



## Systematic Review on Fate of Unused Antibiotics: A Review

Shrijal M Rao <sup>a</sup>, Dr. Christy T Chacko <sup>b\*</sup>

<sup>a</sup> Student, Pharm. D, Srinivas College of Pharmacy, Mangalore, Karnataka, India - 574143

<sup>b</sup> Associate Professor, Department of Pharmacy Practice, Srinivas College of Pharmacy, Mangalore, Karnataka, India – 574143

DOI: <https://doi.org/10.55248/gengpi.5.0224.0516>

### ABSTRACT

Antibiotics, hailed as miraculous remedies against microbes, have been extensively utilized for therapeutic and prophylactic purposes in various sectors, including agriculture and animal husbandry. However, the rise of antibiotic resistance poses a significant challenge, often unnoticed by the public. This review delves into the public's practices concerning the disposal and storage of unused or expired antibiotics, examining their awareness of antibiotic resistance, regulations, and associated challenges. As the market continues to introduce numerous drugs daily for diverse ailments, the responsible disposal of these medications becomes crucial due to their chemical nature, turning toxic upon expiration. While the USFDA has implemented a 'drug take back program' to prevent environmental contamination, a similar initiative is lacking in India, leading to problems such as improper drug disposal through burning, flushing, or discarding, causing environmental pollution. The review identifies a concerning increase in antibiotic resistance, rendering infections like pneumonia, tuberculosis, and gonorrhoea more challenging to treat. The indiscriminate use of antibiotics is a primary driver of microbial resistance, contributing to a limited repertoire for treating multidrug-resistant bacterial infections and resulting in elevated morbidity and mortality. Existing literature underscores the insufficient knowledge among the population regarding antibiotic resistance. Therefore, there is a pressing need to educate the public on the proper disposal of antibiotics, promote drug take-back programs, and address the issue of antimicrobial resistance.

Keywords: *antibiotic resistance, knowledge, rational use, antibiotic disposal, drug take back programme* .

### 1. Introduction

Addressing the responsible use of medications is essential, and the improper disposal of pharmaceuticals that are unused, stored, or expired poses a significant issue <sup>[1]</sup>. A large portion of medication users lacks awareness of proper disposal methods, leading them to flush or discard their unwanted and expired medicines <sup>[2]</sup>. This inappropriate disposal results in contamination of the environment, affecting landfills, water supplies, and drains, with potential toxic effects on humans, animals, and marine life <sup>[3]</sup>. Literature underscores the detrimental health impacts on humans, animals, and aquatic life due to improperly disposed medicines <sup>[3]</sup>. Therefore, proper medicine disposal is a crucial aspect of managing medications.

In line with the concerns mentioned, the World Health Organization has developed a practical guide focusing on Health Care Waste Management, which includes guidelines for the disposal of unused and expired medicines <sup>[4]</sup>. It is emphasized that leftover antibiotics should be disposed of appropriately. The Food and Drug Administration (FDA) provides guidelines for the safe disposal of unused medications, including antibiotics <sup>[5]</sup>. However, it remains unknown whether healthcare providers offer clear instructions for the disposal of leftover antibiotics or how parents dispose of antibiotics remaining from their children's prescriptions. Leftover antibiotics may be stored for future use, either by the original patient or others for whom the antibiotics were not prescribed. Recent studies indicate that parents in the United States often retain leftover antibiotics and share them without consulting a physician, potentially contributing to antimicrobial resistance and adverse drug consequences <sup>[6, 7]</sup>. Moreover, antibiotics may be improperly disposed into the environment, with rural water supplies showing detectable antibiotic residues from direct disposal by surrounding residents <sup>[8]</sup>, and reclaimed water used for irrigation containing low-level antibiotic concentrations even after treatment <sup>[9]</sup>. This unregulated environmental exposure has the potential to impact the resistance profiles of soil microbiota, which are crucial potential sources of human pathogens, thereby significantly affecting human and animal health <sup>[10]</sup>.

Medicines play an integral role in the healthcare system, with millions of people taking them daily for various purposes. Expired drugs, unused, or unwanted medicines may accumulate due to non-adherence, excessive storage of over-the-counter medication, or misuse of drugs <sup>[11-14]</sup>. Common methods employed by the general population to dispose of these medications include throwing them into the dustbin or other locations, burning, and flushing them into the sink or toilet <sup>[15-17]</sup>.

### **1.1 Disposal Methods:**

#### **1. Throwing into Dustbin:**

- This is a prevalent but inappropriate method where individuals discard medications into the dustbin or store them at home when no longer needed.
- The attractive packaging of medications designed for better patient compliance poses a risk, as children or pets may ingest expired or unused medicines, leading to potential toxicity or poisoning.
- Disposing medications in waste bins ultimately leads to landfills, contributing to environmental and health hazards <sup>[11,18]</sup>.

#### **2. Burning:**

- Burning is another improper disposal method where medications, being chemical compounds, are either organic or inorganic.
- The act of burning releases various chemical pollutants into the atmosphere, posing dangers to inhalation.
- Serious issues such as drug toxicity, drug resistance, and even sudden death due to poisoning conditions may arise from burning medications <sup>[12]</sup>.

#### **3. Flushing into Sink or Toilet:**

- This method is commonly used for liquid medicines that are unused or expired.
- Flushing medications down sinks or toilets contaminates water sources, with studies reporting excessively high levels of drug residues in water bodies, leading to microbial resistance <sup>[19,20]</sup>.
- Research indicates the presence of antibiotic-resistant bacteria and genes in water treatment plants, suggesting a potential link between improper drug disposal and treatment failure <sup>[12]</sup>.
- While the chances of toxicity are lower due to dilution, the U.S. Food and Drug Administration (USFDA) acknowledges it as an alternative method for certain medicines, particularly centrally acting ones, if a drug take-back system is unavailable <sup>[12]</sup>.

### **1.2 Environmental Consequences and Solutions:**

#### **Drug Take Back Programme:**

- The Drug Take Back Programme, initiated by the Food and Drug Administration (FDA), aims to provide a safe, convenient, and responsible means of disposing prescription drugs.
- On designated "drug-take back days," authorized collectors from the Drug Enforcement Administration (DEA) collect unused, unwanted, or expired medications from the public.
- Despite its success in collecting over 200 pounds of unused medications, the program is not effectively functional in India, contributing to improper drug disposal <sup>[14,15,17]</sup>.

#### **Environmental Impact in India:**

- Improper methods of disposal, such as throwing, burning, or flushing, prevalent in Indian households, lead to hazardous effects on nature and life, including accidental poisoning, drug abuse, drug resistance, toxicities, and death.
- With India's population surpassing 135 crores, widespread adoption of these practices poses a significant threat to public health and safety.
- The absence of an efficient and authorized system or program exacerbates these activities, necessitating legislative steps to prevent further deterioration.

#### **Legislative Measures:**

- Efforts should be directed towards efficient legislative steps to control improper drug disposal, ensuring public health and safety.
- The Drug Take Back Programme, as well as other disposal systems like mail drops and medicine drop boxes, needs to be made efficient and functional in India.
- While provisions for pharmaceutical industry waste disposal exist in the Biomedical Waste Management Rules 2016, specific and effective provisions for household drug disposal and public education are lacking [26].

In conclusion, immediate and effective measures are essential to prevent the degradation of the environment and public health due to improper drug disposal practices in India.



**Fig. 1 - Disposal methods**

## Objectives

- Demote to body text The primary objective of this study was to investigate how the general public handles the disposal and storage of antibiotics that are unused or expired.
- Ensuring the proper disposal of antibiotics is crucial for maintaining environmental safety and promoting participation in drug take-back programs.

## Methodology

This study employed a rigorous methodology, employing specific inclusion and exclusion criteria. Inclusion criteria focused on articles exclusively addressing practices related to the use and management of unused antibiotics, while exclusion criteria filtered out irrelevant articles. A thorough literature search utilized reputable sources like PUBMED, WHO, FDA, and Google Scholar. Identified articles underwent meticulous evaluation for relevance to the study's objectives. Selected articles were read, critically assessed, and their findings were meticulously interpreted and synthesized to present a cohesive summary, offering valuable insights into prevailing practices related to unused antibiotics in the healthcare domain.

## Future prospective

This review can be extended to a larger span to derive the best conclusions to present to the public and the government for necessary interventions.

## Conclusion

A significant number of individuals are engaging in improper drug disposal practices, with a lack of awareness about the potential consequences of antibiotic resistance. Moreover, a considerable portion of the population is uninformed about the existence of drug take-back systems or other secure methods for disposing of drugs. Thus, there is an urgent requirement to raise awareness regarding antibiotic resistance and to establish initiatives like the drug take-back program, along with other safe drug disposal systems.

## Acknowledgements

I am grateful to the Research Guide, Principal, and Management of Srinivas College of Pharmacy in Mangalore for providing all of the essential resources to complete this research.

---

**References**

---

1. WHO. (2004). WHO medicines strategy: countries at the core 2004–2007.
2. Bashaar, M., Thawani, V., Hassali, M. A., & Saleem, F. (2017). Disposal practices of unused and expired pharmaceuticals among general public in Kabul. *BMC public health*, 17, 1-8.
3. Kinrys, G., Gold, A. K., Worthington, J. J., & Nierenberg, A. A. (2018). Medication disposal practices: increasing patient and clinician education on safe methods. *Journal of International Medical Research*, 46(3), 927-939.
4. Stanojević, K., Radovanović, G., Makajić-Nikolić, D., Savić, G., Simeunović, B., & Petrović, N. (2022). Selection of the optimal medical waste incineration facility location: A challenge of medical waste risk management. *Vojnosanitetski preglad*, 79(2), 125-132.
5. Bicket, M. C., Fu, D., Swarthout, M. D., White, E., Nesbit, S. A., & Monitto, C. L. (2021). Effect of drug disposal kits and fact sheets on elimination of leftover prescription opioids: the DISPOSE multi-arm randomized controlled trial. *Pain Medicine*, 22(4), 961-969.
6. Milanaik, R., Kahan, T. F., & Nair, M. (2019). Diversion of prescription antibiotics: Should you take from Peter to treat Paul.
7. Bharath, A., Sathian, U., Zmitrovich, A., Shane, A. L., Escoffery, C., Kelleman, M. S., ... & Jaggi, P. (2021). Pediatric caregiver behaviors related to oral antibiotic use. *Journal of the Pediatric Infectious Diseases Society*, 10(11), 1033-1036.
8. Chen, D., Liu, S., Zhang, M., Li, S., & Wang, J. (2018). Comparison of the occurrence of antibiotic residues in two rural ponds: implication for ecopharmacovigilance. *Environmental monitoring and assessment*, 190, 1-11.
9. Kulkarni, P., Olson, N. D., Raspanti, G. A., Rosenberg Goldstein, R. E., Gibbs, S. G., Sapkota, A., & Sapkota, A. R. (2017). Antibiotic concentrations decrease during wastewater treatment but persist at low levels in reclaimed water. *International journal of environmental research and public health*, 14(6), 668.
10. Christou, A., Agüera, A., Bayona, J. M., Cytryn, E., Fotopoulos, V., Lambropoulou, D., ... & Fatta-Kassinos, D. (2017). The potential implications of reclaimed wastewater reuse for irrigation on the agricultural environment: the knowns and unknowns of the fate of antibiotics and antibiotic resistant bacteria and resistance genes—a review. *Water research*, 123, 448-467.
11. Klein, E. Y., Van Boeckel, T. P., Martinez, E. M., Pant, S., Gandra, S., Levin, S. A., ... & Laxminarayan, R. (2018). Global increase and geographic convergence in antibiotic consumption between 2000 and 2015. *Proceedings of the National Academy of Sciences*, 115(15), E3463-E3470.
12. World Health Organization, International Pharmaceutical Association, & International Solid Waste Association. (1999). Guidelines for safe disposal of unwanted pharmaceuticals in and after emergencies (No. WHO/EDM/PAR/99.2). World Health Organization.
13. Shwetha, N., & Jha, A. (2018). Knowledge and awareness regarding safe drug disposal system among general population of India. *J Pharmacovigil*, 6(2), 256.
14. Aditya, S., & Singh, H. (2013). Safe medication disposal: Need to sensitize undergraduate students. *International Journal of Pharmacy & Life Sciences*, 4(3).
15. Udupa, N., Muragundi, P. M., Naik, A. N., & Janodia, M. (2013). Disposal of date expired and unused medicines in india—a conceptual framework. *Value in Health*, 16(3), A269.
16. Swaroop, H. S., Charaborty, A., & Virupakshaiyah, A. (2015). Knowledge, attitude and practice of medical professionals towards the safe disposal of unused medications in South India. *World J Pharm Pharm Sci*, 4(5), 1423-30.
17. Maharana, S., Paul, B., Dasgupta, A., & Garg, S. (2017). Storage, reuse, and disposal of unused medications: A cross-sectional study among rural households of Singur, West Bengal. *International Journal of Medical Science and Public Health*, 6(7), 1185-1190.
18. Paul, S. D., & Gandhi, S. Fate of Improper Drug Disposal and its Impact on Health.
19. Lagishetty, R., Nagarajan, P., & Ponniah, T. (2015). Education on disposal of medicines-A concept on safe disposal of drugs in curriculum of Indian Education system. *World Journal of Pharmaceutical Sciences*, 1592-1597.
20. Davies, J., & Davies, D. (2010). Origins and evolution of antibiotic resistance. *Microbiology and molecular biology reviews*, 74(3), 417-433.
21. <https://scroll.in/author/13198>
22. Lamba, M., & Ahammad, S. Z. (2017). Sewage treatment effluents in Delhi: A key contributor of  $\beta$ -lactam resistant bacteria and genes to the environment. *Chemosphere*, 188, 249-256.
23. US Food and Drug Administration. (2017). Disposal of unused medicines: what you should know. Webpage accessed, 2(7), 14.
24. AC, B. (2008). 2007 annual report of the American Association of Poison Control Centers' national poison data system (NPDS): 25th annual report. *Clin Toxicol*, 46, 927-1057.

- 
25. Fass, J. A. (2011). Prescription drug take-back programs. *American Journal of Health-System Pharmacy*, 68(7), 567-570.
  26. Parida, A., Capoor, M. R., & Bhowmik, K. T. (2019). Knowledge, attitude, and practices of Bio-medical Waste Management rules, 2016; Bio-medical Waste Management (amendment) rules, 2018; and Solid Waste Rules, 2016, among health-care workers in a tertiary care setup. *Journal of laboratory physicians*, 11(04), 292-296.