RESEARCH PAPER

Knowledge, Attitude and Practices Regarding Eco-pharmacovigilance and Safe Medicine Disposal Among Healthcare Professionals: Implications for Pharmaceutical Pollution and Antimicrobial Resistance.

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Abstract

Background: Improper disposal of medicines into the environment constitutes a significant public health and ecological concern. Eco-pharmacovigilance focuses on identifying, assessing and preventing the adverse environmental effects of pharmaceuticals. Healthcare professionals play an important role in promoting rational use of medicines and educating patients about safe disposal practices. Hence, the present study was done to assess the knowledge, attitude and practices regarding eco-pharmacovigilance among healthcare professionals.

Methods: A cross-sectional questionnaire-based study was conducted among 153 healthcare professionals. A validated semi-structured questionnaire assessed demographic characteristics and knowledge, attitude and practices related to eco-pharmacovigilance. Data were analyzed using descriptive statistics and Chi-square test to determine associations between variables. A p-value <0.05 was considered statistically significant.

Results: Among 153 participants, 54.4% were aware of eco-pharmacovigilance. Only 46.7% were aware of drug take-back systems. A large majority (83%) believed that there should be a system to collect unused medicines from households. Nearly all respondents (98.7%) agreed that consumers should be educated about hazards of improper medicine disposal. Regarding disposal practices, 33.4% reported discarding unused medicines in household garbage and another 32.2% kept medicines at home until expiry. Statistical analysis showed a significant association between professional role and awareness of eco-pharmacovigilance ($p = 0.047$) and between years of experience and awareness of drug take-back systems ($p = 0.026$).

Conclusion: The study revealed moderate awareness but positive attitudes toward eco-pharmacovigilance among healthcare professionals. However, disposal practices remain sub-optimal. Strengthening eco-pharmacovigilance practices among healthcare professionals may contribute to environmental sustainability and antimicrobial resistance containment.

Keywords: Eco-pharmacovigilance, drug disposal, pharmaceutical pollution, healthcare professionals, environmental safety, antimicrobial resistance.

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1. Introduction

Eco-pharmacovigilance (Eco-PV) is an emerging concept in pharmacovigilance concerned with detection, assessment, understanding and prevention of adverse effects related to the presence of pharmaceuticals in the environment, which affect human and other animal species.1 Pharmaceutical residues are recognized as emerging environmental contaminants associated with ecological toxicity, causing adverse effects on aquatic organisms, endocrine disruption, and decline in wildlife populations. Few studies have also reported antibiotic resistance due to environmental exposure of medications.2-5

National Formulary of India, 2011, and World Health Organization has formulated specific guidelines for disposal of unused medicines.6,7 Although, Healthcare professionals act as critical stakeholders in reducing pharmaceutical pollution through rational prescribing, patient counseling, and promotion of environmentally safe disposal practices, awareness regarding eco-pharmacovigilance among them remains inadequately

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explored in developing countries. Understanding the knowledge, attitudes and practices of healthcare professionals is essential for designing effective educational and policy interventions aimed at reducing pharmaceutical pollution.

2. Materials and Methods

This cross-sectional descriptive study was conducted using pre-designed, validated, semi-structured questionnaire8 by personal interview of HCPs (Doctors, Nurses) of a tertiary care teaching hospital, Bengaluru after obtaining clearance from Institutional Ethics Review Board. Healthcare professionals who provided informed consent and completed the questionnaire were included in the study. Convenience sampling technique was used for participant recruitment. Questionnaire with information on demographic details (age, gender, professional role, years of experience), questions on knowledge, attitude and practices of Eco-PV was distributed through Google form and data was collected. The questionnaire was reviewed for face and content validity by subject experts prior to administration. No personal information was collected or stored.

Statistical Analysis

Data were entered and analyzed using Microsoft Excel. Descriptive statistics were used to summarize the responses and were presented as frequencies and percentages. The Chi-square test was used to determine associations between demographic variables and knowledge of Eco-PV. A p-value less than 0.05 was considered statistically significant.

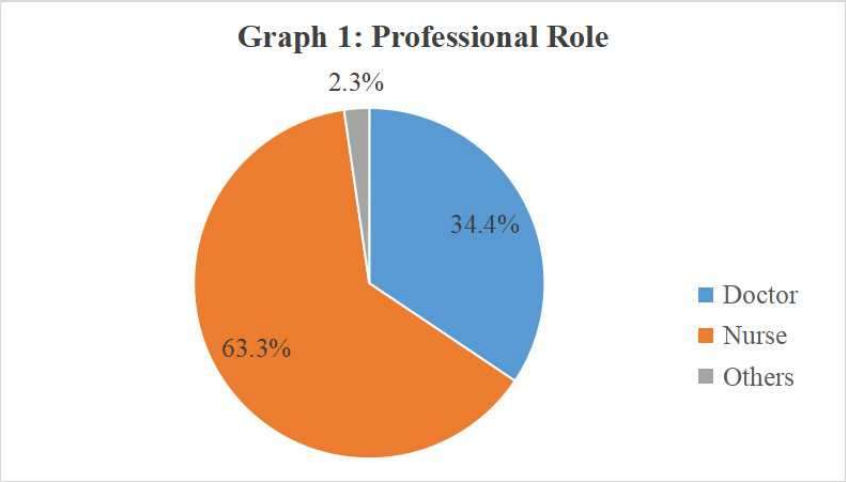
3. Results

Demographic Characteristics: A total of 153 healthcare professionals participated in the study. Among them, most respondents were aged 20–30 years (53.3%) and females constituted 65.6% of the study population.(Table 1)

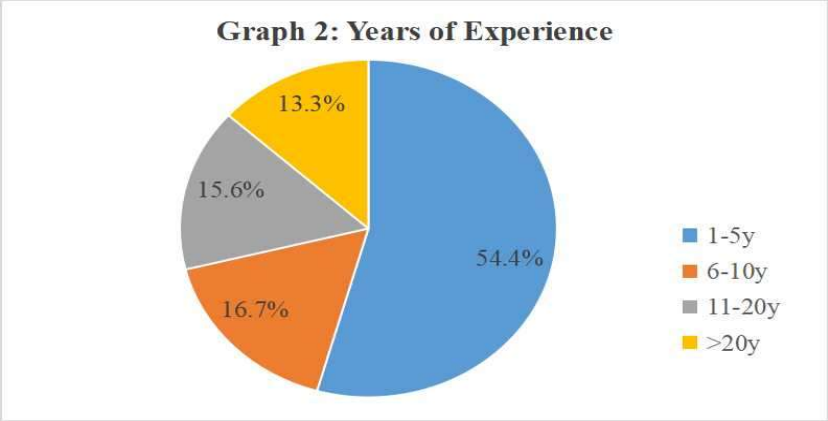
Table 1: Demographic details

Table 1: Demographic details		**n = 153 (%)**
Age (years)	20-30	82 (53.3%)
	31-40	36 (23.3%)
	41-50	17 (11.1%)
	51-60	10 (6.7%)
	>60	8 (5.6%)
Gender	Male	53 (34.4%)
	Female	100 (65.6%)

In terms of professional role, nurses represented the largest proportion (63.3%), followed by doctors (34.4%) and other healthcare professionals (2.3%) (Graph 1) and more than half of the respondents (54.4%) had 1–5 years of professional experience.(Graph 2)



Graph 1: Professional role



Graph 2: Years of Experience

Knowledge Regarding Eco-Pharmacovigilance (Table 2)

Table 2: Knowledge Questions Regarding Eco-PV

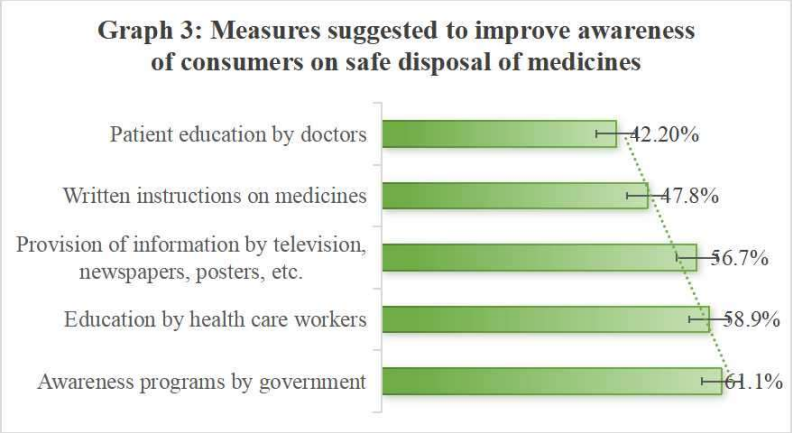
Table 2: Knowledge Questions Regarding Eco-PV		**n=153 (%)**
Have you ever heard about eco-pharmacovigilance?	Yes	83 (54.4%)
	No	70 (45.6%)
What do you understand by the expiry of medicines?	Loss of shelf life	114 (74.5%)
	Production of toxins	26 (17%)
	Treatment failure	13 (8.5%)
Do you know about any drug take-back system?	Yes	71 (46.7%)
	No	82 (53.3%)

The most common reasons stated why antimicrobial should not be discarded in sewage water were Antimicrobial resistance, Environmental hazards, Environmental pollution and Public health hazards.

Attitude Toward Safe Disposal of Medicines (Table 3) (Graph 3)

Table 3: Attitude Questions

Table 3: Attitude Questions		**n=153 (%)**
Do you think that there is a need of a system to collect unused medicines from home?	Yes	127 (83%)
	No	26 (17%)
Do you think that consumers should make aware of hazards of unsafe disposal and safer methods of drug disposal?	Yes	151 (98.7%)
	No	2 (1.3%)
Do you need training regarding safe disposal methods for unused medicines?	Yes	133 (86.9%)
	No	20 (13.1%)



Graph 3: Measures suggested to improve awareness of consumers on safe disposal of medicines

Practices Related to Medicine Procurement and Disposal (Table 4)

Table 4: Practice Questions

Sl no	Table 4: Practice Questions		n= 153 (%)
1	Do you buy drugs in bulk for family members?	YES	48 (31.1%)
		NO	105 (68.9%)
2	Do you always check expiry date before the procurement of medicines?	YES	148 (96.7%)
		NO	5 (3.3%)
3	*What are ways by which you procure medicines for your personal use? (multiple responses allowed)	Purchase on prescription	145 (94.4%)
		Purchase over the counter	39 (25.6%)
		Purchase upon advice of known person	12 (7.8%)
		Purchase after seeing an advertisement	5 (3.3%)
		Receive from friends and others	7 (4.4%)
4	What do you do with unused medicines?	Throw away	53 (33.4%)
		Keep it at home till it expires	49 (32.2%)
		Return to medical store	43 (27.8%)
		Donate to hospital	9 (5.6%)
5	What is the number of unused medicines at your home?	1-5	107 (70%)
		6-10	34 (22.2%)
		11-15	9 (5.6%)
		16-20	0
		>20	3 (2.2%)
6	*Classes of unused drugs at your home (multiple responses allowed)	Analgesics	82 (53.3%)
		Antipyretics	66 (43.3%)
		Antibiotics	63 (41.1%)
		Antacids	63 (41.1%)

		Topical preparations	54 (35.6%)
		Vitamins and mineral preparations	44 (28.9%)
		Antihistamines	37 (24.4%)
		Antihypertensives	17 (11.1%)
		Antidiabetics	12 (7.8%)
7	Large quantity of leftover dosage form at your home?	Tablet	92 (60%)
		Creams/ointments/ Lotions	41 (26.7%)
		Oral liquids	12 (7.8%)
		Capsules	7 (4.4%)
		Lozenges	2 (1.1%)
		Respules	0
8	*Reasons for possession of unused medicines at your home? (multiple responses allowed)	Prescribed more than needed	43 (27.8%)
		Change in treatment strategy by physician	56 (36.7%)
		Self-discontinuation after symptomatic relief.	54 (35.6%)
		Purchased over the counter and not used	24 (15.6%)
		Passed expiry date	32 (21.1%)
9	Possible reasons for discarding the household medicines?	Expired	90 (58.8%)
		Were left unused since long time	56 (36.6%)
		Storage conditions were not maintained	7 (4.6%)
10	Which of the following methods is likely to be followed by the common people for disposal of household medicines?	Throwing in garbage or household thrash	89 (58.2%)
		Burning at home	17 (11.1%)
		In sink water	10 (6.5%)
		Throwing open air	5 (3.3%)
		All of the above	32 (20.9%)
11	*Have you practiced any of the following accepted methods at home for safe disposal of medicines? (multiple responses allowed)	Donate to hospital	22 (14.4%)
		Return to medical store	51 (33.3%)
		Burial in backyard	53 (34.6%)
		Flushing of liquid medicament in sewer after diluting with water	39 (25.5%)

Statistical Associations (Table 5): Chi-square analysis revealed a significant association between professional role and awareness of Eco-PV ($\chi^2 = 6.09$, $p = 0.047$). Years of professional experience were also significantly associated with awareness of drug take-back systems ($\chi^2 = 9.24$, $p = 0.026$). However, no statistically significant association was found between gender and awareness of Eco-PV ($p = 0.866$).

Table 5: Association between demographic variables and awareness

Variables compared	**χ2 value**	**p value**
Professional role vs EPV awareness	6.09	0.047*
Experience vs take-back awareness	9.24	0.026*
Gender vs EPV awareness	0.028	0.866

4. Discussion

The present study assessed the knowledge, attitude and practices regarding eco-pharmacovigilance (Eco-PV) among healthcare professionals (HCPs).

In this, 54.4% of participants were aware of Eco-PV, indicating moderate awareness among healthcare professionals. Similar findings were reported by Zende et al., (86%).8

Awareness regarding drug take-back systems was reported by 46.7% of respondents, suggesting inadequate knowledge about structured disposal programs. The findings are still better compared to previous study by Raja S et al.,9 who reported 77% were not aware of the national drug take back Programme. In many developing countries, formal drug take-back systems are still limited, which may explain the lack of awareness.

The attitude of respondents toward safe medicine disposal was largely positive. A large majority (83%) believed that a system to collect unused medicines from households is necessary, and 98.7% agreed that consumers should be educated about hazards of unsafe disposal. These findings reflect a positive attitude among healthcare professionals toward public awareness initiatives and environmentally responsible disposal practices.

Despite positive attitudes, disposal practices were suboptimal. Approximately 33.4% of respondents reported discarding unused medicines in household garbage, while another 32.2% kept medicines at home until they expired. Retention of unused medicines at home may increase the risk of accidental poisoning, self-medication, and inappropriate drug use. Inappropriate disposal of antibiotics is of particular concern because environmental exposure to sub-therapeutic concentrations of antimicrobial agents can promote the development and spread of antimicrobial resistance (AMR). Environmental reservoirs of resistant microorganisms are increasingly being recognized as an important component of the global AMR crisis.10

The most common unused medicines found at home were analgesics (53.3%), antipyretics (43.3%), antibiotics (41.1%) and antacids (41.1%) which is consistent with findings of the study done by Jindal and Goel, reported analgesics (34%) were the most commonly stored group of drugs followed by antibiotics (29%) and antipyretics (11%).11 The findings may be due to similar disease prevalence and regional prescription trends.

Tablets (60%) were the most frequently reported unused dosage form at home similar to a studies by Gupta R et al., (72.2%)12 and Bhatt S et al., (64.19%)13, likely due to their widespread prescription and over-the-counter availability.

In the present study, participants responded that the main reasons for storing unused medicines at home were change in treatment strategy by physician (36.7%) or Self-discontinuation after symptomatic relief (35.6%). Non-adherence to treatment should be tackled by proper communication practices by HCPs, and guidelines to be enforced and rational treatment to be practiced by all treating physicians.

In our study also, majority of our HCPs (58.2%) responded that most commonly people discard the unused/expired medicines in dustbins similar to other studies by Bhatt S et al.,(87%)13 and Swaroop et al., (65%)14

Throwing unused medications in dust bin is the most common method for disposal which is followed by many healthcare professionals (doctor, student or nurses), across various countries of the world. Also, in few countries, flushing in toilet predominates. But, in some countries like Germany and Sweden, understanding the hazards of improper disposing, they follow the practice of returning it to the pharmacy.15

FDA guidelines recommends that unused/expired medicines should not be flushed in toilet or drain. It was suggested to mix the the solid medications with substances like coffee grounds and put into a disposable container and the liquid medications with salt/turmeric before throwing them in the dustbins. USFDA have initiated the drug take back programme on 25th September 2010, for preventing and controlling these problems.16 Pharmacies interested in program would be identified wherein patients visiting these pharmacies would be encouraged to return the unused/expired medications to the pharmacy. From the pharmaceutical industries they will be given to Bio Medical Waste Management and disposed as per the rules.17 However, no provisions for disposal of drugs from each home and lack of awareness regarding safe disposal persists.

In the present study, statistically significant association between professional role and awareness of Eco-PV ($p = 0.047$), and professional experience with awareness of drug take-back systems ($p = 0.026$) indicating the need for educational programs, policy interventions and structured drug take-back systems at designated

pharmacies to improve safe disposal practices and promote Eco-PV.

The present study addresses an emerging yet underexplored area of eco-pharmacovigilance among healthcare professionals and highlights the environmental and antimicrobial resistance implications of unsafe medicine disposal practices. The World Health Organization also recognizes antimicrobial resistance as one of the major global public health threats, and environmental antibiotic contamination is increasingly implicated in its emergence.18

This study has certain limitations. The study was conducted among healthcare professionals from a single-center setting, which may restrict generalizability of the findings. The responses were self-reported and may be subject to response bias. Additionally, some questions allowed multiple responses, which may influence interpretation of percentages.

Future studies with larger and more diverse populations are recommended to further evaluate Eco-PV awareness and practices.

5. Conclusion

The present study highlights that healthcare professionals possess moderate knowledge but positive attitudes toward Eco-PV. However, safe disposal practices of unused medicines remain inadequate, with many respondents still discarding medicines in household garbage or storing them until expiry. Implementation of educational interventions, awareness campaigns, and drug take-back programs is essential to improve safe disposal practices and minimize environmental contamination caused by pharmaceutical residues. Strengthening eco-pharmacovigilance practices may contribute not only to environmental sustainability but also to global antimicrobial resistance containment efforts.

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Conflict of Interest: None declared

References

1. Medhi B and Sewal RK. Ecopharmacovigilance: An issue urgently to be addressed. Indian J Pharmacol 2012; 44(5): 547–549.
2. Wilkinson JL, et al. Pharmaceutical pollution of the world's rivers. Proc Natl Acad Sci U S A. 2022;119(8):e2113947119. DOI: 10.1073/pnas.2113947119.
3. Srivastava B, Sinha AK, Gaur S, Gaur S, Palaria U. Ecopharmacovigilance: Its importance and challenges. J Biomed and Pharmaceutical Res 2014; 3: 81-87.
4. Oaks JL, et al. Diclofenac residues as the cause of vulture population decline in Pakistan. Nature 2004; 427: 630–633.
5. Kvarnryda M, Grabicb R, Brandta I, Berg C. Early life progestin exposure causes arrested oocyte development, oviductal agenesis and sterility in adult Xenopus tropicalis frogs. Aquat Toxicol 2011; 103: 18–24.
6. National Formulary of India. Govt of India. Ministry of Health and Family Welfare. (2011) Available at: http://apps.who.int/medicinedocs/documents/s23089en/s23089en.pdf. (Accessed on: March 21, 2025).
7. WHO guidelines for safe disposal of unwanted Pharmaceuticals in and after emergencies: Interagency guidelines online. Available at: http://www.WHO/EDM/PAR/99.2.1999. (Accessed on: March 21, 2025).
8. Zende MA et al., Awareness of medical students towards safe disposal of unused & expired household medicines: a survey. Natl J Physiol Pharm Pharmacol 2024; 14(11): 2334-2340.
9. Raja S, Mohapatra S, Kalaiselvi A, Rani R. J. Awareness and Disposal Practices of Unused and Expired Medication Among Health Care Professionals and Students in A Tertiary Care Teaching Hospital. Biomed Pharmacol J 2018; 11(4): 2073-2078.
10. Larsson DGJ, Flach CF. Antibiotic resistance in the environment. Nat Rev Microbiol 2022;20:257–269. DOI: 10.1038/s41579-021-00649-x.

11. Jindal M, Goel RK. A study of knowledge and practice for disposal of unused and expired pharmaceuticals among medical undergraduates at tertiary care teaching hospitals in Uttar Pradesh, India. Int J Basic Clin Pharmacol 2018; 7: 2447-2451.

12. Gupta R, Gupta BM, Gupta A. A study on awareness regarding disposal of unused medicines among consumers at a tertiary care teaching hospital of North India. Inter J Adv Med 2019; 6(1): 91.

13. Bhatt S, Kumar H. Knowledge attitude and practice of medical personnel on eco-pharmacology. Int J Basic Clin Pharmacol 2022; 11: 419-424.

14. Swaroop HS, Chakraborty A and Virupakshaiah A. Knowledge, attitude and practice of medical professionals towards the safe disposal of unused medications in south India. World J. Pharm. Pharm. Sci 2015; 4(5): 1423-1430.

15. Paut Kusturica M, Tomas A, Sabo A. Disposal of Unused Drugs: Knowledge and Behavior Among People Around the World. Rev Environ Contam Toxicol 2017; 240: 71-104.

16. US Food and Drug Administration. For consumers: how to dispose of unused medicines. Available at: https://www.fda.gov/consumers/consumer-updates/where-and-how-dispose-unused-medicines. (Accessed on: April 17, 2026).

17. The Bio-Medical Waste Management (Amendment) Rules (2018). Available at: https://qps.nhsrcindia.org/sites/default/files/2022-01/Amendment_BMWM_Rules2018.pdf. (Accessed on: April 17, 2026).

18. World Health Organization. Antimicrobial resistance. Geneva: WHO (2023). Available at: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance. (Accessed on: May 25, 2026).