



Review article

Pharmacist-led interventions in addressing improper disposal practices of unused and expired household medication: A systematic review

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ABSTRACT

Background: Improper household medication disposal practices are a source of significant threat to environmental safety and public health. Pharmacists play a crucial role in mitigating these risks by educating the public about proper medication disposal. Evidence regarding the effectiveness of efforts conducted by health professionals to reduce the risks associated with improper disposal practices is still lacking. Therefore, this study aimed to systematically review pharmacist-led interventions in addressing unused and expired household medication disposal.

Method: A comprehensive literature search was conducted using PubMed, Scopus, and Google Scholar databases to identify studies evaluating pharmacist-led interventions and the effectiveness in improving household medication disposal practices until January 2024 with no constraints on publication year. Two reviewers independently performed the study selection process, data extraction, and outcomes assessment. Subsequently, the entire collected data were extracted and synthesized using qualitative and quantitative methods.

Results: The results showed that two among the total 83 studies retrieved during the search process met the inclusion criteria. The identified pharmacist-led interventions included the provision of an at-home medication disposal kit and an informational handout on proper disposal. However, these interventions showed no significant effects in improving household medication disposal practices, and all studies reported a low engagement rate with interventions.

Conclusion: The systematic review identified limited literature on pharmacist-led interventions for unused and expired household medication disposal practices, with no observed significant effects. Active patient and pharmacist engagement were required to enhance the effectiveness of interventions. Furthermore, the included limited studies suggested the need for the development of

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more pharmacist-led interventions to facilitate the role of pharmacist in educating the public on proper household medication disposal.

1. Introduction

Pharmaceutical waste is common in a majority of countries [1] due to the increased daily use of pharmaceutical products. In this context, factors contributing to the excessive accumulation of unused medication include a change or discontinuation of treatment regimen, non-adherence, adverse effects, and overprescription [2]. However, unused and expired household medication is often discarded in garbage bins and sinks or flushed down a toilet [3,4]. A study in Jeddah reported that 91.57 % of the participants disposed of expired medication by discarding it along with household waste [5]. According to 76.5 % in Kuwait [6], the most common disposal method was throwing medication in the garbage, followed by flushing down the toilet (11.2 %). In Indonesia [7], more than 80 % of participants reported that the most popular method of discarding unused medication was disposal in household garbage. These prevalent practices may be attributed to the lack of awareness of the risks associated with improper disposal [8] and insufficient access to appropriate disposal options [9].

The improper disposal of household medication poses significant risks to human health and the environment [10]. For example, some drinking water supplies have been identified to contain microscopic levels of antidepressants, hormone replacement treatment residues, and antibiotics [11,12]. The contamination can have serious consequences, including environmental toxicity as biologically active substances enter the food chain, leading to potential adverse effects on the human population [10]. The presence of antibiotics in the drinking water systems contributes to the development of antibiotic resistance, posing a serious health threat [11]. However, previous systematic review focusing on interventions for disposal of general medication [13] and opioids [14] have identified limited literature as well as conflicting results regarding the effectiveness [13,14]. Studies exploring the impact of healthcare professional-led interventions on medication waste disposal are lacking [13].

Pharmacists play an essential role in educating the public about the proper disposal of unused and expired household medication to minimize the environmental effects [15]. The public often views and trusts pharmacists as the primary healthcare professionals responsible for raising awareness about safe medication disposal practices [15–17]. However, the majority of previous studies showed that pharmacists provide inconsistent or occasional information about medication disposal [18–20]. In a previous investigation, only 21 % of 517 participants reported receiving education about medication disposal from pharmacists [21]. A high number of pharmacists are unaware of the variety of strategies that can be used to reduce medication waste in the supply chain [22]. Consequently, interventions conducted by these professionals are limited among the general public [3,23–25], leading to the need for increased guidance to minimize environmental damage [16]. Several previous systematic review did not focus on pharmacist-led interventions and the effectiveness as a key outcome measure. Therefore, this study aimed to systematically review pharmacist-led interventions in addressing unused and expired household medication disposal.

2. Method

This study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guideline [26] (Appendix 1).

2.1. Information sources and search strategy

A comprehensive literature search for past studies until January 2024 was conducted in the PubMed, Scopus, and Google Scholar databases, without any restriction on publication year. This observation was supplemented by reviewing the reference list of included articles. The search terms were developed using the PICO mnemonic, namely Participants (patients at home), Interventions (all interventions for unused and expired household medication disposal practices led by pharmacists), Comparison (all controls), and Outcomes (improvement in proper unused and expired household medication disposal practices). The full searching strategy adopted a combination of medical subject heading terms and text words, as presented in Appendix 2.

2.2. Eligibility criteria

The inclusion criteria comprised paid (subscription) or free (open access) experimental studies published in English, with a focus on pharmacist-led interventions and the effects on managing unused and expired household medication disposal practices. Experimental studies were reviewed due to being considered the gold standard for evaluating the effectiveness of interventions. Unused and expired household medication was predefined as those unrequired any longer and needing appropriate disposal [2]. Meanwhile, exclusion criteria consisted of conducted studies describing or assessing the use of interventions in case reports without measuring the effects, as well as lacking comparison groups and full-text availability. Additionally, commentaries, letters to the editor, and editorials were excluded because of the tendency to reflect individual opinions or responses to previous publications, compared to presenting original investigations. Study protocols and abstracts from conference proceedings were excluded due to lacking rigor and comprehensive data necessary for systematic review.

2.3. Selection process

A total of two independent reviewers (DOW and FA) assessed study eligibility based on titles and abstracts. In the second stage of the screening process, these reviewers retrieved and reviewed full texts of potentially eligible articles. An independent third reviewer (SDA) conducted further verification of the abstract and full-text screening, any disagreements were resolved by consensus.

2.4. Data extraction process

BA, FA, and DOW extracted data from the selected articles, while SDA checked and verified any doubts from the extraction process. Furthermore, a standardized form with predefined and piloted data extraction criteria was adopted, and data were manually extracted in Microsoft Excel as well as backed up on Google Drive.

2.5. Data items

Extraction was performed for information including the country, design, and length of study, as well as follow-up duration, sample size, type of interventions, effectiveness, and funding sources. In cases of incomplete data, necessary efforts were carried out to contact the corresponding author by email.

2.6. Synthesis method

Descriptive statistics were used to present the characteristics of the studies, and in cases of multiple publications, only the most comprehensive was adopted. When certain interventions were discussed in more than one article, the concerned study was considered as a single item but the outcomes were presented separately. Due to the diversity in populations, interventions, comparators, methods, and outcomes, data synthesis was conducted using a narrative method to analyze the results. Relative Risk (RR) with 95 % confidence intervals (CIs) and p-values were presented as effect measures of dichotomous outcome data.

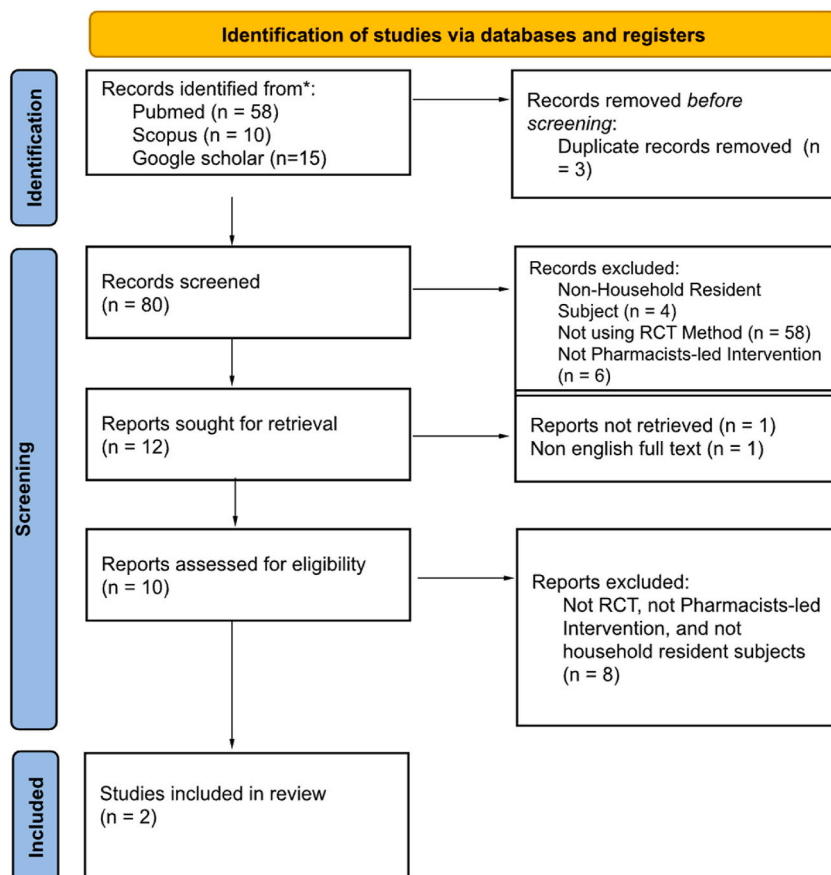


Fig. 1. Flow diagram of the study selection process.

2.7. Quality assessment of the included studies

Studies that met the eligibility criteria for methodological quality were assessed, and further independent verification was conducted. Any disagreements among the reviewers were resolved through consensus. The quality of the included studies was determined with the Jadad score [27] consisting of three assessment domains, namely randomization, blinding method, and participant withdrawal. Scores ranged from 1 (poor quality) to 5 (good quality), with <3 and ≥ 3 , signifying low and good quality, respectively [27].

3. Result

3.1. Studies identified

A total of 83 studies were retrieved in the literature search across three databases. Following the removal of duplicates, 80 were screened based on title and abstract. A total of 12 proceeded to the full-text screening. The final results of the full-text screening identified two studies that met the inclusion criteria, as detailed in Fig. 1.

3.2. General characteristics of the studies

A total of two studies were conducted in the USA and focused on disposal of unused opioids [28,29]. A study using multi-arm randomized controlled was performed in outpatient pharmacies among 499 patients with a median age of 34 years (interquartile range [IQR]: 16–56) and mainly consisted of women (55 %) [29]. The most commonly recommended opioid was oxycodone found in 88 % of all prescriptions [29], while the median daily and total oral morphine equivalents prescribed were 45 mg (IQR: 30–45) and 112.5 mg (IQR: 75–187.5), respectively [29]. Moreover, a total of 499 patients were randomized and provided with the intended interventions. The primary analysis included 227 patients (45 %) who reported certain leftovers after stopping the use of prescribed opioids (73 in medication disposal kit group, 91 in the fact sheet group, and 63 in the control. A total of 71 participants (14 %) used all opioids, and 46 (9 %) continued receiving opioids, but 100 (20 %) were not reached for follow-up assessment [29].

A study using quasi-randomized trials was performed in a hospital outpatient surgery center among 45 patients with an average age of 61.9 years and mostly consisted of female (55.6 %) [28]. The majority of patients (32, 71.1 %) received a prescription for hydrocodone-acetaminophen 5–325 mg tablets. Furthermore, the average quantity dispensed was 41.4 tablets for an average supply of 5.6 days. Out of the 14 patients possessing leftover opioids and randomized to receive disposal packet, only five (35.7 %) reported using the packet for disposal. Among the nine who possessed leftover opioids without receiving disposal packet, the rate of appropriate disposal was lower, as one patient (11.1 %) deposited medication at the local police station and another one (11.1 %) disposed of opioids through mixing with coffee grounds and dropping in the trash. A third patient reported using the trash to dispose of leftover opioids, which were not recommended practices [28].

Pharmacists led interventions in both conducted studies, which consisted of the passive provision of an at-home disposal kit and informational handout [28,29]. Standardized telephone surveys were performed to assess the use of a safe opioid disposal method as an outcome during six weeks [29] and one month [28] follow-up, respectively [28,29], with Table 1 presenting general characteristics of the included studies.

A study showed no statistically significant difference in the appropriate opioid disposal rate between participants provided with medication disposal system alongside education and participants in the education-only group (35.7 % vs. 22.2 %, (p-value = 0.47) [28]. However, participants who received the at-home kit exclusively used it for opioid disposal as opposed to applying another route [28]. Differences in safe disposal were not observed between the group receiving disposal kits (14 % [10/73]) (risk ratio = 1.44; 95 % confidence interval: 0.55 to 3.74) or the group given a fact sheet (11 % [10/91]) (risk ratio = 1.15; 95 % confidence interval: 0.44 to 3.01) compared to the non-interventions group (10 % [6/63]) [29].

3.3. Methodological quality properties

All included studies showed good quality, with a score of 3 according to the Jadad scale, and Appendix 3 provided a detailed assessment of the risk of bias.

4. Discussion

Pharmacist-led interventions included providing at-home kit and informational handouts on proper medication disposal practices. However, these showed no significant effects on proper disposal rates, with low engagement observed across all included studies.

At-home disposal kit was reported as an effective strategy for increasing household medication disposal, particularly considering the barrier caused by inconvenience [30]. However, the combination of these interventions had similar rates of any-means unused opioid disposal compared to patients who did not receive the kit [28]. The results were inconsistent with previous reports that patients given disposal kit alongside an educational video had higher proper disposal knowledge [16,31,32]. This inconclusiveness was attributed to the counseling provided to all eligible patients by pharmacists and informational handout [28], potentially limiting effectiveness due to minimal room for improvement. This study was designed with a relatively small number of participants, leading to the inability to statistically differentiate groups [28]. Disposal kit was exclusively adopted compared to alternative routes [28], thereby suggesting that possession of the kit simplified decision-making for unused opioid disposal.

Table 1
Characteristics of included studies (N = 2).

No	Author, Year	Setting	Sample Size	Intervention	Control	Duration	Outcome Measurements	Results	Funding
1.	Coleman et al., 2023 [28]	A hospital outpatient surgery center in Midwest, USA	45 ambulatory surgery outpatients filling an opioid prescription.	Patients were given counseling about medication disposal by pharmacists at the bedside and an informational pamphlet detailing recommended disposal method. Patients on even-numbered dates received an at-home medication disposal package (n = 24).	Patients were given the same counseling procedure on how to properly dispose of medication waste but did not receive the at-home disposal package (n = 21).	1 month	Patients were interviewed about medication disposal behaviors one month after discharge.	<ol style="list-style-type: none"> Among 14 patients who had excess opioids and were randomized to receive disposal packet, five (35.7 %) reported disposing of the excess using the packet. The rate of appropriate disposal was lower among patients who did not receive the packet, where only two of nine (11.1 %) disposed of the opioids through deposition at the local police station or mixing with coffee grounds and discarding in the trash. The general rates of appropriate disposal for the two groups were similar (p = 0.47). 	American Pharmacists Association (APhA) Foundation
2.	Bicket et al., 2021 [29]	Outpatient pharmacies in Maryland, USA	499 patients	At the prescription collection point: 1.) Patients were given an informational handout detailing the US FDA recommended ways to properly dispose of leftover opioids (n = 188), and 2.) Informational handout was provided along with a drug disposal kit and the instructions to use (n = 170).	Patients received no interventions at the prescription collection point (n = 141)	Six weeks	Participants were later contacted over the telephone and the use of a safe opioid disposal method was assessed through a standardized survey.	<ol style="list-style-type: none"> There was no significant difference in safe opioid disposal between the group that received disposal kit and the informational handout (RR = 1.25; 95%CI = 0.55–2.83). Safe opioid disposal rates did not significantly differ between the control and the drug disposal kit group (RR = 1.44; 95%CI = 0.55–3.74; p-value = 0.46) as well as the informational handout group (RR = 1.15; 95%CI = 0.44–3.01; p-value = 0.77). The majority of participants continued flushing unused medication down the toilet. Five participants reported using a kit to dispose of unused medication. Passive provision of medication disposal kit at the prescription collection point did not increase rates of leftover opioid disposal when compared with the provision of a fact sheet alone or zero interventions. 	Department of Pharmacy at the Johns Hopkins Health System, Pharmacy Services at Johns Hopkins Home Care Group, and the Department of Anesthesiology and Critical Care Medicine at the Johns Hopkins University School of Medicine, Baltimore, Maryland, USA.

The simple provision of disposal kits at the prescription collection point did not improve the rate of safe opioid disposal compared to providing a fact sheet alone or zero interventions [29]. This result was inconsistent with previous studies that provided disposal kits to postoperative patients [21,33,34] and the difference was based on the passive or active form of interventions. For example, Bicket et al. reported that disposal information was provided passively by pharmacists in the form of written handouts during prescription collection [29] without verbal communication about the contents, correlating with outpatient pharmacy practices [29]. This method correlated with other passive interventions, such as educational posters delivered and designed by investigators, which did not significantly improve proper household medication practices [35]. Other trials included interactive discussions by a nurse or an investigator with participants, thereby increasing the rate of leftover opioid disposal [33,34]. In the study of Brummett et al. [34], interventions were delivered actively by a nurse who described disposal kit, showed disposal product, and reviewed instructions on the application. Lawrence et al. [33] reported that families reviewed instructions about kit usage before patient discharge. Furthermore, achieving improvement in proper disposal practices as an outcome may be more difficult compared to enhancing knowledge. A previous study on educational interventions showed positive effects on knowledge acquisition, but there were no differences in disposal rates [35]. However, several households returned unused medication when a face-to-face interview, educational material, and physical assistance were provided [36]. Both kit and written handouts need to be routinely accompanied by active patient and pharmacist engagement through continuous education and repeated counseling to enhance medication disposal practices.

5. Implications and future direction

The literature reviewed in this study showed a global deficiency in the engagement of pharmacists in household medication disposal. Previous systematic review reported that only one study included pharmacists as a team with physicians and nurses in the in-person educational interventions [14]. Therefore, this study could be valuable in identifying potential directions for future investigations, particularly concerning pharmacists.

The systematic review identified that active patient and pharmacist engagement, along with the provision of kit and written informational handouts were essential in promoting proper medication disposal. All interventions delivered in the included studies lacked consideration for factors capable of influencing engagement rate among participants, as well as the applicability across diverse demographic groups. Therefore, further investigations into factors influencing participation rates and the use of theoretical frameworks for behavior change are needed. A previous study reported that holding interventions and related programs regularly, compared to implementing occasionally or only in a single event, could increase public willingness to participate [35]. Furthermore, the practicality of intervention programs, which provide patients with free disposal resources, may enhance the engagement rate [37]. The enactment of this authority necessitates the collaboration of the national drug regulatory agencies, policymakers, local organizations, and public health officials.

Previous studies identified poor knowledge, lack of counseling, and funding as potential barriers to the effectiveness of interventions. Periodic workshops or training as well as adding relevant course units to undergraduate pharmacy programs can promote learning more about basic topics. This tends to boost the confidence of pharmacists when counseling patients and increase public awareness regarding the national rules on proper medication disposal [20,38]. Furthermore, raising awareness may require the engagement of stakeholders capable of contributing to the sustainability of these programs by sponsoring needed funds [38]. Future studies are recommended to explore concrete method to ignite the knowledge and participation of pharmacists in counseling the public about safe medication disposal. To support decision-making among stakeholders, more investigation on the cost-effectiveness of implementing medication disposal programs is required.

6. Strengths and limitations

This study can be distinguished from others [39,40] due to the focus on randomized controlled trials (RCTs) conducted by pharmacists, thereby offering a method to evaluate the effectiveness of interventions aimed at addressing unused and expired household medication disposal practices. Through the prioritization of RCTs, a high level of methodological rigor and control was ensured, minimizing bias and confounding factors. Furthermore, the inclusion criteria specifically targeted interventions led by pharmacists to increase the adoption rate as compared with those conducted by investigators. A higher percentage of good-quality studies reviewed signified the implementation of a rigorous method, which reduced the possibility of systematic errors or confounding factors. This enhances confidence in the synthesized evidence and strengthens the reliability of the conclusion reached. The systematic review conducted may pose a greater assurance about the validity of the results and reflect the true effects of interventions. Additionally, household inclusion as the target population improved the relevance and applicability of the results. This study provides valuable insights into the effectiveness of pharmacist-led interventions in improving unused and expired medication disposal practices.

The limitations of this study comprised the inclusion of only articles published in English and articles with available full-text. Consequently, some important results or perspectives from the omitted studies might not be evaluated, potentially limiting the comprehensiveness of the general analysis. The implementation of pharmacist-led interventions should be considered to vary based on individual circumstances. The systematic review process examined the effectiveness of interventions, but it identified that the actual implementation and sustainability were crucial and different among various populations. The level of individual engagement was affected by factors such as rewarding [41], effectively delivered instruction [42], accessibility [42,43], habitual routine [42,44], and personal preferences [37]. This limitation showed the potential variability in the real-world impact of interventions and presented the need for contextual considerations when interpreting the results. Studies with small sample sizes were included, hence the results might not accurately extrapolate to real-world settings or larger populations, leading to restriction of the generalizability of the review conducted.

7. Conclusion

In conclusion, this systematic review identified a limited body of literature on pharmacist-led interventions for disposal of unused and expired household medication but found no significant effects. This showed the need for pharmacists to improve contributions and strategies to promote active engagement with patients, which could have a positive impact on household medication disposal practices. Additionally, the few included studies suggested the importance of developing more pharmacist-led interventions to facilitate the role played in educating the public on proper household medication disposal. Future investigations should be conducted to identify the facilitators and barriers impeding public active engagement in interventions.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Data availability statement

Data are included in the supplementary materials.

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CRediT authorship contribution statement

Sofa D. Alfian: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Data curation, Conceptualization. **Bagus Adhinagoro:** Writing – review & editing, Project administration, Formal analysis, Data curation. **Devani O. Winardi:** Project administration, Formal analysis, Data curation. **Fidelia Angela:** Project administration, Formal analysis, Data curation. **Meliana Griselda:** Writing – review & editing, Visualization, Project administration. **Vesara A. Gathera:** Writing – review & editing, Visualization, Validation, Supervision. **Rizky Abdulah:** Writing – review & editing, Visualization, Validation, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e37764>.

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