



Impact of practice settings on knowledge, attitude, and practice of disposal of unwanted pharmaceuticals among pharmacists in a selected city of Tamil Nadu

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ARTICLE INFO

Received on: 16/03/2021
Accepted on: 27/04/2021
Available online: 05/12/2021

Key words:

Unwanted medicines, safe disposal, practice settings, pharmacists, knowledge, attitude, practice.

ABSTRACT

A cross-sectional study was conducted among 86 hospital pharmacists of a tertiary care university hospital and 86 community pharmacists in the metropolitan city in Tamil Nadu to assess the impact of practice settings on their knowledge, attitude, and practice of safe disposal of expired and unwanted medicines. A 19-item validated questionnaire was administered to the study subjects, and their responses were analyzed statistically. Around 65% of the hospital pharmacists and only 30% of community pharmacists stated returning drugs to the source as the best method of unwanted drug disposal. 67% of the hospital pharmacists were aware of the environmental hazards caused by improper disposal of medicines, but only 32% of community pharmacists were aware of the same. 88% of the hospital pharmacists accepted the use of collection boxes and display of posters on safe disposal in the pharmacies and both consented to participate in educational programs focusing on safe disposal of medicines. Pharmacists practicing in the hospital pharmacy setting had significantly better knowledge and attitude on safe disposal of unwanted medicines than those practicing in the community. Continuous educational interventions and awareness workshops for the community pharmacists on safe medication disposal is the need of the hour.

INTRODUCTION

Disposing drugs in an unsafe manner poses a serious threat to the environment and is also associated with environmental pollution and health hazard (Albaroodi, 2019). In this context, “eco-pharmacovigilance” is an important area with a definition as follows: the science and activities associated with the detection, evaluation, understanding, and prevention of adverse effects of pharmaceuticals in the environment (Holm *et al.*, 2013). There is a persisting environmental issue on the disposal of expired, unused, or unwanted medicines in India. Due to the lack of studies in this area, the exact repercussions are unknown (Mani and Thawani, 2019).

Most of the pharmacies in India return the unused medicines to the source of purchase for money or throw them in the garbage. Awareness of the hazards of improper drug disposal to the environment is very less, and a lot of pharmacies dispose of syrup, ointments, and even tablets using common, everyday disposal methods, such as throwing medicines in the garbage, toilet, and sink.

Over the years, human pharmaceuticals have been detected increasingly in the surface water (Sonowal *et al.*, 2017) due to patient excretion into the sewage system, direct release through sewage in manufacturing units, and disposal of unused medication via trash or flushing through toilets (Srivastava *et al.*, 2014). In addition to the environmental and ecological effects, the risk of adverse effects is also increased due to the stocking of expired and unused medicines or the donation to others leading to accidental or inappropriate ingestion. There is a hazardous effect on the vulnerable population including pregnant women, newborns, and children due to the long-term exposure of pharmaceuticals (Daughton, 2003). Studies show that there is an alarming decrease in the sperm count in men in the last

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few years (Carlsen *et al.*, 1992). Also, there is evidence showing the presence of antibiotics in the environment which leads to antibiotic resistance (Costanzo *et al.*, 2005).

In India, bacteria resistant to ciprofloxacin were found downstream of a pharmaceutical factory, drinking water had genes of antimicrobial multi-resistance, and the water sprayed on vegetables contained multi-resistant *Salmonella*. The water sprayed in vegetables in Europe was the point of origination for multi-resistant enterohemorrhagic *Escherichia coli*. A wide spectrum of antibiotics was found in quantities toxic to the microbes, animals, and plants with enterococci resistant to all known antibiotics in India. In the milk of cows and goats, several pharmaceuticals were found and there is a significant effect on human life due to the bio-accumulation of pharmaceuticals in aquatic plants and animals (Azzouz *et al.*, 2011).

The National Formulary of India (2011) had specified guidelines for the disposal of medicines, which most people are unaware of. In India, there has been no sufficient voicing for safe the disposal of pharmaceutical products and there is also the need for developing a proper disposal guideline with a monitoring mechanism. The take-back programs should be developed and popularized through public awareness (National formulary of India, 2011).

Pharmacists, being the pivotal members of the healthcare team, are in direct contact with the medication consumers concerning both prescription and over-the-counter medications. Therefore, they are in a suitable position to promote the rational use of medicines and safe disposal of expired or unused medicines in the community. However, the awareness of the pharmacists on safe and appropriate disposal of pharmaceuticals is a subject to be explored, especially among those rendering pharmacy services at different healthcare settings like a hospital and in the community. Therefore, a study was proposed to assess the influence of the hospital and community settings on the practicing pharmacists toward their knowledge, attitude, and practice of safe disposal of unwanted pharmaceuticals.

MATERIALS AND METHODS

A cross-sectional survey was conducted among hospital pharmacists of a tertiary care university hospital and the community pharmacists in Chennai, Tamil Nadu, from November 2019 to February 2020. The study was conducted after obtaining the approval of the Institutional Ethics Committee (CSP/19/Nov/81/414) and the voluntary informed consent of the participants. The sample size was arrived at with nMaster software version 2.0 by applying an expected proportion of 0.659%, 10% precision, and 95% confidence interval.

Sampling technique

Group I

86 hospital pharmacists working in the hospital pharmacy of a tertiary care teaching hospital, who consented to fill the questionnaire.

Group II

86 community pharmacists working in either individual or chain pharmacies in two selected zones of Chennai City Corporation.

The selected zones were considered as 2 clusters and 43 pharmacies from each cluster were selected. The pharmacist from the first pharmacy to be included in each cluster was selected randomly and the pharmacists from 42 consecutive community pharmacies were included in each cluster; thus, group II totaled 86 community pharmacists.

Material/questionnaire

A standardized, 19-item, self-administered questionnaire was designed and developed to assess pharmacists' knowledge, attitude, and practice of disposal of unused and expired medicines. The questionnaire was self-developed based on the literature (Shivaraju and Gandhagar, 2017; Swaroop *et al.*, 2015) and the information obtained from the guidelines given by the World Health Organization (1999) and the US Food Drug Administration (US and Food Drug Administration, 2019) on the "Disposal of Unused Medicines" and validation was carried out to assess whether the study tool measured the intended goal of the study.

Validation of the questionnaire

The questionnaire was given to four subject experts to validate for the item to total correlation, inter-rater, and intra-rater reliability, and the responses were graded as highly relevant, moderately relevant, and less relevant with the scores of 2, 1, and 0, respectively. The responses obtained were assessed statistically using Cohen's kappa and a kappa value of 0.674 (approximate significance = 0.008) was obtained, which indicated almost perfect agreement (a kappa value of 1 was considered perfect agreement for inter- and intra-rater reliability). The internal consistency of the questionnaire was validated statistically using Cronbach's alpha and a value of 0.650 was obtained, which was found to be satisfactory for the study.

The questionnaire consists of 19 questions in 4 sections (A, B, C, and D), which include the following information:

Section A: Participants' demographic data, which includes age, gender, educational status, type of pharmacy, and years of experience in a pharmacy.

Section B: Participants' knowledge of proper methods of drug disposal.

Section C: Participants' attitude on the safe disposal of drugs.

Section D: Practice of the participants on drug disposal. To find methods implemented by the pharmacist to dispose of the expired or unused medicines safely.

Statistical analysis

The collected data were analyzed with IBM Statistical Package for the Social Sciences statistics software version 23.0. The categorical variables of the two groups were expressed using descriptive statistics like frequency and percentage and the continuous variables were expressed as mean and standard deviation (SD). The association of significance in categorical data of the two groups was assessed using Fisher's exact test. In all the above statistical tools, the probability value of 0.05 was considered significant.

RESULTS

Table 1 explains the characteristics of the study population, which includes the mean age in years, gender,

Table 1. Baseline characteristics of study population.

Characteristics	Group 1 N = 86 (%)	Group 2 N = 86 (%)	Significance <i>p</i>
Gender			
Male	27 (31)	75 (87)	0.0005**
Female	59 (69)	11 (13)	
Educational status			
Diploma in Pharmacy	80 (93)	70 (81)	0.054 (NS)
Bachelor in Pharmacy	6 (7)	16 (19)	
Mean age in years ± SD	28.84 ± 7.67	42.09 ± 10.25	0.0005**
Mean years of experience ± SD	6.92 ± 5.92	18.92 ± 8.7	0.005**

** $p \leq 0.01$ —Highly significant; NS—Non significant.

educational status, and mean years of experience of group 1 and group 2. In Group 1, out of 86 hospital pharmacists, 27 were male and 59 were female, with a mean age of 28.84 ± 7.668 years. The educational status showed that 80 had completed Diploma in Pharmacy and 6 had completed Bachelors in Pharmacy. The hospital pharmacists had 6.92 ± 5.92 mean years of experience. In Group 2, out of 86 community pharmacists, 75 were male and 11 were female, with a mean age of 42.09 ± 10.11 years. The educational status showed that 70 had completed Diploma in Pharmacy and 16 had completed Bachelors in Pharmacy. The community pharmacists had 18.92 ± 8.72 mean years of experience. There was a statistically significant difference in the baseline characteristics between both the groups ($p = 0.0005$ for mean age; $p = 0.0005$ for gender; and $p = 0.005$ for mean years of experience), except for educational status ($p = 0.054$).

Table 2 depicts the “knowledge” component of pharmacists on drug disposal. Majority of the hospital pharmacists stated the expired and unused drugs in parenteral, solid, liquid, and semi-solid dosage forms to be returned to the source as the best method of disposal. On the contrary, 52% of the community

pharmacists opted to throw the solid dosage forms into the garbage, 48% opted draining in the sink as the best method of disposal of liquid dosage forms. However, majority of the community pharmacists also felt that returning to the source as the best method of disposal for parenteral and semi-solid dosage forms. There was a highly significant difference in the knowledge component ($p < 0.001$), with hospital pharmacists having better knowledge than the community pharmacists on the methods of safe disposal of unused and expired medicines in solid and liquid dosage forms.

Table 3 explains the “attitude” of pharmacists on drug disposal. In this study, 95% of the hospital pharmacists and 81% of the community pharmacists were aware that improper disposal of drugs could be a cause for environmental pollution and a risk for public safety. The percentage of hospital pharmacists with a negative or lack of opinion on the impact of improper disposal of drugs on environmental pollution was less (<5%) when compared to that of the community pharmacists (10%) and this difference was statistically significant ($p = 0.027$). When asked whether the unsafe disposal of medicines could lead to antibiotic resistance 67% of hospital pharmacists and 33% of community pharmacists answered positively, but 20% of hospital pharmacists and 36% of community pharmacists answered negatively. There was a highly significant difference among the hospital and the community pharmacists in their attitude toward antibiotic resistance due to unsafe drug disposal ($p = 0.005$). 85% of the hospital pharmacists knew about the guidelines for safe disposal of drugs, whereas only 62% of community pharmacists were aware of the guidelines; however, 15% of the hospital pharmacist and 38% of the community pharmacist gave a negative response ($p = 0.004$). Likewise, 76% of hospital pharmacists were aware of the drug take-back system, but only 57% of the community pharmacists were aware of it and the difference was statistically significant ($p = 0.022$).

Table 4 depicts the “practice” component of the pharmacists on the disposal of unused and expired medicines. It assessed whether

Table 2. Knowledge of hospital versus community pharmacists.

Questions and responses	Group 1 N = 86 (%)	Group 2 N = 86 (%)	Significance <i>p</i>
K1—What is the best method for disposal of parenteral?	a—Garbage	21 (24)	0.298 (NS)
	b—Deep burial	6 (7)	
	c—Return to source	58 (67)	
	d—Others	1 (1)	
K2—What is the best method to dispose solid dosage forms like tablets, capsules etc.?	a—Garbage	21 (24)	0.001**
	b—Sink	8 (9)	
	c—Return to source	53 (62)	
	d—Others	4 (5)	
K3—What is the best method to dispose liquid dosage form like syrup, eardrops, mouths wash etc.?	a—Garbage	7 (8)	0.073 (NS)
	b—Sink	32 (37)	
	c—Return to source	47 (55)	
	d—Others	0	
K4—What is the best method to dispose semi solid dosage forms like ointment, gel etc.?	a—Garbage	18 (21)	0.127 (NS)
	b—Sink	7 (8)	
	c—Return to source	50 (58)	
	d—Others	11 (13)	

** $p \leq 0.01$ —Highly significant; * $p \leq 0.05$ —Significant; NS—Non significant.

Table 3. Attitude of hospital versus community pharmacists.

Questions and responses		Group 1 N = 86 (%)	Group 2 N = 86 (%)	Significance <i>p</i>
A1—Can improper disposal of drugs cause environmental pollution	a—Yes	82 (95)	70 (81)	0.027*
	b—No	2 (2.5)	9 (10)	
	c—Don't know	2 (2.5)	7 (9)	
A2—Is there a risk to public safety due to the improper disposal of expired/unused medicines	a—Yes	77 (90)	73 (85)	0.374 (NS)
	b—No	8 (9)	9 (10)	
	c—Don't know	1 (1)	4 (5)	
A3—Do you think that unsafe disposal of drug can lead to antibiotic resistance	a—Yes	58 (67)	28 (33)	0.005**
	b—No	17 (20)	31 (36)	
	c—Don't know	11 (13)	27 (31)	
A4—Do you think there are guidelines for safe disposal of drugs	a—Yes	73 (85)	53 (62)	0.004**
	b—No	6 (7)	16 (18)	
	c—Don't know	7 (8)	17 (20)	
A5—Are you aware of drug take back system	a—Yes	65 (76)	49 (57)	0.022*
	b—No	13 (15)	15 (17)	
	c—Don't know	8 (9)	22 (26)	

** $p \leq 0.01$ —Highly significant; * $p \leq 0.05$ —Significant; NS—Non significant.

Table 4. Practice of hospital versus community pharmacists.

Questions and responses		Group 1 N = 86 (%)	Group 2 N = 86 (%)	Significance <i>p</i>
P1—Do you have collection boxes for unused drugs/expired drugs in your pharmacy?	a—Yes	76 (88)	22 (26)	0.0005*
	b—No	10 (12)	64 (74)	
P2—Have you ever given information about how to dispose unused and unwanted medicines to your customers?	a—Yes	54 (63)	44 (51)	0.087 (NS)
	b—No	32 (37)	42 (49)	
P3—Do you have any poster in your pharmacy about safety disposal of drugs?	a—Yes	56 (65)	4 (5)	0.0005*
	b—No	30 (35)	82 (95)	
P4—If an educational course on take back program is conducted, will you participate in it?	a—Yes	74 (86)	71 (83)	0.670 (NS)
	b—No	12 (14)	15 (17)	
P5—If an awareness program on safe disposal of expired and unsafe medications is conducted, will you participate in it?	a—Yes	72 (84)	78 (91)	0.102 (NS)
	b—No	14 (16)	8 (9)	

** $p \leq 0.01$ —Highly significant; * $p \leq 0.05$ —Significant; NS—Non significant.

they were having collection boxes in their pharmacy and whether they were ready to take any educational training if conducted. It is evident from the responses of 88% of hospital pharmacists that the collection boxes were available at the hospital pharmacy. On the contrary, 74% of community pharmacists said that there were no collection boxes at community pharmacies, and the difference was statistically significant with a “*p*”-value of <0.005. Also, 65% of hospital pharmacists had accepted that they had displayed posters that explain the safe disposal of drugs in their pharmacies, while 95% of the community pharmacists did not have any posters in their pharmacies; the difference was statistically significant at $p < 0.005$. Both hospital and community pharmacists consented to participate in the educational programs focusing on take-back of drugs and safe disposal of expired and unsafe medications.

DISCUSSION

This study examined the knowledge, attitude, and practice of safe disposal of unused and expired medicines among

the community and hospital pharmacists and was taken up due to the lack of safe disposal methods in India. This issue is also emphasized in the literature (Mani and Thawani, 2019).

In this study, among the total female population, 69% were hospital pharmacists and 13% were community pharmacists. On the other hand, out of the total male population, 31% work in the hospital pharmacy, while a majority of 87% work in the community pharmacy and the gender difference between the work sites was highly significant ($p < 0.0005$). A higher female populace was found in the hospital setting due to job security and the rarity of insecurities. The educational status revealed that most of the hospital and community pharmacists were diploma holders in pharmacy. The community pharmacists had more years of experience than the hospital pharmacists. Despite being at the same level of educational qualification and lesser years of experience than that of the community pharmacists, the hospital pharmacists had better knowledge and attitude toward improper disposal of drugs and the consequences.

In India, an unused or expired strip of tablets is often thrown into the garbage and a liquid preparation is flushed off in the sink. In this study, 40% of the hospital pharmacists and 60% of the community pharmacists acknowledged the same. As per the World Health Organization (WHO)'s guidelines, liquid dosage forms can be flushed off into the sewer with proper procedures like readily biodegradable material such as vitamins or glucose should be diluted and then flushed into the sewer (World Health Organization, 1999). 60% of the hospital and community pharmacists agreed that returning to the source as the best method for parenteral and semi-solid dosage forms, while the rest of the 40% acknowledged that throwing into the garbage and flushing it off in the sink as the best disposal method, which is similar to the report given in a study (Swaroop *et al.*, 2015). The WHO, Food and Drug Administration (FDA), and Indian guidelines for safe disposal of pharmaceuticals (Bio-Medical Waste (Management and Handling) Rules, 2016) recommend high-temperature incineration for solid, semi-solid, and powder dosage forms. Methods like incineration and encapsulation cannot be practiced by individual pharmacists in India; hence, returning to the source is the only best option which a community pharmacist can opt for.

This study reveals that most of the hospital pharmacists preferred to return the expired and unused drugs to the source which happens to be the best method of disposal. Hospital pharmacists have better knowledge on the methods of safe disposal than community pharmacists. The reason behind such knowledge is due to the training structure that the hospital offers in the form of continuing professional development programs and newsletters, as it becomes a mandate for the hospitals to meet the standards prescribed by the National Accreditation Board for Hospitals and Healthcare Providers.

There are also posters in the hospital pharmacy that educate the staff on the disposal of different categories of drugs. A similar study was conducted in Chennai, among healthcare professionals in a hospital, where most of them preferred throwing expired medicines in the garbage (Umamageshwari *et al.*, 2017).

All medicines are chemicals and their improper disposal poses a serious threat to the environment and public safety. The majority of pharmacists accepted the fact that improper disposal of drugs can cause environmental pollution and risk to public safety (Abahussain *et al.*, 2012). The FDA and WHO outlined their guidelines for proper drug disposal and this research evaluated pharmacists' knowledge regarding these guidelines (Albaroodi, 2019). In the present study, as expected, the hospital pharmacists had more knowledge than the community pharmacists regarding guidelines on safe disposal since they are exposed to structured policies, which reflected on the highly significant statistical difference in the knowledge between the two groups.

In this study, most of the hospital pharmacists were aware of antibiotic resistance caused by unsafe disposal of medication, but it was almost vice versa in the case of community pharmacists. This is because in a hospital setting the pharmacists are either a part of or are exposed to drug policies like medication safety, antimicrobial stewardship, and infection control. Also, unlike the community pharmacists, hospital pharmacists have more

opportunities to be enlightened on drug-related policies through interaction with other healthcare professionals.

More than 50% of the pharmacists in both groups were aware of the drug take-back system and opined that it provides a safe, convenient, and responsible means of disposing of drugs. Unfortunately in India, the drug take-back program is not functional, even though it is mentioned in the Pharmaceuticals Export Promotion Council of India. However, in a similar study conducted on the general population of India, 73% of the people were not aware of drug take-back program (Shwetha and Jha, 2018). In the present study, almost 90% of the hospital pharmacists were aware of the existence of collection boxes as a practice of medication disposal. Inversely, most of the community pharmacists were not aware of and were not practicing the collection boxes. Even though few community pharmacies have collection boxes, there was no utilization of them. Regarding the practice of pharmacists, the first and foremost thing that every pharmacist can do is to keep collection boxes for expired and unused drugs.

If pharmacists provide information on disposal during medication counseling, the consumers will develop positive disposal practices. When asked whether they have given information about how to dispose of unused and unwanted medicines to their customers, the majority of the pharmacists irrespective of their workplace agreed that they had never done so.

On observing the presence of posters in the pharmacy, the hospital pharmacy had a display of posters on the safe disposal of the drugs. Even though it was displayed as a poster in the pharmacy, some of the hospital pharmacists were not even aware of that. But this was not the same in community pharmacies. There are not many studies enquiring about the display of posters in pharmacies, but it has a vital role in educating people on the safe disposal of the drugs.

The majority of pharmacists (80%–90%) in both groups were willing to participate in educational courses on the take-back system and awareness program on the safe disposal of medicines. Interestingly, there was no significant difference in the responses of the two groups. Intervention by education about prudent drug disposal techniques that are also environmentally safe and acceptable will help change their behavior (Sangeetha *et al.*, 2018). The same has also been iterated in a study conducted in New Delhi (Bhayana *et al.*, 2016) and in another study conducted in the general population of India (Shwetha and Jha, 2018).

A program should be conducted to create awareness among the general population regarding the harmful effects of improper drug disposal systems. Educating the healthcare professionals, especially the pharmacists working in the community on the importance of safe disposal of medicines and the methods to be adopted would build confidence in them to impart the same to their customers too. Also, a proactive approach such as incorporating this important issue in the pharmacy curriculum is the need of the hour. The present study is among the first few studies that addresses and enlightens on pharmacists' disposal practices and attitudes in different pharmacy practice settings (community and hospital). The data obtained could be an added emphasis for the professional statutory bodies to develop programs on creating awareness among the pharmacists, where ever it is needed.

LIMITATIONS

There were some limitations to the present study. The data represent a single tertiary care hospital over a defined period, while there are many other primary clinics, government clinics, and private healthcare systems that may follow different drug disposal practices. Similarly, for community pharmacists, only two densely populated zones of a metropolitan city were selected in this study. A convenience sample may not be a representation of the population under study (pharmacists), so a generalization cannot be made; hence, studies conducted among pharmacists practicing in pharmacies at different hospital settings and community pharmacies in rural and other urban areas are warranted. However, the present results provide a basis for conduct of well-designed studies in future, highlighting the extent of medication disposal problems, investigating on its environmental effects, quantifying the disposed medication formulations, identifying the potential health consequences of unsafe disposal, and the strategies to be adopted to educate pharmacists and other healthcare professionals on safe disposal of unwanted pharmaceuticals.

CONCLUSION

The study identified that the hospital pharmacists had better knowledge and attitude on the safe disposal of medicines than the community pharmacists. Also, the hospital pharmacists had better practice on prevention of unsafe disposal of drugs than the community pharmacists. This is because, in a hospital setting, the pharmacists are either a part of or are exposed to drug policies like medication safety, antimicrobial stewardship, and infection control. Efforts taken by the statutory bodies to create awareness among the pharmacists working in community settings through continuing educational programs focusing on safe medication use and disposal practices and legislations for the development of drug take-back program or other safe drug disposal system are the need of the hour.

AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

FUNDING

There is no funding to report.

CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

PUBLISHER'S NOTE

This journal remains neutral with regard to jurisdictional claims in published institutional affiliation.

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How to cite this article:

Nagasubramanian VR, Sivashree RS, Saranya S, Sarang P, Shivani R. Impact of practice settings on knowledge, attitude and practice of disposal of unwanted pharmaceuticals among pharmacists in a selected city of Tamil Nadu. *J Appl Pharm Sci*, 2021; 11(12):151–157.