



Safe medication disposal: Need to sensitize undergraduate students

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Abstract

The presence of pharmaceuticals in potable waters is escalating with an evergrowing consumption of medications. Concerns regarding environmental significance and human health risk involved are often raised but control at source generation is not being adequately emphasized. To explore the knowledge, attitude, beliefs about drug wastage and methods adopted by students to dispose unused and leftover medications at home. This was a cross-sectional, descriptive survey. A detailed, anonymous questionnaire having both open and close-ended questions to assess drug disposal practices was administered to second, third and fourth year dental students. The data collected was analyzed and expressed as counts and percentages. 236 dental students participated in the survey. 70% reported the possession of upto five expired medications at home. The major reason for possession of unused, expired medicines was purchase of over the counter (OTC) drugs for self-medication. 52% agreed that drug wastage can be managed by returning to pharmacy. 97% had not heard of drug take-back initiatives. 92% admitted that no advice on drug disposal had been received by them. Antipyretics (54%) and analgesics (64%) were the major drug class stockpiled unused and expired drugs in students' homes. The predominant method adopted for drug disposal was via household trash (94%) followed by storing in home medicine chests (28%). 48% students agreed that returning to pharmacist is an acceptable way to dispose drugs. Knowledge about environmental implications of unsafe medication disposal was found to be inadequate among dental undergraduate students. There is need to increase their awareness about safe and prudent disposal methods. With reduced wastage of medication, the ecological footprint of medicines can be greatly reduced.

Key-Words: Active pharmaceutical ingredients, safe medicine disposal, take-back initiatives

Introduction

Annual consumption of drugs is forecast to increase worldwide. Escalating introduction to the market place of new pharmaceuticals, expanding usage of existing drugs and growing practice of procuring prescription drugs from other countries are adding exponentially to the already large and diverse array of pharmaceutical and personal care products (PPCPs) belonging to varied chemical classes.^[1] The drug industry sold drugs worth \$ 773 billion in 2008 and this figure is expected to rise to \$ 1,100 billion in 2015. High usage rate invariably corresponds to more drug wastage.^[2] Drug wastage is a direct measure of efficiency and success of overall healthcare system.^[3] A cross-sectional study conducted in the elderly population estimated that drug wastage accounted for 2-3% of all drug costs representing more than \$ 1 billion in drug wastage in the United States (US).^[4]

An API is a chemical constituent having pharmacological activity or other useful effect in the diagnosis, cure, mitigation, treatment, or prevention of disease or one that affects the structure or function of the body. Small molecule APIs are formulated into more than 20,000 parenteral, topical and oral drug products. These APIs eventually find their way into surface waters, ground waters, drinking waters, marine environments, sewage sludge and biosolids, tissues of animals, and food chains.^[5, 6] The ambient environmental levels of APIs are influenced by pharmacokinetics, dosage form and patient compliance. For example- in case of APIs that are extensively excreted unchanged or have high rates of patient compliance, disposal to sewers contribute small increments to total environment loading; on the other hand, medications in transdermal formulations such as rotigotine, flurandrenolide and lidocaine serve as a major source of API residues.

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APIs affect both the abiotic and biotic systems. A large scale ecological disaster in the Indian subcontinent involved cattle that had been treated with diclofenac and lead to mass extirpation of vulture species that fed upon the carcasses.^[10] Antibiotics in the effluent could increase selection pressure and promote the transfer of resistance genes from harmless environmental microbes into deadly pathogens, leading to emergence of deadly drug resistant microorganisms. Abnormal thyroid function, decreased fertility, decreased hatching success and alteration of immune function in birds and demasculinization and feminization of male fish has been linked to exposure to endocrine disrupting chemicals (EDCs) (byproducts of industrial waste).^[11]

Pharmaceuticals enter the environment by means of three main pathways: excretion after use, removal of topically applied products, and disposal of leftover medications. Presence of APIs as trace pollutants is primarily a function of patient use.^[1, 10] Disposal and storage of drugs such as those with addictive potential (controlled drugs) like opioids has been found to be improper among patients.^[8] Fentanyl patches can retain up to 84% of their original fentanyl content, a more than sufficient fatal oral dose for an infant or fatal dermal dose for an opioid naïve adult.^[9] When flushed, new dermal patches containing methylphenidate can contribute the equivalent amount of APIs as resulting from excretion of 3,280 oral doses; patches containing ethinyl estradiol can contribute the equivalent of 214 doses.

Medicine disposal habits are influenced by environmental awareness, availability of official state guidelines, dosage form, social and cultural attitudes. Sink, toilet and rubbish bins are the most commonly used but environmentally unfriendly routes of drug disposal. Conventional sewage treatment facilities do not remove trace constituents such as pharmaceuticals, leading to their accumulation in sewage effluents. A huge pileup of expired and unused medications in the medicine cabinets among public reflects ignorance regarding disposal techniques and how drugs affect the environmental health.^[12] A recent analysis of 8 medications, which had expired 28 to 40 years ago, showed that majority of the active ingredients persisted in concentrations 90% or greater of the amount indicated on the label; eight of these ingredients retained potency for at least 480 months.^[13] In addition, unsecured stockpiling, leftover/disposed drugs can further promote diversion to others, resulting in drug abuse or purposeful or accidental poisoning in human and pets.^[7]

The present study was conducted to assess the knowledge of undergraduate dental students regarding drug disposal methods used by them to dispose various drug formulations and explore the reasons for accumulation of leftover/expired drugs. This will give an impetus to devise and implement strategies to minimize drug wastage.

Material and Methods

The present study was carried out in a teaching dental hospital in North India. This was a descriptive cross-sectional survey of dental students based on a structured questionnaire format. The purpose of the study was explained to the participating students; confidentiality was ensured. Informed consent was obtained from the students before filling the questionnaire.

The questionnaire consisted of demographic data, questions on the type of unused/expired medications at home, reasons for stockpiling of leftover drugs, disposal techniques adopted by them to dispose solid, liquid and semi-solid medications and questions exploring knowledge, attitude and beliefs about safe drug disposal methods.

The data collected was analysed and results are expressed in counts and percentages.

Results and Discussion

244 students from second, third and fourth academic year, aged between 18-25 years participated in the study. 8 respondents were excluded due to incomplete forms. Out of 236 respondents who successfully completed the questionnaire, 77% (n=181) were females. Majority of the respondents (72%, n=171) reported the possession of up to five medicines at home [Table 1].

Qualitative analysis of expired medications at home revealed antipyretics (54%), analgesics (64%), followed by antihistamines (35%) to be hoarded in home pharmacies/medicine chests. Other drugs were antibiotics (26%), antacids (23%), topical drugs (39%) and supplements (vitamins) (41%) [Fig 1].

Excessive buying of over-the counter (OTC) drugs (53%); self-discontinuation (17%), and expiration of drugs (24%) resulted in possession of unused/leftover medications at home [Table 2].

Majority of students disposed medications in trash (94%). Rinsing down the sink (32%), flushing down the toilet (12%) and returning to pharmacy (3%) and storing in house (28%) were the other ways adopted to dispose the drugs. Solids (92%), liquids (74%) and semi-solid medications (94%) were disposed of in garbage. For liquid medications, rinsing in sink (18%) and flushing in toilet were also employed (3%). Semi-

solid medications (ointments and gels) were disposed in garbage (94%) [Fig.2].

Most students thought that municipality collection from home (43%) or returning to pharmacist (48%) are acceptable ways to dispose leftover expired drugs [Table 3].

92% respondents had never received any advice on drug disposal. A whopping 97% had never heard of drug take-back initiatives. 46% respondents admitted to having no knowledge about drug-environment interaction; 41% agreed that drugs pose a threat to the environment; 41% admitted to being ignorant about any relationship between drugs and environment. Students favored returning to pharmacy (52%) as a suitable solution to managing drug waste.

In concordance with other studies, presence of leftover drugs was high. [15, 18] The study reaffirms the increasing trend of hoarding and piling-up of medications resulting in an increased burden of leftover, unused or unwanted medications at homes. Drug wastage is defined as "any drug product either dispensed by prescription or purchased over the counter, that is never fully consumed." Drug wastage can lead to delay in-treatment, disease progression, treatment of ensuing complications that include exacerbation or prolongation of illness, uncontrolled chronic disease, hospitalization, disability and death adding to overall increase in cost of treatment. [7]

The main source of these stocked drugs are OTC medicines bought for a previous illness and stored as a standby for future use. Medicines may accumulate due to reasons such as medication misuse, poor medication adherence, changes in therapy, complex medication regimens, polypharmacy and patient death. [14] In this study, self-discontinuation contributed to presence of unused drugs at home in 17% respondents.

Common classes of medicines reported as leftover, unused or expired were analgesics-antipyretics followed by antihistamines. In a study by Auta *et al*, leftover medicines in residents' rooms were analgesics (36.4%), antibiotics (33.1%), and antihistamines (11.9%). [15] In-house storage of antibiotics reflects easy accessibility to these prescription drugs and calls for stringent legislation governing their sale.

Presence of antibiotics in home medicine chests could be the result of non-compliance to prescribed antibiotics, over prescription of antibiotics or antibiotics obtained as a result of self-medication. The hoarding of antibiotics not only reflects callous approach of health consumers towards their health due to their inaccurate perception and judgement about when to stop drug but also calls for action to combat unrestricted antibiotic prescription and sale.

[20] Suboptimal use propagates emergence of antibiotic resistant microbial strains.

Our study showed lack of knowledge of correct and safe methods of drug disposal among students. Availability of formalized protocols/guidelines for medicine disposal is a major influence on drug disposal. 43% students preferred drug collection by local authorities to be a suitable solution to this problem. In a study by Wilson *et al*, two-thirds of the respondents had no knowledge of any documented guidelines pertaining to proper drug disposal. [16] In two studies, only 20 to 30% respondents had received previous advice on safe medication disposal. [2, 15] The Food and drug administration (FDA) recommendations enlist 26 dangerous medications, which should be flushed down the toilet. For other medications, take-back or mail-back program is recommended. Drug "take-back" programs are community-based systematic initiatives that allow public to bring leftover drugs to a central location for proper disposal. In India, there is need to implement stringent take-back and also impart awareness to public regarding this serious concern. More environmentally safe practices include incineration or mixing them with refuse solids such as kitty litter or coffee grounds and disposing in impermeable containers. [17] Consumer changes in drug disposal practices will help to minimize the amount of environmental exposure to APIs.

In this study, trashing was the predominant mode of drug disposal for unused and expired medications followed by disposal in sink/toilet. Storing in house (28% in this study) is a popular practice. [2] Returning to the pharmacy was practiced by 3% respondents only. In a study by Abrons *et al*, 12.8% patients disposed medication appropriately; 27.2% respondents flushed medication down the toilet whereas 34.6% dumped medication in trash. [19] In a study conducted in Malaysia, solid medications (tablets and capsules) were predominantly disposed in household waste (65%) and returned to pharmacy (8%); liquid medications were disposed in sink/ toilet (62%) and trash (27%); semi-solid medications were predominantly disposed in household waste (83%) and returned to pharmacy (12%). [18] In a study in Egypt, 12% respondents returned unused medicines to pharmacy, 26.27% disposed in garbage and 11.39% flushed them down the toilet. [4]

By serving as trusted drug information resources, pharmacists are in forefront of tackling issues of medication misuse and poor medication adherence as well as appropriate medication disposal methods. They can be part of solution to the growing problem of medication wastage by imparting correct knowledge to patients, who are end users of drugs. [14] It is an

obligation of the pharmacist to counsel the patients before they leave pharmacy counter. ^[20]Previously counseled respondents are more likely to return medication to a pharmacy. ^[2]

Limitations of our study include a small sample size from a specific region; so a generalization cannot be made. Self reported data is subject to recall bias and is thus a confounding factor. Moreover, mutual influence between the students could not be ruled out. Nevertheless, this study gives an insight into a problem that has not been given the importance it deserves. More such studies are warranted to estimate the burden of drug wastage to help chalk out an action plan to combat this problem.

Conclusion

Knowledge and practice of drug disposal was inappropriate among dental students. Intervention by education about prudent drug disposal techniques that are also environmentally safe and acceptable will help change their behavior. A proactive approach such as incorporating this important issue in their curriculum is the need of the hour. There is also a pressing need to establish cost-effective and acceptable state-run collection and disposal systems. Conscientious and proper disposal of medications can help to decrease environmental load of drugs.

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Table 1: Number of unused/leftover drugs at students' homes

S.No	Number of unused/leftover medications	N (%)
1.	0	11 (5%)
2.	1-5	171(72%)
3.	6-10	44 (19%)
4.	11-25	8 (3%)
5.	>25	2 (1%)

Table 2: Reasons for possession of unused/leftover medications at home

S.No	Reason	N (%)
1.	Doctor changed treatment	12 (5%)
2.	Doctor prescribed more than needed	21 (9%)
3.	Self –discontinuation after condition resolved	33 (14%)
4.	Leftover from previous over-the-counter drug purchase	126(53%)
5.	Passed expiry date	56 (24%)
6.	Adverse effect to prescribed drug	9 (4%)
7.	Other	7 (3%)

Table 3: Students' perception about drug disposal

S.No	Acceptable method to dispose medication	N (%)
1.	Rinsing down a sink	10 (4%)
2.	Flushing down a toilet	9 (4%)
3.	Returning to pharmacist	113 (48%)
4.	Municipality collection from home	97 (41%)
5.	Giving away to friends,relatives,etc.	7 (3%)

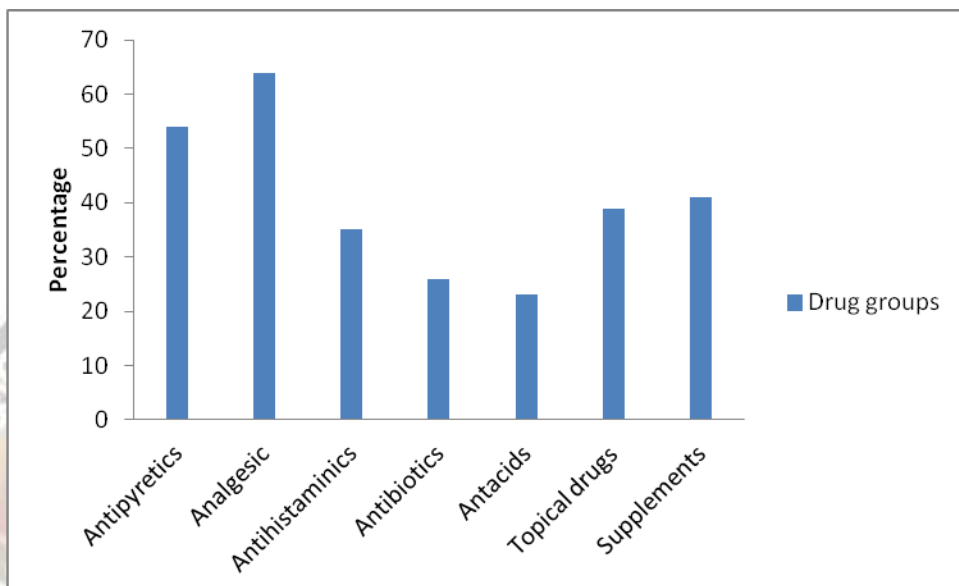


Fig. 1: Classes of expired drugs present at homes of students

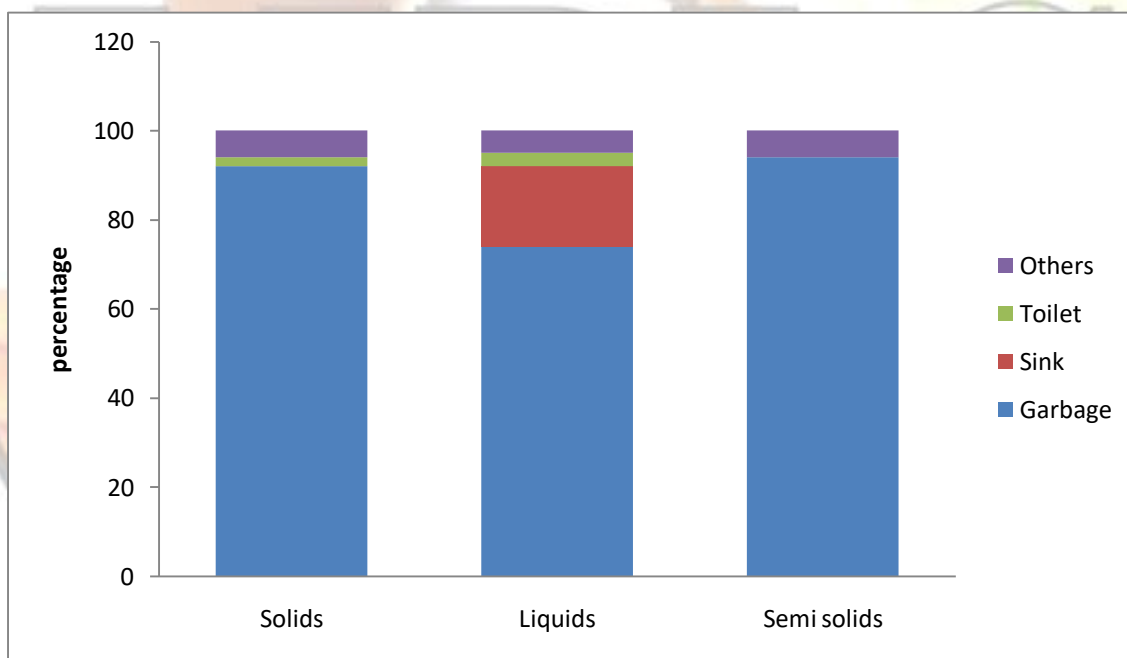


Fig. 2: Methods of drug disposal adopted by students