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The Impact of Pharmaceuticals Waste on Environment in India

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Abstract

Pharmaceutical waste is a major contributor to the destruction of the environment to a certain extent. Prior to commercialisation and distribution, most medications are studied for human safety and efficacy, but their possible detrimental effects on the environment have not been determined. Pharmaceutical chemicals such as analgesics, antidepressants, antihypertensive, contraceptives, antibiotics, steroids, and hormones have been found in ground water, home waste water, and industrial effluents at various amounts. Untreated or partially treated wastes are discharged or discarded directly into the environment due to a lack of stringent controls. As a result, proper legislation and monitoring are required to prevent pharmaceutical effluents from entering drinking water sources, thereby protecting the environment from health risks. This document gives an overview of the various routes by which medicines enter the environment. It also gives an update on current legislation and penalties for improper pharmaceutical disposal, as well as the consequences for human health.

Keywords: Pharmaceutical Waste, Drug Disposal, Unused Medicines, Environmental Pollution, Impact of Pharma Waste

INTRODUCTION

In the field of medicine, pharmaceuticals play an important role. They are used to prevent, treat, and diagnose a variety of illnesses around the world. Many businesses, such as pharmaceuticals, chemicals, and paints, are expanding rapidly in India, producing significant amounts of trash during industrial processes and discharging their effluents into streams either directly or after partial treatment. Increased output results in greater waste.

According to the World Health Organization (WHO), more than half of all medications are prescribed and marketed incorrectly, wasting storage space and posing harm to the environment. Noncompliance with medication might also result in storage at home. Nearly half of all patients do not take their medications exactly as prescribed. As a result, more frequently than not, families and patients are in possession of unused or expired prescriptions, which is drawing worldwide attention (WHO, 2002).

It's tough to quantify pharmaceutical waste. According to one source, between 1992 and mid-1996, 50–60 percent of the 27,800–34,800 metric tonnes of medical goods supplied to Bosnia and Herzegovina were deemed inappropriate, resulting in an estimated 17,000 metric tonnes of worthless pharmaceuticals stacked in warehouses and clinics around the nation (WHO, 1999).

Pharmaceuticals Global Market

Two-thirds of all pharmaceutical manufacturers worldwide are located in just five main nations: the United States, Japan, Germany, the United Kingdom, and France; China and India are regarded as low-cost producers. The pharmaceutical industry in India is the third-largest in the world by volume and the 14th largest by value. It is increasing at a pace of approximately 8% to 9% annually (Chander et al., 2016). In China and India, there are about 7500 and over 20,000 pharmaceutical units.

Fig. 1 displays the pharmaceutical production by continent at the global level.

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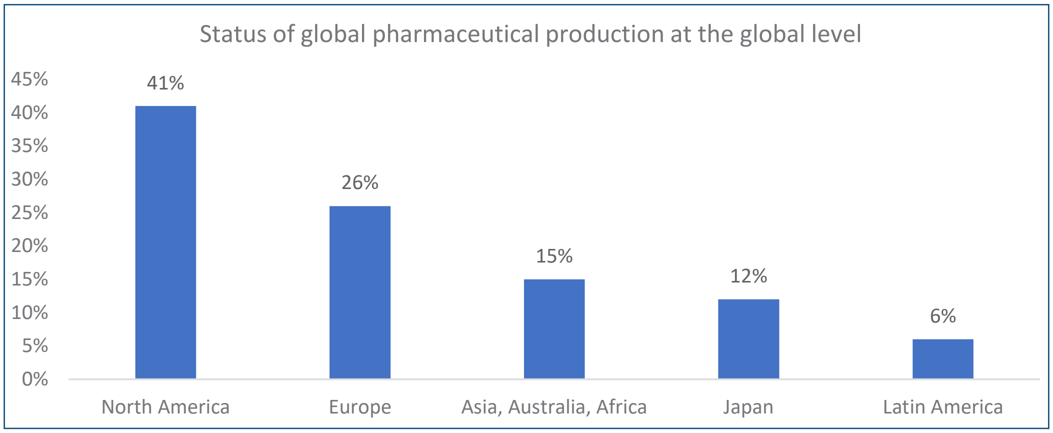

Fig. 1: Status of Global Pharmaceutical Production as Per Continent

In 2021, India's domestic pharmaceutical market is expected to be worth US$ 42 billion, rising to US$ 65 billion by 2024 and US$ 120-130 billion by 2030. In terms of volume, Indian medicines account for 20% of the global pharmaceutical industry and 1.4% in terms of value. India is the world's top supplier of generic pharmaceuticals. In terms of volume, Indian generics account for 20% of global exports and meet over 50% of global demand for various vaccines, 40% of generic demand in the United States, and 25% of all pharmaceuticals in the United Kingdom by the year 2025 (IBEF, 2023).

According to the reports from IBEF (India Brand Equity Foundation), the revenue of Indian pharma sector in 2019 was around US$ 20 billion, with an increase of 28% from 2015 (Fig. 2) (IBEF, 2023; EY 2021).

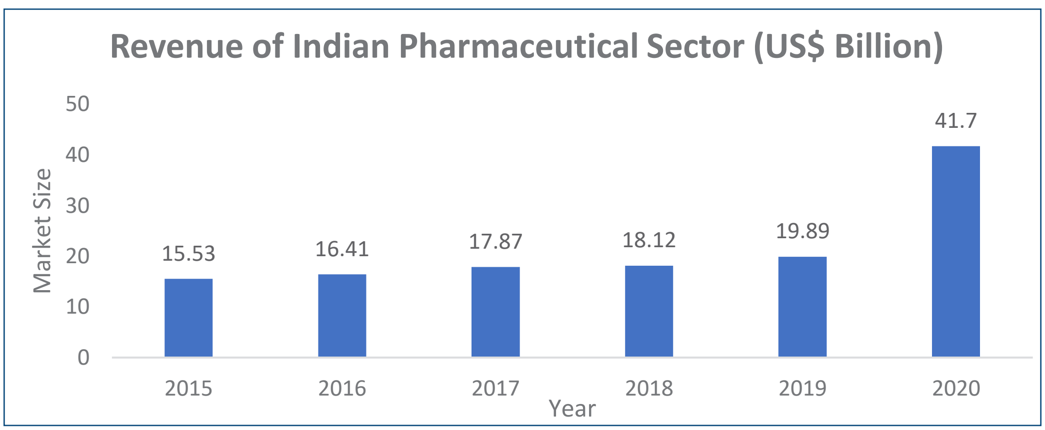

Fig. 2: Revenue of Indian Pharmaceutical Sector

Causes of Medicinal Waste: The reason of medicinal wastes may be classified in two major class that may be preventable or non-preventable (Table 1) (Bekker et al., 2018).

Table 1: Classification of Medicinal Waste

Preventable	*Non-Preventable*
Stockpiling of medicines at home	Patient death
Medicines past their expiry date	Medication is no longer required due to a change in the prescriber's instructions (prescription changes)
Prescription, order, or supply errors (e.g. excess supply of medicine, repeat prescription)	Adverse effect from drugs
Patient non-adherence	Medicines stopped by patient's due resolution of symptoms

Pharmaceuticals' Presence in the Environment: Pharmaceutical substances can infiltrate the environment in a variety of ways, such as through discharge of treated wastewater, seepage from landfills, septic systems, sewer lines, animal wastes, land application of manure fertilizers etc. The presence of pharmaceuticals in drinking water has concerned the public, and the consequences for aquatic ecosystems are even more dangerous (Rodriguez-Mozaz et al., 2010).

The appropriate disposal of unwanted and expired medications is a serious issue because it directly affects the environment and all living things. Pharmaceuticals have been discovered in drinking water sources and wastewater treatment facility effluents. A little amount of pharmaceuticals in drinking water for an extended period of time can have serious consequences for human health and aquatic life (Kümmerer, 2008; Derksen et al., 2004). As indicated in Fig. 3 (self-creation), pharmaceutical chemicals reach the environment through a variety of methods, including discharge of treated wastewater, seepage from landfills, sewer lines, and runoff from animal wastes. Due to a lack of legislation and knowledge, unwanted drugs are frequently dumped into trash and regarded as household waste.

Fig. 3 various paths of pharmaceutical compounds entering the environment.

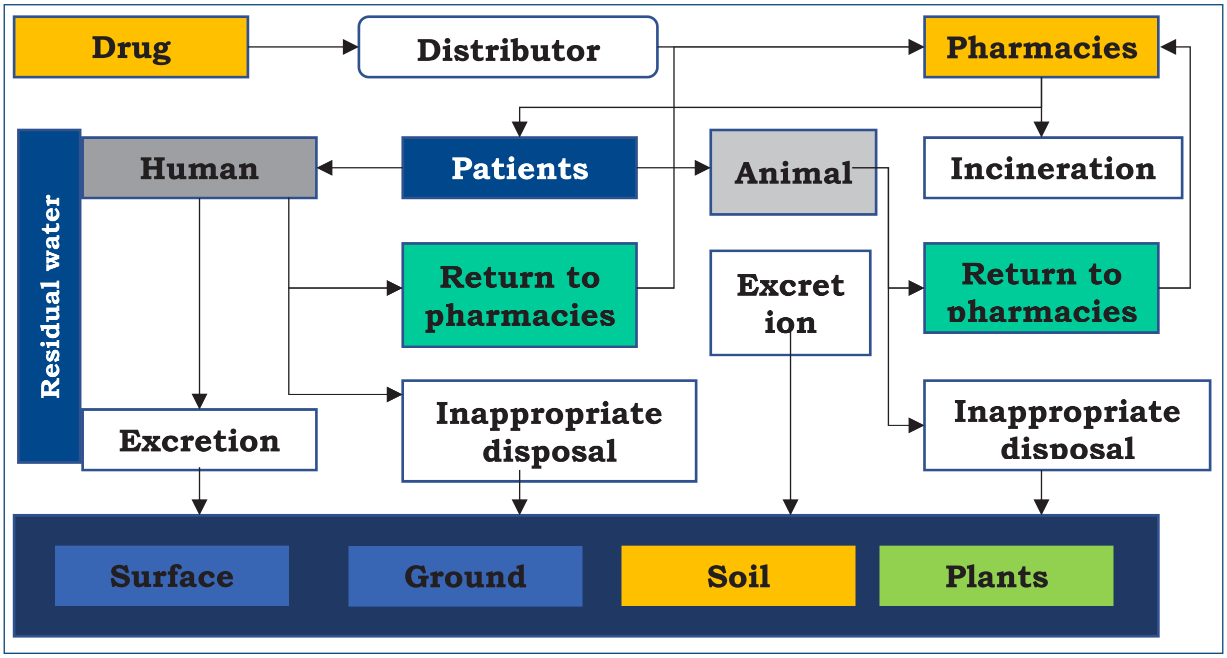

Fig. 3: Various Paths of Pharmaceutical Compounds Entering the Environment

Clofibric acid, a byproduct of a lipid-lowering drug, was discovered in low concentrations in treated wastewater in the United States in 1976. It was discovered in rivers across the United Kingdom and in Canadian wastewater (Strauch, 2011). Pharmaceuticals of various therapeutic classes have been identified in drinking water at concentrations ranging from "parts per billion" to "parts per trillion." Antibiotics and lipid-lowering medicines are currently the most globally active pharmaceutical compounds in the environment, followed by diclofenac, a nonsteroidal anti-inflammatory drug (NSAID) (Ebele et al., 2017). Diclofenac has been shown to be extremely harmful to cattle and vultures (Swan et al., 2006). In the effluent of a sewage treatment plant in Patancheru, Hyderabad, Larsson and his colleagues discovered metoprolol, enrofloxacin, citalopram, norfloxacin, lomefloxacin, ciprofloxacin, losartan, cetirizine and ranitidine. Sulfamethizole, an antibiotic, and antipyrine, an analgesic, were found in drinking water sources in the United States for the first time (Fick et al., 2009). Beside pharmaceuticals, personal care substances have been discovered in wastewater and drinking water all around the world.

Brodin et al. found oxazepam in effluent-influenced surface water at quantities of 1.8 mcg/L (Brodin et al., 2013). In Kerala's Kaveri, Tamiraparani, and Vellar rivers, large amounts of carbamazepine and triclosan were discovered in the surface water (Ramaswamy et al., 2011).

In a monitoring study carried out in California, substances such as acetaminophen (0.32% detection frequency), codeine (0.16%), p-xanthine (0.08%), sulfamethoxazole (0.41%), caffeine (0.24%), carbamazepine (1.5%) and trimethoprim (0.08%) were found at concentrations higher than or equal to the detection limits of selected methods. Furthermore, pesticide (33%) and trihalomethane (28%) detection frequencies in the same sources were reported to be significantly higher. 16 Individual pharmaceutical ingredient concentrations in wastewater treatment effluents are typically less than 1 g/L, while high amounts of many mg/L have been reported in effluent from treatment plants receiving waste from pharmaceutical production facilities.

Instrumental Technique

Advanced techniques were used to confirm the presence of pharmaceutical residues in diverse water samples. The use of advanced techniques has supported researchers to detect, quantify pharmaceutical residues with specific extraction methods. High performance liquid chromatography (HPLC), high-performance liquid chromatography coupled with mass spectrometry (HPLC-MS), from mg/L to ng/L, and high-performance liquid chromatography combined with tandem mass spectrometry (HPLC MS/ MS) are some of the instrumental techniques used to detect these residues (Kim et al., 2009; Madureira et al., 2010; Santos et al., 2009).

Consequences of Improper Disposal

The expired pharmaceuticals are as such not a serious threat to public health or to the environment but its Improper disposal that contributes to contamination of water supplies or local sources used by nearby communities or wildlife may be hazardous. Scavengers may access expired medications kept in locked landfills. Pharmaceuticals may be stolen from a stockpile of expired drugs or during sorting and then sold on the black market for resale. Most medications lose their efficacy after their expiration date, and a few may acquire a new adverse drug reaction profile. Contamination of drinking water, which poses a life-threatening threat, is one of the health risks posed by incorrect disposal. Non-biodegradable antibiotics, antineoplastics, and disinfectants dumped into the sewage system may kill essential bacteria for sewage treatment, causing aquatic life to suffer. Medicine wastes, when burned at low temperatures or in open containers alongside household waste, discharge harmful contaminants into the air.

Presence of Pharmaceuticals in Drinking Water

Emerging Contaminants of Concern

According to the United States Geological Survey, emerging contaminants are "any manmade or naturally occurring chemical or any microbe that is not widely monitored in the environment but has the potential to penetrate the environment and have detrimental ecological and human health effects" (USGS, 2010).

Water from the surface, drinking water, wastewater and sewage treatment plant effluents, and runoffs from concentrated animal feeding operations are all frequent sources and channels for these developing pollutants.

According to the report, 80% of the pollutants were discovered in 139 streams across 30 states. Veterinary and human medications (including antibiotics), hormones, detergent metabolites, plasticizers, fire retardants, and pesticides were among the chemical pollutants (Strauch, 2011).

Environmental Contamination

Pharmaceuticals are released into the environment through a variety of methods, including manufacturing plants, hospital effluents, and land applications. Sewage treatment plants, on the other hand, aren't always successful in removing active compounds from wastewater. As a result, pharmaceuticals make their way into aquatic systems, where they have direct effects on aquatic creatures and eventually enter food chains.

Pharmaceutical residues from treated or untreated sewage effluent have been detected in marine water. Not many studies reveals the effects of various pharmaceutical residues detected in the environment on plant, animal and microbial life. However, there are evidences that even low levels of certain pharmaceuticals residues have both acute and chronic effects on various organisms, as well as indirect potential effects on ecosystems (Patel et al., 2019).

Primary and secondary routes of entry into the environment are used by active medicinal components. Urine containing medications that are renally discharged and faecal contamination from post-consumption metabolism are the primary sources of household waste, with incorrect disposal being the secondary cause. The medications that have not been destroyed by any of the procedures are released into the water supply. Antiseptics, antihypertensive drugs, hormones, contraceptives, antibiotics, and antiviral drugs are all emerging as general environmental contaminants. Physical and biological activities in the aquatic ecosystem result in the reduction of numerous pharmacological substances. However, traces of human and veterinary pharmaceutical chemicals, as well as their metabolites, have been found in a variety of water sources (Daughton et al., 2009).

Pharmaceutical Pollutants: Impact on Water Quality

Many pharmaceutical industries are responsible for generating toxic effluent in the form of biological and chemical compounds during their manufacturing Process that changes the quality of water. Pharmaceutical effluents are also categorized using unusual turbidity, conductivity, COD, TSS, and total hardness. Waste water from a septic tank's inlet and outlet was found to have TDS, BOD, COD, copper, arsenic, selenium, fluoride, and iron concentrations that were 5-10 times higher than the maximum permissible limit in the Patancheru industrial area of Bangaluru, India, which houses a number of pharmaceutical companies (Shivkumar et al., 1995; Kavitha et al., 2012; Lokhande et al., 2011). Estrone, estradiol, and estriol, natural feminine hormones, were measured up to 6 ng/L, 2 ng/L, and 60 ng/L, respectively, which is 20-600 times higher than the allowed limit. Some pharmaceutical category of medicine was found in various number of countries in the aquatic medium (Table 1A)

Drugs like tamoxifen and cyclophosphamide used against breast cancer and Ifosfamide, used for a large variety of cancer have already been detected in surface water. Taloja (Mumbai) industrial area effluents, when tested for pH, temperature, total solids, total dissolved solid (TDS), total suspended solid (TSS), chloride, oil and grease, biochemical oxygen demand (BOD), and chemical oxygen demand (COD) tests all showed greater pollution levels (Lokhande et al., 2011). There have been 69 different therapeutic classes identified as >0.1 mg/L in urban waste water, corresponding to salbutamol and acetaminophen concentrations of 0.10 mg/L and 38.00 mg/L, respectively (Verlicchi et al., 2012). The metabolism of ibuprofen leads to the formation of hydroxyl-ibuprofen (OH-Ibuprofen), carboxy ibuprofen (CAIbuprofen) and carboxy-hydratropic acid (CA-AH) which reaches aquatic environment through metabolic process from human body. The important parameter to determine pollution in industrial waste water are BOD and COD which measures the concentration of organic and inorganic material including nitrogen and phosphorous in terms of oxygen present. The important parameter of water quality also include pH and total suspended solids (TSS) (Gawad et al., 2016).

Table 1A: Pharmaceuticals Found in the Aquatic Medium of Countries

Pharmaceutical	*Category of Medicine*	*Number of Countries*
Diclofenac	Analgesics	50
Estrone	Estrogens	35
Paracetamol	Analgesics	29
Estriol	Estrogens	15
Sulfamethoxazole	Antibacterial	47
17-αEthinylestradiol	Estrogens	31
Ciprofloxacin	Antibacterial	20
Norfloxacin	Antibacterial	15
Ibuprofen	Analgesic	47
17-β-Estradiol	Estrogens	34
Clofibric acid	Lipid lowering	23
Carbamazepine	Anti-epileptic	48
Naproxen	Analgesics	45
Trimethoprim	Antibacterial	29
Ofloxacin	Antibiotics	16
Acetylsalicylic acid	Analgesic	15

In addition, a number of researchers have examined heavy metal concentrations in pharmaceutical wastewater from various parts of India (Table 2) (Singare et al., 2014; Sankpal et al., 2012) and physicochemical properties (Table 3) (Ramola et al., 2013; Singh et al., 2012; Damodhar et al., 2013) which eventually affect water quality.

Table 2: Heavy Metals in Pharmaceuticals Industrial Effluents; ND: Not Detected

Sr. No.	*Test Parameters (mg/l)*	*Sankpal et al. (Ref)*	*Singare et al. (Ref)*	*Ramola et al. (Ref)*	*Lokhande et al. (Ref)*
1	Chromium	2.34	0.57	0.31	30.6
2	Cadmium	ND	-	0.55	35.8
3	Nickel	-	0.43	0.12	33.6
4	Zinc	-	3.31	1.3	26.8
5	Copper	2.30	14.06	0.38	17.6
6	Lead	ND	0.42	0.263	21.7
7	Iron	19.38	18.93	19.38	10.4

One plastics component (bisphenol A), three medications (carbamazepine, sulfamethoxazole, and meprobamate), and the caffeine degradate 1, 7-dimethylxanthine were discovered in more than 0.5 percent of samples, according to a study done in the United States in 2019. The concentration of hydrocortisone was higher than a human-health standard (Bexfield et al., 2019).

A Brazilian study found that pharmaceutical pollution has a variety of negative effects, including harm to wild organisms, the emergence and spread of bacteria that are resistant to antibiotics, disruption of species, ability to reproduce, develop, and survive and an increase in the prevalence of cancer in humans (Freitas et al., 2021).

Table 3: Pharmaceutical Wastewater: Physico-Chemical Parameters

Sr. No.	*Test Parameters, Unit*	*Singare et al. (Ref)*	*Lokhande et al. (Ref)*	*Damodhar et al. (Ref)*	*Singh et al. (Ref)*
1	Conductivity, µs/cm)	27,400	-	1733	1534
2	Total suspended solids,mg/l	2980	654	348	2673
3	Total dissolved solids,mg/l	8741	3412	873	2655
4	Biological oxygen demand,mg/l	546	1083	52	341
5	Chemical oxygen demand, mg/l	1271	2797	218	698
6	Dissolved oxygen, mg/l	3.5-4.7	-	5.78	8.43

Pharmaceutical Pollutants: Impact on Health

Pharmaceuticals found in water bodies have a direct impact on human health, causing respiratory disorders, cancers, reproductive issues, chronic depression, and congenital issues including mental retardation and physical abnormalities. On the other hand, agricultural land productivity is decreased, agricultural infrastructure is altered, and livestock and fish are killed as a result (Cherukupalli, 2010; Wang et al., 2015; WHO, 2013).

According to the World Health Organization (WHO), the Cd content in drinking water that is considered tolerable is 0.003 mg/L, 10 ug/L for lead, and 70 ug/L for nickel (Rehman et al., 2018).

Drinking water can be contaminated with chemicals from industrial sources either directly through discharges or indirectly through diffuse sources caused by the usage and disposal of items and products containing the chemicals. In rare instances, improper treatment and disposal can cause water contamination (Table 4) (WHO, 2011).

Table 4: Natural-Occurring Compounds in Drinking Water with Health Implications have Guideline Values

	Guideline Value		*Remarks*
Chemical	*Ug/l*	*Mg/l*	
Inorganic			
Arsenic	10 (A, T)	0.01 (A, T)	-
Barium	700	0.7	-
Boron	2400	2.4	-
Chromium	50 (P)	0.05 (P)	For total chromium
Fluoride	1500	1.5	Volume of water consumed and intake from other sources should be considered when setting national standards
Selenium	40 (P)	0.04 (P)	
Uranium	30 (P)	0.03 (P)	Only chemical aspects of uranium addressed
Organic			
Microcystin-LR	1 (P)	0.001 (P)	For total microcystin-LR (free plus cell-bound)

Note: P, provisional guideline value due to uncertainties in the health database; A&T provisional guideline value due to calculated guideline value being below the achievable quantification level; provisional guideline value, because the computed guideline value is lower than what can be attained through practical treatment procedures.

A residual amount of pharmaceuticals in drinking water may source considerable adverse effects to human health after extensive exposure as per the standard (IS 10500:2018, Reaffirmed-2017) Table 5 (Indian Standard, 2011).

Table 5: Adverse Effects to Human Health on Long Term Exposure

Test Parameters	*Limits mg/l*		*Impact (if Values are Beyond Limits)*
	AL	*PL*	
Aluminium (as Al)	0.03	0.2	Cumulative effects reported to cause dementia
Copper (as Cu)	0.05	1.5	Render astringent taste
Cadmium (as Cd)	0.003	NR	Toxic, Bio-Accumulative
Cynide (as CN)	0.05	NR	Toxic, Reactive
Lead (as Pb)	0.01	NR	Toxic,Bio-Accumulative
Mercury (as Hg)	0.001	NR	Toxic, Bio-Accumulative
Nickel (as Ni)	0.02	NR	Allergic on high exposure
Total Arsenic (as As)	0.01	NR	Toxic, Bio-Accumulative
Total chromium (as Cr)	0.05	NR	Toxic, Bio-Accumulative
Calcium (as Ca)	75	200	Render hardness,Scaling
E.Coli/100ml	Shall not be detected	Shall not be detected	Meninigitis, Urinary tract and intestinal infection

AL:Allowable limits, PL: Permissible limits (in absence of alternate source) NR-Not required.

Impact of Improper Medicines Disposal

The understanding among the regulatory authorities for the improper pharmaceuticals disposal is that they have poor impact on environment and human life. Unused medicines burying because contamination of ground water, fumes from open burning is harmful for aquatic organism/human health. Dumping of waste unused liquid lead to contamination of water sources. Acute and long-term effects are possible when pharmacological combinations are exposed to streams of water (Crane et al., 2006). The influence may result in tissue buildup, behavioral modifications, and reproductive harm. According to one of the research, fish exposed to wastewater effluents experienced aberrant reproductive behavior. Additionally, fish exposed to traces of birth control pills found in the environment have drastically reduced levels of reproduction (Sanderson et al., 2004).

The recommended technique for disposal is summarised in Table 6, according to WHO guidelines. These methods should be utilised by country regulatory agencies in order to improve drug disposal practices and create a more sustainable environment.

Table 6: Method for Discarding of Unused Medicines as Per WHO

Solids	Landfill - maximum of 1% of daily municipal waste should be disposed of in an untreated (non-immobilised) landfill per day.
Semi-Solids	Encapsulation of waste, incineration, inertification, and landfill.
Powders	Inertia of waste Incineration at medium and high temperatures (cement kiln incinerator).
Liquids	Antineoplastic should not be disposed of in a sewage. Incineration at high temperatures (cement kiln incinerator).
Ampoules	Flush diluted fluid to ETP after crushing ampoules (Effluent treatment plant).
Anti-infective Drugs	Encapsulation of waste Antibiotics in liquid form can be diluted with water, allowed to sit for many weeks, and then disposed of in a sewer. Inertia of waste Incineration at medium and high temperatures (cement kiln incinerator).
Antineoplastics	Return to the maker or the donor Unless enclosed, do not place in landfill. Encapsulation of waste It is not acceptable to sewer. Inertia of waste There will be no incineration at a medium temperature. Incineration at medium and high temperatures (cement kiln incinerator) (chemical decomposition).
Controlled Drugs	Encapsulation of waste unless enclosed, do not place in landfill. Inertia of waste Incineration at medium and high temperatures (cement kiln incinerator).
Aerosol Canisters	Landfill Encapsulation of waste Not to be burned: it has the potential to explode.
Disinfectants	Use Small amounts of diluted disinfectants should be added to a sewer or a fast-flowing stream (max. 50 litres per day under supervision). There will be no undiluted disinfectants in drains or waterways.
Paper, Cardboard	Landfill, Recycle and burn.

REGULATIONS AND LAWS

In order to prevent environmental deterioration, the regulatory bodies for the pharmaceutical industry must ensure consistent monitoring and application of the regulations governing the proper disposal of medical waste. Some of the Legislation and regulatory authority of the countries are mentioned in Table 7.

The Water Act of 1974 and the Water Cess Act of 1977 established the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs), which gave people in India the option of paying a fine for breaking the law (Maria, 2003). To enforce the regulations governing the pharmaceutical industry, the CPCB (Central Pollution Control Board) created Minimum National Acceptable Standards (MINAS) (Central Pollution Control Board, 2023).

According to the Drugs and Cosmetics Act and rules of the Government of India's Ministry of Health and Family Welfare (Department of Health), sewage and effluents (solid, liquid, and gas) from the factory must be disposed of in accordance with the requirements of the Environment Pollution Control Board.

The regulations of Bureau of Indian Standards (BIS) have not yet specified any allowable limits for pharmaceutical detection in wastewater or drinking water (Patneedi et al., 2015).

As per the gazette of India published on 12th August, 2021 (Ministry of Environment, Forest and Climate Change Notification, New Delhi), have notified Bulk Drug and Formulation Pharmaceutical effluent in the Environment (Protection) Rules, 1986, in Schedule-l, serial number 73. Various test parameters such as pH, BOD, COD,TSS, Ammonical nitrogen and Bio assay have been introduced with the Limiting value for concentration (in mg/l except for pH and Bio assay) (The Gazette of India, 2011).

The US Fish and Wildlife Service, the American Pharmacists Association, and the Pharmaceutical

Research and Manufacturers of America created the SMARxT Disposal public awareness campaign in 2007. The purpose to formally educate and inform people about how to securely dispose of unneeded medicines: (I) do not flush or pour unwanted medications down the drain; (2) dispose of unwanted medicine in household garbage after sealing it and mixing it with cat litter, coffee grounds, or sawdust to make it less appealing to pets and children; and (3) remove any personal identifying labels from the packaging before recycling.

Since 2010, the US Drug Enforcement Administration has sponsored an annual programme known as National Prescription Drug Take Back Day in states around the country, when consumers can dispose of unneeded drugs, particularly those classified as controlled substances. This programme has been successful in getting dangerous narcotics and controlled substances out of drug cabinets and eventually out of the environment. Governments have also established their own medicine collection systems, each with its own set of restrictions, limits, and methods (CBS News, 2023).

In Australia, a non-profit programme called Return Unwanted Pharmaceuticals (RUM) was launched in 1998, and it was the first of its kind to manage and eradicate unused and expired medicines. People could return unused prescriptions at any time to a specific type of container at any pharmacy; the medications were subsequently destroyed according to Australian EPA requirements, preserving the environment and water supply from harmful substances (RUM Project, 2023).

Table 7: Legislation and Regulatory Authority of Countries

Country	*Regulatory Authority*	*Legislation*
India	Ministry of Environment forest and climate change	Bio-Medical Waste Management & Handling Rules, 2016
Mauritius	Ministry of Health, Ministry of Environment	Environment Public Health Act, 1925 and Standards for Hazardous Waste Regulations, 2001
Laos	Ministry of Health	Healthcare Waste Management Regulation, 2004
Pakistan	Ministry of Environment	Hospital Waste Management Rules, 2005
Vietnam	Ministry of Health	Regulation on Healthcare Waste Management
Nepal	Ministry of Population and Environment	National Health Care Waste Management Guidelines, 2002
Cambodia	Ministry of Health	Natural Resources Management and Environmental Protection 1996 and Sub decree on Solid Waste & Hazardous Substance Management 1999.
Mongolia	Minister of Health and DG of the National Emergency management	Regulations on Removal and Disposal of Hazardous Waste (2002)
China	Ministry of Health	State Environmental Protection Administration Medical Waste Control Act 380
Iran	Ministry of Health	Medical Waste Management Regulations, 2008
Turkey	Ministry of Environment and Forestry	Medical Waste Control Regulation, 1993, 2005

Penalty for the Violation

Pharmaceuticals circulate in the environment primarily through aquatic medium, followed by food-chain dissemination. The exposed population's health is unquestionably jeopardised if incorrect medicine disposal techniques are used. As a result, certain regulations have established fines for such violations.

If an industry's effluent does not comply with the Water Act, SPCBs have the jurisdiction to restrict power, shut down the plant, or even file a public interest lawsuit in the Supreme Court.

According to Chapter III of the Environment Protection Act of 1986 (Prevention, Control, and Abatement of Environmental Pollution), whomever fails to comply with any of the Act's provisions;

Be punishable by imprisonment for a term of up to five years or a fine of up to one lakh rupees, or both, and, if the failure or contravention continues, by an additional fine of up to five thousand rupees for each day during which the failure or contravention continues after the conviction for the first such failure. The offender faces a sentence of up to seven years in prison if the failure or violation persists for more than a year from the date of conviction (Bakshi, 1992).

The Ministry of Environment & Forests (MoEF) notified the Bio-medical Trash Management Rules, 2016 pertaining to academic institute waste under the Environment (Protection) Act, 1986 (Central Pollution Control Bo, 2017).

CONCLUSION

Continuous release of waste pharmaceuticals in various forms is having a rising influence on the environment, which is a major issue. The methods for properly disposing of unused pharmaceuticals that are now accessible do not provide enough environmental protection. Due to the lack of medical activist groups in India, such topics are rarely discussed in the media.

Medicine distribution is currently unregulated, and the amount of medicine that ends up in the environment is undoubtedly far more than anticipated. Because the monitoring agencies are not watchful, the public continues to be exposed. If it is not managed, it will have a significant negative influence on the ecosystem.

The government should act quickly and implement measures to reduce pharmaceutical waste in the environment. Pharmaceutical emissions should essentially be included in GxP. The packaging from discarded pharmaceuticals such as paper, glass, and plastic should be separated and recycled. Treatment options vary depending on the type of material and its intended application.

According to the findings, a system of take-back policies should be in place to collect leftover medicines from homes or collection places. Simultaneously, health authorities should organize an awareness and training programme for all practitioners, nurses, pharmacists, and pharmacy shops or retailers in order to urge the reduction of surplus medicine supply. As a result, consumers are becoming more aware of proper pharmaceutical disposal as well as the detrimental impact of wasted prescriptions. The study of the most regularly used pharmaceutical chemicals in drinking water should be included in India's water quality recommendations. To prevent long-term environmental and health risks, remedial actions must be implemented across the board in pharmaceutical industrial unit effluent treatment plants.

Authorisation should be governed, markets should be regulated, and legislation should be strengthened. Individuals' attitudes about garbage disposal, as well as waste management and treatment, must be legally regulated.

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