanganate, reducing agents like sodium sulfite, and organic chemicals like oils, disinfectants, insecticides, and rodenticides, etc.

Wastes with high content of heavy metals:[1]
The primary sources of heavy metals found in biomedical wastes include medications, personal hygiene items, garden pesticides, mercury waste from malfunctioning clinical equipment, etc. Heavy metal-containing wastes are typically extremely poisonous and seep into the soil, contaminating it with heavy metals like lead, copper, zinc, and so forth.

Radioactive Waste:
The undesirable radionuclide solutions meant for therapeutic or diagnostic use, waste from spills, and the breakdown of radioactive spills are examples of biomedical wastes containing radioactive chemicals.

Pharmaceutical Waste:
It is necessary to properly dispose of expired medications as well as unused, spilled, and contaminated pharmaceutical products, such as vaccinations and sera that are no longer in use. Pharmaceutical wastes may also include items like glass bottles and aluminum packs that come into touch with the medication products.

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Effect of Pharmaceutical Waste on Environment and Humans:

Modern society uses pharmaceuticals for a wide range of reasons, yet the pharmaceutical industry releases a great deal of hazardous pollutants into the environment, either directly or by chemical alteration. Twelve pharmaceutical chemicals find their way into the environment through a variety of channels, including waste water discharge, seepage from landfills, sewage lines, and animal feces[14] [11] The aquatic ecosystem's diverse physical and biological processes also lead to a decrease in the concentration of pharmaceutical substances, both veterinary and human, as well as their metabolites, which are found in various water sources[15] India's pharmaceutical industry ranks 14th in terms of value and third in terms of volume worldwide. It is valued at 4.5 billion dollars and is expanding at a rate of 8 to 9% a year. The rapidly expanding Indian pharmaceutical, chemical, paint, and other industries dispose of their wastewater into streams either directly or through partial treatment.[16] Once they entered the environment, pharmaceutical substances were regarded as contaminants. Much greater ambient concentrations were found in several pharmaceutical production sites, possibly as a result of the medications themselves.[17] Large amounts of waste are produced during the operation of pharmaceutical plants. These wastes may end up in drinking water sources or the effluent of waste water treatment plants, where they will be detrimental to both aquatic and human life.[18]As of right now, there are no Bureau of Indian Standards (BIS) rules or limits on the amount of drugs in drinking or waste water.

Nevertheless, pharmaceutical compounds—which are widely used by humans—have been included by the US Environmental Protection Agency 21 to the list of the most current of contaminant.

Pharmaceutical Waste Management and Disposal Methods:[4]

The following technologies are listed in India's Pharmaceutical Waste Regulations for the treatment and disposal of pharmaceutical waste:

Incineration:

The process of incinerating solid waste results in the combustion of the trash, which produces residue and gaseous products. Solid waste management and waste water management both benefit from the adoption of this technique. Approximately 20 to 30 percent of the volume is lost during this process compared to its initial volume. Another name for it is thermal therapy. Incinerators transform waste materials into heat, gas, steam, and ash.

The industry engages in both small- and large-scale incineration. Waste that is solid, liquid, or gaseous is disposed of with it. It is acknowledged as a workable technique for getting rid of hazardous trash. Given that it releases gaseous contaminants, this technique of disposing of garbage is controversial. Containers holding pressurized gas should not be incinerated.

Autoclaving:

Using this method, biomedical waste is exposed to saturated steam inside a pressure vessel at a certain temperature and time, which kills germs. BMW establishes guidelines for safe disinfection, including minimum autoclave temperature, pressure, and dwell time. garbage from autoclaving can be piled high with municipal garbage. There is a stream of wastewater that must be disposed of with the proper regulations. An autoclave with a medium initial investment and operational cost requires a certified technician to operate.

Microwaving: Using this method, biomedical waste is exposed to saturated steam inside a pressure vessel at a certain temperature and time, which kills germs. BMW establishes guidelines for safe disinfection, including minimum autoclave temperature, pressure, and dwell time. garbage from autoclaving can be piled high with municipal garbage. There is a stream of wastewater that must be disposed of with the proper regulations. An autoclave with a medium initial investment and operational cost requires a certified technician to operate.

Chemical disinfection: This process destroys or inactivates microorganisms and is mostly used to handle liquid waste, such as blood, feces, urine, powerful antioxidants, and aldehyde and phenol chemicals.

shredded solid waste, mutilated sharps, and microbiological culture etc. are also cleaned using a chemical disinfection technique.

The duration of contact with the waste, the chemical's concentration, and the kind of chemical all affect how effective a disinfectant is.

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Because chemical disinfection is harmful, it cannot be dumped into surface waterways or huge volumes into sewers. The user should exercise caution when performing a sanitizing technique because it may have harmful consequences[19]

Deep burial:

The biomedical waste rule states that garbage should be buried deep in rural regions and in cities with less than 500,000 residents. A 2-meter-deep trench or digging should be done to prepare the site for deep burial. The region shouldn't be prone to erosion or flooding. Half of the pit's height should be filled with biomedical waste, which is then covered with lime within 50 cm of the surface and the other portion filled with soil.

Waste should always be added to the cover pit whenever it is added to the pit soil.

Secure land filling:

Deposited waste is normally compacted to increase its density and stability, and covered to prevent attracting vermin (such as mice or rats). Biomedical waste rule states that disposal of discarded medicines, cytotoxic drugs; solid chemical waste and incineration ash is secured landfills. Secure land filling is disposal of solid waste and hazardous substance by land filling. Most of countries use secure land filling method for disposal of biomedical waste. Landfills done in unused land which is away from city. Properly designed and well managed land filling is effective, hygienic and economic method.

Improper management can cause hazardous effects on environment. One of the disadvantages of this method is byproduct which is gas mostly methane or carbon dioxide. When organic waste breakdown an aerobically the gas is produced. Gas can crate odour problem, it is greenhouse gas. Modern method of land filling includes leach ate such as clay and plastic lining material. Some techniques include extraction of gas from landfill. Gas is pumped out of the land using perforated pipes which is used to generate electricity.

Waste immobilization: encapsulation:

The process immobilizes pharmaceutical solid waste in a steel or plastic drum. Drums need to be completely cleaned and devoid of any potentially explosive or dangerous materials. 75% of the capacity of drums is filled with solid or semi-solid material. 25% of the remaining space should be filled with a medium, such as sand, cement/lime combination, plastic foam, or cement. Drums are filled to 75% of their capacity after which a mixture of lime, cement, and water is added in a weight-based ratio of 15:15:5.

Occasionally, additional water is added to the mixture to change its consistency. Spot or seam welding is used to seal steel drums. barrels that are sealed and buried in new municipal solid garbage at the landfill's base.

Waste immobilization: Inertization:

As a variation on encapsulation, inertization entails taking the medicines' paper, cardboard, and plastic packing out. The pills must be taken out of their blister packs. To create a uniform paste, the medicinal ingredients are then crushed and combined with water, cement, and lime. There may be a dust threat, so worker protection in the form of masks and protective clothes is necessary. The paste is then decanted into regular municipal rubbish at a landfill after being brought there in its liquid state by a concrete mixer truck. After then, the paste solidifies and becomes distributed throughout the municipal solid waste. The procedure can be completed quickly and affordably with a few basic pieces of equipment. The two primary necessities are a road roller to break up the stocks of medications, a concrete mixer, and lime, cement, and water.

Sewer:

Certain medications, such as syrups and IV fluids, are liquid and can be diluted with water and flushed into sewers in modest amounts over time without having a significant negative impact on the environment or public health. Little amounts of antiseptics or diluted liquid medications flushed through quickly moving waterways. When sewers are destroyed by war or are in poor condition, the services of a hydro geologist .

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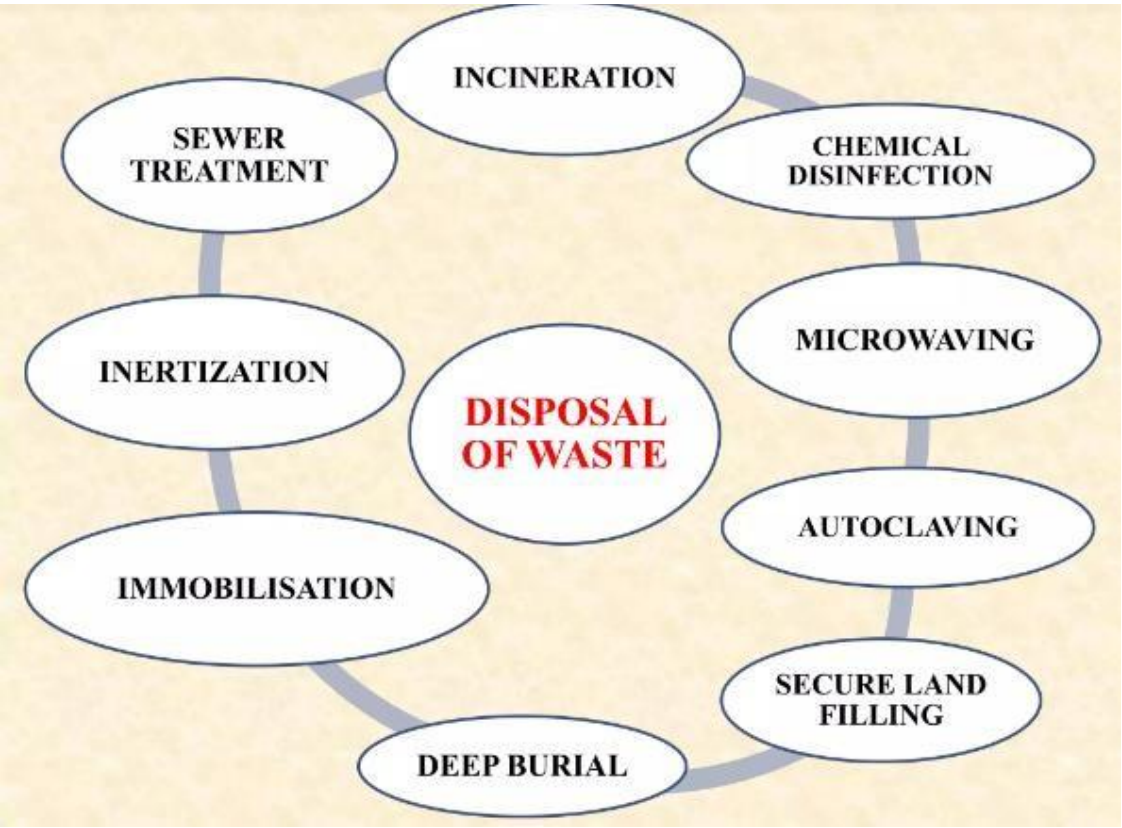

Precaution to be taken at the time of disposal[8] [16]

It's important to prevent drinking water contamination. Landfalls have to be built and positioned to reduce the chance of leaking into drinking water systems, surface waters, or groundwater.[20]

Antibiotics that are not biodegradable, anti-plastics, and disinfectants shouldn't be disposed of in the sewer system since they may destroy the bacteria required for sewage treatment. It is not advisable to dump antineoplastics into waterways as they could cause harm. water quality or harm aquatic life. Likewise, it is not advisable to release copious amounts of disinfectants into a water body or sewage system. When properly diluted, they can be added.

Toxic pollutants are released into the air when medicines are burned at low temperatures or in open containers. Ideally, one should steer clear of this.

Drugs that have passed their expiration date may be diverted due to careless and inefficient sorting and disposal. to be sold again to the wider population. Scavenging in unsafe and unprotected landfalls poses a risk in certain countries.

If unused medications are stored safely and dry, they pose no risk, even in the absence of appropriate disposal locations and qualified staff to oversee disposal. It is better to keep drugs in drums with the immobilized pharmaceuticals inside to prevent diversion, which can occur if they are kept in their original packing.[21]

Hazardous waste management statergy

Waste minimization: garbage reduction, or the process of preventing the creation of garbage, is a crucial component of waste management. Reusing used goods, fixing broken items rather than purchasing new ones, designing products to be refillable or reusable (like cotton shopping bags instead of plastic ones), urging customers to forgo using disposable goods (like throwaway cutlery), emptying any leftover food or liquid from cans, packaging, and creating products that require less material to accomplish the same task are some avoidance strategies. [22]

Reuse: Reusing a product refers to using it more than once without having to reprocess it, either for the same or a different purpose. Reusing materials prevents them from being thrown into the waste stream after their original purpose

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is over. Reusing products in their original state is ideal. Examples of this include utilizing used clothing, returnable plastic pallets, and empty glass jars for storing goods. Reuse often makes more sense than recycling because it doesn't require the item to undergo a thorough treatment procedure, which reduces the need for energy and materials.[23]

Recycling: Recycling involves the treatment or reprocessing of a discarded waste material to make it suitable for subsequent re-use either for its original form or for other purposes. It includes recycling of organic wastes but excludes energy recovery. Recycling benefits the environment by reducing the use of virgin materials. Recycled materials come in a wide variety. Waste materials can be recycled into products that are different from their original use, such as recycling plastic bottles into fleece jackets or using construction and demolition waste as road aggregate, or they can be recycled into products similar to their original use, such as paper recycling. Up to 13% of municipal garbage in the EU gets recycled.[7]

Energy recovery: Waste materials have the potential to be either utilized as fuel for direct burning or indirectly converted into another fuel through processing. Thermal treatment encompasses a variety of methods, such as utilizing trash as fuel for cooking or heating purposes and utilizing gas fuel (discussed above) to power boilers that produce steam and electricity for a turbine. Two similar thermal treatment methods that heat waste materials to high temperatures while limiting their availability of oxygen are pyrolysis and gasification.

Usually, the procedure takes place under high pressure in a sealed vessel. Solid waste can be pyrolyzed to produce solid, liquid, and gaseous products. The gas and liquid can be refined into additional chemical products (chemical refinery) or burned to generate energy. Char, the solid residue, can be processed further to create goods like activated carbon. Syngas, which is made up of hydrogen and carbon monoxide, is produced directly from organic materials through the processes of gasification and enhanced plasma arc gasification.[5]

After that, the gas is burned to create steam and electricity. High temperature and pressure supercritical water breakdown (hydrothermal monophasic oxidation) is an alternate process to pyrolisis.[19]

Steps that should be followed to manage pharmaceutical wastes:

Step 1:- establish a pharmacy management plan

Step 2:- identify your hazardous and non-hazardous wastes Step 3:- implement best management practices

Step 4:- determine your waste generator status

Step 5:- comply with guidelines for transport and disposal

Difference between Hazardous Waste and Non Hazardous Waste:

Hazardous Waste	Non Hazardous Waste
1) Hazardous waste is waste that harmful to human health or the environment if improper disposed it.[9]	1) Non Hazardous waste is waste which does not directly harm to human health or the environment, but it cannot dump in sewer line because of risk.[9]
2) Hazardous waste contains Explosive, Flammable Liquids/Solids, Poisonous, Toxic, Ecotoxic, Infectious Substances.[10]	2) Non Hazardous waste contains paper, plastic, metals, glass etc.[9]
3) The Hazardous waste regulated under the Resource Conservation and Recovery Act (RCRA).[9]	3) The non Hazardous waste regulated under state and local governments through the federal government.
4) It can be produced from companies and households as well as worksites.	4) This can be produced from general household waste like food or bathroom rubbish and recycling, and from industrial or agricultural sources.[11]
5) There are two types of Hazardous waste:- Listed and Characteristics waste.[9]	5) Disposal method of non Hazardous waste is vary because of different types of waste and various regulations governing them.[9]
6) Examples:- pesticides, herbicides, paints, industrial solvents, fluorescent light bulbs and mercury-containing batteries.[9]	6) Examples:- Agricultural waste, Batteries, Construction debris, Industrial waste, Medical waste, Municipal solid waste, Scrap tires, Special wastes.[9]

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Role of pharmacist: Research suggests that in order to reduce the negative effects of medications on the environment, pharmacists should take some of the blame for altering the entire medication-use process. the whole prescription, distribution, pharmaceutical care, medicine disposal, and, in the end, the decrease in the release of metabolic waste into the environment[24] The pharmacy practitioner can encourage more sensible prescription practices that would decrease the quantity of medications that are left behind. This would also lessen possible environmental dangers. Pharmacists are in the forefront of addressing concerns about responsible drug disposal techniques for end users of drugs because they are the most reputable, trustworthy, and easily accessible providers of drug knowledge. It is important for all pharmacists to be aware of the drug disposal programs in their area and to be able to suggest them to their patients. In light of the current state of affairs in India, it is imperative that basic changes be made to the curriculum for pharmaceutical education. Information about appropriate drug disposal, the environmental aspects of medication, and its use in practice should all be included. The curriculum also offers a solid foundation in medicine metabolism and toxicology, which can help students understand how drugs and related substances react in the environment and what potential environmental effects they may have. These topics are currently missing from many Indian university curricula.25

Effective eco-friendly pharmaceutical and healthcare waste management initiatives necessitate cross-sector collaboration and engagement at all levels. The pharmacy profession and its practitioners have a fantastic chance to take the lead in solving the environmental problems related to pharmaceutical use.36 Appropriate patient counseling regarding the proper disposal of medications can have a major impact on public health and surroundings, as a few studies have demonstrated.1

At every level, continuing education and training are recommended to raise awareness of the risks connected to the careless disposal of pharmaceutical items that are unused or expired—a developing environmental concern.16

II. CONCLUSION

Today, medication disposal is a concerning topic that both consumers and healthcare professionals are becoming more and more aware of. Given their excellent position to inform patients on safe drug disposal, pharmacists have the opportunity to lead this movement among healthcare professionals. Effective patient counseling regarding the proper disposal of medications can have a big impact on the environment and public health.

As the urgent need of the hour, there should be a realistic way to include this significant problem in the curriculum. It is also essential to build societally acceptable and economically viable government-run systems for collection and disposal. For the same, there have to be some standards and strict restrictions. Drug pollution can be reduced by properly disposing of medications in an environmentally responsible manner. The public, government, NGOs, doctors, pharmacists, patients, and other multidisciplinary stakeholders should collaborate to lessen the environmental impact of wasted and expired medication. To protect public health and the environment, waste management strategies must be implemented properly.

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