JMPF Vol. 11 No. 1 : 73-90
ISSN-p : 2088-8139
ISSN-e : 2443-2946

A Scoping Review of Disposal of Unused Medicines in Take-Back Programs

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Submitted: 17-11-2020 *Revised: 15-02-2021* *Accepted: 18-03-2021*
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ABSTRACT

Unused medicines in the household cause many problems. Medicines take-back programs were established to prevent inappropriate medicines disposal, abuse, accidental poisoning, and help reduce the number of unused medicines in households. A literature search using the keywords "*unused AND medicine*", "*disposal AND unused AND medicine*", "*reasons AND medicine AND disposal*", "*medicine AND take-back program*" and "*cost AND medicine AND take-back program*" in PubMed, Science Direct, Scopus and Google Scholar. Articles published in 2010 – 2020 in English report the medicine take-back program with the number of medicines and/or reasons for the return and/or economic value of medicines collected in the medicines take-back program. A total of 16 articles were included in the criteria for this systematic review. The medicine take-back program was majority-owned in the US (69%). Two programs focus on returning controlled medicines. Gastrointestinal, respiratory, cardiovascular, antimicrobial, and non-narcotic analgesics were the most common of all medicines returned. The expired medicine and treatment discontinuation by (doctors/prescribers) were the most reason medicine was returned to the medicines take-back program. The total cost of all medicines returned topped $1,118,020. Medicine take-back program was an essential solution to the inappropriate medicine disposal problem. Good coordination was required between the government and other authorities. This medicine take-back issues can help solve the problems of medicine use, storage, and disposal that lead to the country's economy.
Keywords: Medicines Take-Back Program; Disposal; Cost; Waste; Reason

INTRODUCTION

Medications that are not used are kind of drugs or pharmaceutical products that are not fully consumed either facilitated with or without a prescription and can come from households or activities in health care facilities[1]. Many problems emerge from unused drugs. Improper storage of medications that are no longer used, especially in households, will result in medicine damage due to exposure to high heat, light or humidity. The difficulty in identifying expiration dates due to prolonged storage adds to the potential for problems as a source of accidental poisoning.

In addition, improper disposal of medications that are not used creates problems for the environment. A study in US households showed that the most common ways to dispose of medications are to throw it away (50%) and down to the toilet (26%)[2]. This of course will cause damage to the water ecosystem. The active metabolites of the drugs have been reported to be detected in groundwater and drinking water as a result of sewage treatment that is unable to remove the active metabolites from various drugs[3].

Another problem arises from an economic perspective. The costs due to unused drugs are quite big. The total value of pharmaceutical products stored in households in Jordan was $21,875[4]. In Yogyakarta City, the total estimated economic value of pharmaceutical products stored by households in Yogyakarta City is Rp. 7,082,556 where 63.6% are drugs that are being used, 32.2% are unused drugs, 4.2% are expired drugs[5]. This economic value really depends on the number of unused drugs.

In order to reduce the number of unused drugs in households, a program has been established to provide facilities to the community so that they can return unused drugs in the home to the dedicated place. Several countries already have a take-back program, such as Australia, the United States and Egypt[6–8]. This medicine return program will prevent improper medicine disposal and

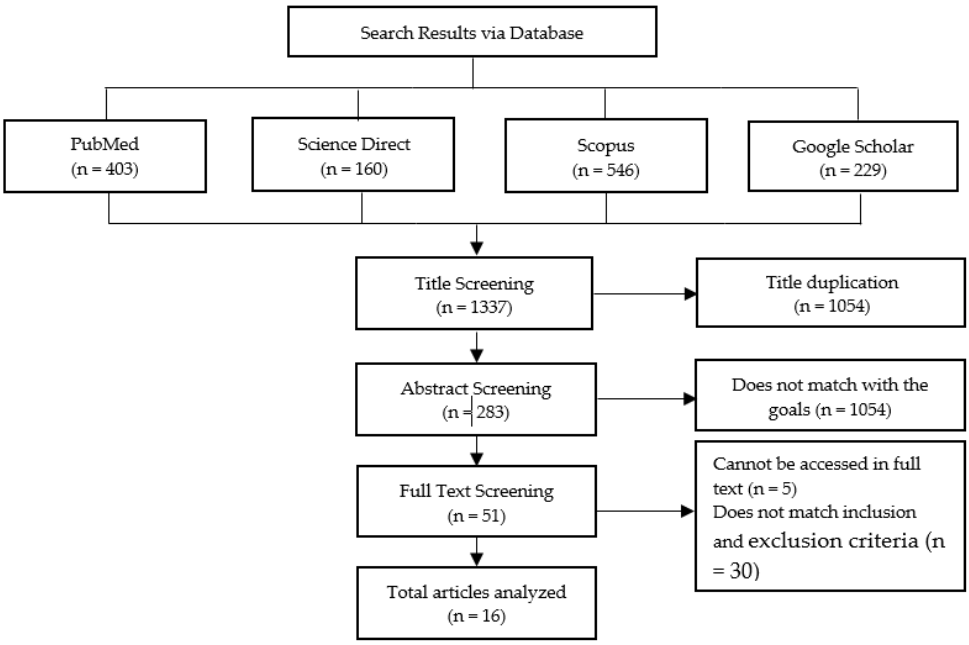

Figure 1. A PRISM diagram of the selected literature

Table I. Inclusion and exclusion criteria for selected articles

Inclusion Criteria	Exclusion Criteria
1. Articles written in english	1. Articles in the form of systematic reviews or meta-analyzes, letters and comments
2. Articles published in the period 2010 – 2020	2. Articles that discuss unused drugs outside the household
3. Mention the available drugs return programs	
4. State the amount and cost of drugs collected in the drugs return program	
5. Can be accessed in full text	

help reduce the incidence of medicine abuse and accidental poisoning. This scoping review aims to review the medicine return programs around the world, in terms of the number of drugs, reasons for return and the economic value of drugs collected.

METHODS

This review has several steps in its preparation. First, determine the problem to be reviewed. Second, establish specific criteria in the form of inclusion and exclusion criteria. Third, perform literature searches from various databases using keywords. Fourth, the selection of literature that is relevant to the objectives. And the fifth makes a review of each selected literature.

Identification of literature

The literature used in compiling this scoping review was obtained from the PubMed, Science Direct, Scopus and Google Scholar databases. In conducting literature searches, keywords are used with the help of Boolean Operators to narrow and broaden the search scope. The keywords used in the literature search include,

"Unused AND medicine", "disposal AND unused AND medicine", "reasons AND medicine AND disposal", "medicine AND

take-back program" and "cost AND medicine AND take-back program". Literature search was carried out since March 2020. The used inclusion and exclusion criteria can be seen in table I.

Literature search process

A total of 1337 articles were identified and 1054 of them were not in accordance with the objectives of this scoping review. Furthermore, the articles were reviewed based on titles and abstracts, there were 1285 duplicate articles of titles, not in accordance with the scoping review criteria and could not be accessed in full text. Of the remaining 51 articles, they were reviewed and found 16 articles to be analyzed because they met the inclusion and exclusion criteria. This article is selected without considering the study design of each article. The PRISMA diagram of the selected literature is shown in Figure 1.

Data extraction

All analyzed articles were extracted by SAK and MAR researchers with the help of a reference manager, called Mendeley. The data extracted included the country where those studies were carried out, the study period, the research objectives, the name of the drugs return program, the number and categorization of drugs collected in the drugs return program. Researchers also reviewed data on the reasons for exclusion from enrolled respondents and the cost or economic value of drugs collected in the drugs return program.

Article Quality Assessment

The assessment of the quality of the articles was carried out by the two researchers, namely SAK and MAR.

RESULTS AND DISCUSSION

Literature Search

A literature search that was carried out resulted in 1337 articles obtained from the PubMed, Science Direct, Scopus and Google Scholar databases. Quality assessment and data extraction were carried out for all articles obtained and resulted in 16 articles appropriate to this scoping review. The data characteristics from each article are summarized in table II.

Article Characteristics

Of the 16 articles obtained based on the literature search, all of them had a cross sectional study design. In table 2 it can be seen that 11 articles (69%) were conducted in the United States[2,3,17,6,10–16]and 1 article (6%) each were conducted in Australia[18], Cairo[8], Malta[19], Mexico[20]and Sabah[21]. The majority of articles (63%) had a clear objective, that is to measure the medicines collected in medication return program[2,6,8,11,13–16,19,20]. In terms of data collection methods, there were 5 articles (31%) that conducted a survey to participants who collected medicines in medication return program provided. The survey given is used to obtain information on perceptions of medicine risks for environment and the desire to join a medication return program[3]. In addition, the survey was also used to know the practice and reasons of medicine disposal by the participants[6,8,11,21]. And all articles describe the data collection methods completely.

Medication Return Program

As many 7 (44%) articles reported that the medication return program was held routinely in each place designated for medicine collection[2,13,15,18–21]. Meanwhile, 9 (56%) of them held a special event for medicine returns and 2 of them focused on medication return events for controlled drugs[3,6,8,10–12,14,16,17]. Most of this programs are held in pharmacies. However, there are some who carry it out in clinics[3,10], school environments[16,17], local communities[11]and retail companies such as supermarkets[12].

This scoping review focuses on medication return programs implemented in several countries. This review is inspired by the increasing number of unused medicines in households that can cause various problems in the future. A study revealed that the number of unused medicines in households reaches 15 - 98% throughout the world[22]. Improper disposal methods also a problem the whole world has to face, both in developing and

Table IIa. Article characteristics included in scoping review

Author, Year	Location	Purpose	Period	Medication Return Program	Methods Data Collection
Bergen *et al.*, 2015[18]	Australia	To conduct an audit of safe and accessible disposal methods for disposal of unwanted and expired medicines	2013	National Return and Disposal of Unwanted Medicines (NatRUM) was established by Australian government in 1998 to facilitate a safe medicine disposal for the community. Through this program, whole community can dispose unwanted and expired medicined for free to pharmacies collaborated with this program. The NatRUM program is available at every pharmacy in Australia.	The medicines returned to the pharmacy are placed in special yellow medication return containers. When the container is full, it will be collected by the Pharmaceutical Wholesaler (PBF) to be destroyed according to the regulations and requirements of applicable environmental protection authority in the country.
Ma *et al.*, 2014[10]	Hawai'I, United States	To describe the efforts of the Hawai'i Drugs Enforcement Division to carry out medication return on four large islands in Hawai'i	2011 - 2012	Take-back Event/Medication return event is held twice a year. All events were held for 3 days in Kaiser Permanente (KP) Clinic at O'ahu, Maui, Kaua'i and Hawai'i island. This event was promoted on newspaper, TV, radio, brochure in drugstore and doctor office, and from word of mouth.	The returned medications were gathered, recorded to document their generic name, medication class, doses, amount and dosage form. Excel spread sheet was developed to record all of medications that have been manually calculated. Identification and/or verification of medications are conducted by utilizing an online software (*Facts and Comparisons Identidex*©). The identity of verified medications were detached from their label. Documentation process until final destruction was conducted by *Narcotics Enforcement Division* (NED), students and *Daniel K.*staffs. *Inouye College of Pharmacy* (DKICP).

Table IIb. Article characteristics included in scoping review

Author, Year	Location	Purpose	Period	Medication Return Program	Methods Data Collection
Stoddard *et al.*, 2017[3]	Denton, Texas, the United States of America	To evaluate the purpose of D4 (*Denton Drug Disposal Days*) that specifically evaluating aspects affecting preparedness to pay *Take-Back Program* (TBP), deciding socio-economic characteristics, demographic and geographic of D4 respondents, and to evaluate benefit of TBP for citizens health.	2010 - 2011	*Denton Drug Disposal Days* (D4) is an event of the disposal of drugs conducted collectively. D4 is a medication return program developed by Denton City government and researchers from *University of North Texas* (UNT) on April 2010. First D4 event was held on April 24th, then October 2010, Mei 2011, and October 2011. All events were held at *Denton Regional Medical Center* (DRMC).	Data were collected from surveys and from medications collected during D4 event. Prior to first D4 event, surveys were conducted by phone to gather informations regarding citizens perception of risk concerning medication around their area, medication disposal practices, and their willingness to pay for participation in D4 program. Data of collected medication was documented in accordance with information of medication type and amount collected. Data of medication was then analyzed by using Microsoft Excel.
Perry *et al.*, 2014[11]	Handcock, the United States of America	- To evaluate motives of medication collection and disposal method - To measure returned medication	April 2009 – April 2012	Return of medication event was developed by *Alcohol, Drug Addiction and Mental Health Services* (ADAMHS), local authorities, environmental organization, and students of *University of Findlay College of Pharmacy*. Event held for 7 days between April 2009 – April 2012.	Medications were returned to the specified place. While participants were returning the medication, surveys were given with 8 questions answered voluntarily. After all medications were collected, medications sorting was conducted. Afterwards, those medications transferred to inventory in order to record the medication names, dose, amount, and source on Microsoft Excel spread sheet.

Table IIc. Article characteristics included in scoping review

Author, Year	Location	Purpose	Period	Medication Return Program	Methods Data Collection
					Medications were quantified by utilizing doses unit (for example pill or capsule for oral dosage form, milliliter or gram for liquid or topical dosage form). Medications type, name, and source were specified by information on prescription label. Any medications that were not available in its original package documented as unknown.
Yang *et al*., 20156	Lansing, the United States of America	T assess the number of medications collected in households by determining the ratio of remaining medication unit compared to medications dispensed and to identify therapy class with higher ratio than the remaining medication unit	Septe mber 2013	Medication return event is a part of annual Pharmacy Day of *Michigan Pharmacist Association* (MPA). The event were held on September 10th, 2013, for 4 hours. Volunteers in the event comprised of apothecary students, teaching staffs of *Ferris State University* and MPA. All citizens were allowed to bring unused medications during the event.	Collected medications were calculated and information recorded to Microsoft Excel spread sheet. Documented data, comprised of medication names, dosage, the remaining amount, the prescribed amount, generic or branded and source of origin (local drugstore, order by mail). All collected medications transported from collection point to kiln at the end of the event. Apart from collecting medications, participants were asked to fill in website-based operational surveys consisting of 9 inquiries to collect more informations regarding medication disposal practice they did at home.
El-hamamsy *et al*., 2011[8]	Cairo, Egypt	To determine the amount, type, and cost of collected medications at drugstore, identify	April 2009	Medications which are no longer used by citizens returned to 20 community drugstores in Cairo. Medication return process lasted	Collected medications were computed and classified according to *British National Formulary* (BNF) 2006. Recorded data was comprised of medication names, dosage form, , the origin amount, the remaining

Table IId. Article characteristics included in scoping review

Author, Year	Location	Purpose	Period	Medication Return Program	Methods Data Collection
		and evaluate various methods of medication disposal which have been conducted		for one period, specifically on April 2009.	percentage estimation of prescribe rounded up to closest quartile (0, 25%, 50%, 75% or 100%), prescribe classification (prescribe, sample or *Over The Counter*/OTC) and original content and expired date. The cost is calculated by multiplying the cost per pill with the estimated total pills left in the container according to the drug price list from the Health Ministry of Egypt. Only solid medications are taken into account. Respondents are also inquired to when and how they dispose of their medications..
Law *et al.*, 2015[2]	USA	To measure the grade, type, and price of the unused drugs and the reason for the consumption among households	April – June 2011	Medication-return events held in 3 nearby community drugstore that has been asked to participate in the medication-return campaign.	The returned medications would be recorded based on the total and the type. The categorization of the drugs is based on the therapy group of *Drug Information Handbook Lexi-Comp.* The price of the medication is estimated using AWP and the average retail price.
Vella and West, 2019[19]	Malta, Europe	To determine the type, total, and price of discarded medications into designated especially for medications disposal	April – December 2018	Medication return program was held in a community drugstore in a small village, Malta with a 3.500 population. Medication disposal bin is placed within the drugstore by the front door. Each person who lives in the Village in Malta can dispose of unused or expired medication at the drugstore.	The collected medication every 3 months are recorded for the names, active ingredients, strength, dosage form, total, and expiry date. Solid medications are counted manually, the liquid medications are counted with calibrated measuring tube, dermatologist preparation is measured with a kitchen scale, and inhalers with measurement are recorded as the number

Table IIe. Article characteristics included in scoping review

Author, Year	Location	Purpose	Period	Medication Return Program	Methods Data Collection
				In the last 3 intervals, manager pharmacist would empty the collected medication and record the 3 months collected drugs.	shown. Inhaler with no measurement, eye drops, ear drops, nose drops, and oral and nasal spray are not counted for they cannot be total exactly. The medication cost was counted based on the retail price in March 2019. The collected medication were also classified based on the ATC code from World Health Organization (WHO).
Gracia-Vásquez *et al.*, 2014[20]	Mexico	To compile characterization of collected medications	March 2012 – February 2013	The medication collection program was held in 85 collection centers at the community drugstores in 9 cities in the Monterrey area. The unused or expired medications from households are collected in the specified bin that is placed in a visible spot at the drugstores.	The data of medications were retrieved randomly from the total of collected medications. The data was then documented in Microsoft Excel sheets including the type of therapy group, total items of each group, the type of dosage form, expiry date, prescription or Over The Counter (OTC) drugs, and whether the medications was supplied by Mexico health system or the patients bought themselves.
Gray-Winnett *et al.*, 2010[12]	Knoxville, USA	To reduce the total amount of existing medications, reducing the consumption of medications either with intention or not, as well as increasing the awareness to dispose of the medications appropriately	November 2008 – November 2009	The events of medications collection were held 4 times in various community retail companies. The civil officials and local college students work together to advertise and implement the program.	The medications were collected by the volunteers and then listed by the ingredients. The plastic bottle, the lid, and the paper container were recycled, while sharp objects were placed in a specified container.

Table IIf. Article characteristics included in scoping review

Author, Year	Location	Purpose	Period	Medication Return Program	Methods Data Collection
Stewart *et al.*, 2015[13]	Maine, USA	To evaluate the total and the type of medications that have been collected in the unused medications return program	2011 - 2013	Medications return program is a coordination result of the Pharmaceutical Collection Monitoring System (PCMS) with Generation Rx, part of the branch American Pharmacists Association's Academy of Student Pharmacists' in the University of New England. This program is held in 11 locations with support from the volunteers.	All the returned medications would be placed in the bags with a label of participant number before they put in the PCMS. The recorded information consists of classification (prescription, Over the Counter, or controlled prescription drugs), name of the drugs, the strength, dosage form, original amount, total returned (manually counted), the company that produced them, and expiry date.
Jaramillo-Stametz *et al.*, 2018[14]	Arkansas; Florida; Maine; Missouri; Pennsylvania; and Texas; USA	To characterize and measuring controlled substance of medications on the medications return program	2011 - 2015	Medications return events are designed for households and held on the National Medication Take Back day, DEA (Drug Enforcement Administration). Drugs return events are held 80 times in 6 states. Some of them held with drive-up/drop-off and walk-up concepts.	All the collected medication items are documented. However, the reported data in this research is the controlled medications in solid preparation only. Data collection uses the website-based collecting and reporting tools, Pharmaceutical Collection Monitoring System (PCMS). The recorded information consists of classification (prescription, Over the Counter, or controlled prescription drugs), name of the drugs, the strength, dosage form, original amount, total returned (manually counted), the company that produced them, and expiry date.

Table IIg. Article characteristics included in scoping review

Author, Year	Location	Purpose	Period	Medication Return Program	Methods Data Collection
Fleming *et al.*, 2016[15]	North Carolin, USA	To describe the Operation Medicine Drop result in North Carolina	March 2010 – June 2014	Operation Medicine Drop (OMD) is a program coordinated by Safe Kids North Carolina, an organization of childhood injury prevention. This program enables people to dispose of unused medications safely and legally.	The collected medications were measured by total each dosage per unit in pills as a general measurement result. The reported final data is in the pound, which converted into dosage unit (total pills) using standard conversion, it is 1 pound = 750 pills.
Moustarah *et al.*, 2020[16]	Michigan, USA	To collect, count, and classify the type of collected medications	May 2017	The event of controlled medication collection was held with the cooperation of the team from the Michigan Opioid Prescribing Engagement Network at University of Michigan. The venue is the middle schoolyard at the city center of Saginaw on Saturday morning. The coming visitors dropped their unused medicines in a checkpoint secured by the police. The volunteers took the medicines and placed them in medication delivery box.	All medicines gathered were then processed and documented. Each medicine or substance without proper container or its actual packaging would be classified as unknown medicine and placed in mixed medicine group. Data of these medicines was collected as a form written in Microsoft Excel spreadsheet for further analysis. Medicines were classified based on category and substance of dependent potency. This research was specialized in reporting medication with dependent potency, such as opioid, schedule II medicines and benzodiazepine.
Shealy *et al.*, 2019[17]	Clinton, South Caroline	To observe the level of picking and identifying medication return trend that was	2013 - 2016	The take-back event was supported by Drug Enforcement Agency (DEA) and was held in Presbyterian College School of	Information on these medications were documented, including active ingredients and estimated quantity of each taken-back items. Furthermore, these medications were classified as prescribed

Table IIh. Article characteristics included in scoping review

Author, Year	Location	Purpose	Period	Medication Return Program	Methods Data Collection
		potentially misused misused during the take-back return event.		Pharmacy from fall of 2003 to fall of 2017. Medicine gathered were recorded by volunteers under direct supervision of pharmacist and independent local law enforcer from DEA.	were classified as prescribed medicines, non-prescribed and controlled substance medicines. These ingredients were then re-classified into therapy class based on Hospital Formulary in America. Medicine that was often misused were identified according to the medicine list from National Institute for Drug Abuse January 2018. The data were collected in a Microsoft Excel file and were analyzed by using descriptive statistic.
Yang *et al.*, 2018[21]	Sabah, Malaysia	To report the awareness regarding medication return program and its benefit, to evaluate environment awareness related to inappropriate disposition, and exploring disposal practice of unused medicines	August 2016	Medication Return Program (MRP) was introduced for the first time in 2010. This was an initiative program from Pharmacy Service Division, Health Ministry of Malaysia. The aim of this program is to conserve the environment in order to be spared from dangerous pharmaceutical compound and to prevent deliberate consumption, an abuse of unused medication. MRP provides safe place for the public to dispose unused medicines.	The study was conducted in 33 outpatient pharmacy. The coming 244 participants delivered their medicines and were given questionnaire containing 4 domains, that are socio-demographic, awareness of MRP and knowledge and practice of unused medicines.

developed countries[23]. Providing a container of medicine disposal for the public is a solution to solve this problem.

Most of reviewed articles were from the United States. The program implemented is a medication return program established by the local government assisted by other authorities. This program aims to provide a safe and legal place for people to dispose the medicines that are no longer used. The whole community can come to the designated disposal location and dispose unused or expired medicines in the container provided[15,18,21]. Most articles (31%) reported the implementation of medication return program located at local community pharmacies. This is because pharmacies are considered as places that are easily accessible by the community[2]. In addition, the community basically need a special program to return medicines. A study stated that 80% of respondents felt the needs of a program to collect unused medicines, especially in the households[24].

The program implementation period varies widely. Research conducted by Yang *et al*., (2015) reported on a medication return program in Lansing, United States in special event of medication return. This event is held once a year and only lasts 4 hours[6]. Different in Australia, the National Return and Disposal of Unwanted Medicines (NatRUM) program has taken place at every pharmacy in Australia. This program provides facilities for all people to come to the pharmacy to dispose their unused medicines[18].

There are 2 articles that only discuss about medication return programs for controlled medicines. First, a study conducted by Jaramillo-Stametz *et al*., (2018) which reported the results of a special medication return event for controlled medicines[14]. Second, study by Moustarah *et al*., (2020) who also reported a medication return event that was deliberately designed only for controlled medicines in Michigan, United States. This event of returning controlled medicines is held at certain times with the location closely guarded by the police[16]. A special medication return program like this is important to be held, considering many problems caused by controlled medicines. Substances contained in controlled medicines tend to have an addictive effect and very potentially abused. Even, a study in Tennessee, United States reported that 932 of death rate were caused by opioids and 36.5% of them did not have a prescription for opioids[25]. It indicates how important to manage medicines in the household, especially for controlled medicines like this.

Returned Medicines

This preview also discusses the total and types of medicine being returned to each Medication Return Program. From 16 articles, 1 article did not report the total of returned medicines in the program. The total of returned medicines were reported in item unit and dose unit. However, 3 articles reported the total medicines in weight unit, that is pounds[3,10,12]. The most returned medicines, as reported by Flemming *et al*., (2016) who collected the medicines in March 2010 to June 2014 were as much as 69,6 million dose unit[15]. More detailed data is presented on table III.

All gathered medicines through the program were calculated manually in order to find the rest of the returned medicines. However, a research conducted by El-hammamsy and Jaramillo calculated only the solid medicines[8,14]. Vella *et al*., also did not calculate all forms of medicines, especially no-measurement inhaler form of medicines, drops medicines and sprayed medicines due to the difficulty to determine the medicine's total amount[19].

Fleming *et al*., reported the biggest number of returned medicines in 4 years research period (March 2010 – June 2014) were 69,6 million unit of medicine dose[15]. Not only on dose unit, some articles reported the amount of returned medicines were also informed in pound. The heaviest medicines collected were reported by Ma *et al*. to reach 8.011 pound. These medicines were gathered

Table III. Total medicines returned in each medication return program

Author, Year	Total of Returned Medicine
Bergen *et al*., 2015[18]	More than 24.000 medicine items were taken representatively from 686 medicine disposal places.
Ma *et al*., 2014[10]	8.011 pounds of medicines
Stoddard *et al*., 2017[3]	- April 2010 = 368 pounds - October 2010 = 514 pounds - Mei 2011 = 524 pounds - October 2011 = 1150 pounds
Perry *et al*., 2014[11]	786.882 dose units
(c). Yang *et al*., 2015[6]	1.824.854 medicine units is collected from 3.633 containers
El-hamamsy *et al*., 2011[8]	541 medicine items
Law *et al*., 2015[2]	776 medicine items
Vella and West, 2019[19]	441 medicine items
Gracia-Vásquez *et al*., 2014[20]	22,140 medicine items
Gray-Winnett *et al*., 2010[12]	From November 2008 to November 2009, more than 1100 pound unwanted medicines were collected through events and drop boxes. Moreover, more than 470 pound of recyclable packaging were gathered.
Stewart *et al*., 2015[13]	553,019 medicine items
Jaramillo-Stametz *et al*., 2018[14]	280,813 medicine items
Fleming *et al*., 2016[15]	69,6 million units of medicine dose
Moustarah *et al*., 2020[16]	74.363 dose units, yet only 57.499 units were analyzed
Shealy *et al*., 2019[17]	- Year 2013 = 742 medicine items - Year 2016 = 1006 medicine items - Year 2017 = 294 medicine items

during one period of medication return program in Hawai'i that was held two times a year and each events were held only in three days[10]. The large number of medications returned indicates that the community is quite enthusiastic about participating in the medication return program provided. It is supported by a statement from Lystlund *et al.*, which proves that 61% of respondents intend to take part in a medication return program provided at a local pharmacy in Oklahoma, USA. [26].

Medications returned in medication return program are categorized based on the class of therapy, dosage form and types of prescription or over-the-counter drugs. Most of the articles categorize drugs by class of therapy. Table IV shows that out of the 8 articles categorizing medications based on therapy class, gastrointestinal, respiratory, cardiovascular, antimicrobial and non-narcotic analgesics were the most commonly found therapeutic class categories. [2,6,8,10,11,19–21]. In addition, there are 4 articles stating that prescription drugs are more commonly found in medication return programs [13,17,19,20]. Gracia-Vásquez *et al*., was the only article reporting medication categories based on class of therapy, dosage form, prescription or over the counter (*OTC*) drugs and by the acquisition of medications. NSAID (*Nonsteroidal Anti-inflammatory Drugs*) class of anti-pain therapy was the largest therapeutic class found (16.11%). And almost all the medications

Table IV. The frequency of medication therapy classes found on medication return programs

Therapy class (n = 8)	%
- Gastrointestinal	87.5%
- Respiratory tract	87.5%
- Cardiovascular	87.5%
- Antimicrobial	62.5%
- Non-narcotic analgesics	62.5%
- Electrolytes and supplements	50.0%
- Antidiabetic	50.0%
- Antihyperlipidemia	50.0%
- Dermatology	37.5%
- Hormonal	37.5%
- Antidepressants	37.5%
- Nervous system	37.5%
- Antibiotics	37.5%
- Miscellaneous	25.0%
- Others	25.0%
- Urinary system	25.0%
- Antiepileptic	12.5%
- Antiallergic	12.5%
- Antimycotic	12.5%
- Antiparasitic	12.5%
- Antivirus	12.5%
- Ophthalmic	12.5%
- Hypovolemic	12.5%

(91%) collected were prescription drugs[20].

Cardiovascular therapy classes were observed to have a sufficiently reported number of 8 articles. One article reported the causes of cardiovascular medication to be the highest category collected. This is due to the fact that cardiovascular disease requires long-term treatment and requires a lot of adjustments, which can result in a change of treatment[13]. In addition, adherence to treatment is also the reason why many medications are not used until they are returned to the return program. This is particularly true for medications that have been prescribed for regular use, e.g. antibiotics. This review also pointed that prescription drugs were more common than non-prescription drugs and the *World Health Organization's* (WHO) Medicine Situation Report stated that adherence to prescribed drugs for long-term conditions only reached 50%[27]. Auta *et al*., also concluded that non-adherence, overprescription and indiscriminate acquisition of antibiotics were the reasons why many antibiotics left unused[28].

Reasons for disposal of medication

Another review of this review discussed the reasons why participants returned the medications to an existing medication return program. The reasons related to the practice of medication disposal by the community were only reported in 7 articles presented in table V.

Table V. Frequency of reasons for disposal of medications in the medication return program

Reasons for disposal of medication (n = 7)	%
- The medications have expired	85.7%
- The medication are deemed no longer necessary	71.4%
- Replacement with other medications	42.9%
- Discontinued prescriptions by the doctor	28.6%
- Patient has passed away	28.6%
- Forgot to take the medication	28.6%
- Side effects occur	14.3%
- Deemed ineffective	14.3%
- Unknown	14.3%

Table VI. The economic value of medications returned to the medication return program

Author, Year	Economic Value
Perry *et al*., 2014[11]	$ 1,118,020 of the 786,882 dosage unit collected. Gastrointestinal and respiratory medications have the highest costs ($ 94,354 and $ 84,334)
El-hamamsy *et al*., 2011[8]	The total wholesale price of the medications returned was 10,988.84 Egyptian pounds ($ 1,962.32)
Law *et al*., 2015[2]	The total of estimated cost using the AWP is $ 123,965.90
Vella and West, 2019[19]	The total cost for 9 months reached € 2,613.28. The medications that have not expired are worth € 333.99. And the total monetary cost associated with prescription drugs was € 974.04, while drugs sold without a prescription amounted to € 1,639.24.
Fleming *et al*., 2016[15]	Only the costs of the event on September 27th, 2014 included the total cost of the medications collected, which was £ 10,800
Moustarah *et al*., 2020[16]	The opioids collected have an estimated average wholesale price of $ 2137 in the form of generic drugs and $ 9091 in the form of the brand name. In Michigan, the same amount of opioids can yield an estimated dollar value of at least $ 5653. Benzodiazepines have generic and brand name wholesale costs that are estimated at $ 1048 and $ 11,355, respectively

Various reasons for disposal of medications were reported, one of which states that expired drugs were the main reason for the disposal of medications[2,3,6,8,11]. Other reasons such as medication changes, discontinuation of treatment by doctors and patients feeling better were reported quite frequently.

In line with this, Perry *et al*., (2014) reported that 50% of respondents returning medications due to the expiration of medications and 40% were due to treatment discontinuation by the prescribing physician. In a study reported by Yang *et al*., respondents who collected medications at a medication return event held in Lansing stated a variety of reasons for returning medications. Out of the 70 respondents participated in the online survey, 80% of them stated that expiration were the reason why the medications were returned. Other reasons include switching to other medications, discontinuation of treatment by doctors, side effects, feeling ineffective, the user passed away and other reasons[6].

Economic Value of Medications Returned

This review also discusses the economic value generated by medications that are returned to the medication return program. In table VI, it is presented that only 6 articles reported the economic value of medications returned to the medication return program.

The economic value is calculated based on the remaining amount of the medications and the unit price. The unit price uses the wholesale price of each medication[2,8,16]. A study conducted by Perry *et al.*, (2014) reported the total economic value of all unit doses collected at the medication return event reached $ 1,118,020. This medication return event lasted for 3 years. And the highest economic value is held by medications with gastrointestinal therapy class ($ 94,354) and respiratory ($ 84,334)[11]. In Hawai'i, a one-year medication return event held to collect the medications at a total cost estimated from the average wholesale price of $ 123,965.90[2]. The high economic value resulting from the medications collected in the medication return program can be attributed to the waste of drugs. This is clearly an economic burden for the government and society which occur from the direct costs that must be spent on medications, costs for disposal and disposal of medications as well as costs for overcoming environmental problems arising from medicine waste[9].

The results of this review could provide new informations about various countries that have implemented medication return programs. For program organizers, it is important to report the amount and economic value of medications collected in the program. This, certainly, will be related to the waste value of medications that are not used by the community that have been collected in the medication return program. In addition, the number and reasons for participants who returned the medications to the return location also need to be documented as material for evaluation of program implementation. This review is also useful as a reference for countries that have not or are currently developing medication return programs, such as Indonesia, which has just implemented a medicine waste disposal movement in only a few cities. With this review, it is expected that policy makers will be able to consider implementing medication return program as a solution to overcome inappropriate medicine disposal by the community.

The limitation of this review is the lack of information on interest and participation in the medication return program. This review only observes the number of drugs, the reasons for return and the economic value of medications collected in the medication return program. In addition, there are many other return programs that cannot be analyzed in this review. Therefore, further studies are needed to see the effectiveness of the medication return program from other aspects.

CONCLUSION

Medication return programs are important solution to the problem of improper disposal of medications. The public are now quite aware of the problems and dangers posed by their unused medications. The medication return programs attract the public's interest to participate. In addition, good coordinations between the government and other authorities are needed so that this medication return program can help overcome the problems of medicine use, storage and disposal that affect the country's economy.

REFERENCES

1. Kristina SA, Wiedyaningsih C, Cahyadi A, Ridwan BA. A survey on medicine disposal practice among households in Yogyakarta. Asian J Pharm. 2018;12(3):S955–8.
2. Law A V., Sakharkar P, Zargarzadeh A, Tai BWB, Hess K, Hata M, *et al*. Taking stock of medication wastage: Unused

medications in US households. Vol. 11, Research in Social and Administrative Pharmacy. 2015. p. 571–8.
3. Stoddard KI, Hodge V, Maxey G, Tiwari C, Cready C, Huggett DB. Investigating Research Gaps of Pharmaceutical take back Events: An Analysis of take back Program Participants' Socioeconomic, Demographic, and Geographic Characteristics and the Public Health Benefits of take back Programs. Environ Manage [Internet]. 2017;59(6):871–84. Available from:
4. Abushanab AS, Sweileh WM, Wazaify M. Storage and wastage of drug products in Jordanian households: A cross-sectional survey. Int J Pharm Pract. 2013;21(3):185–91.
5. Ridwan BA. Praktik Pembuangan Obat Di Kalangan Rumah Tangga Kota Yogyakarta dan Evaluasi Dampak Ekonomi. Universitas Gadjah Mada; 2018.
6. Yang C, Doshi M, Mason N. Analysis of Medications Returned During a Medication Take-Back Event. Pharmacy. 2015;3(3):79–88.
7. Kelly F, McMillan S, Spinks J, Bettington E, Wheeler AJ. "You don't throw these things out:" an exploration of medicines retention and disposal practices in Australian homes. BMC Public Health. 2018;18(1):1–12.
8. El-hamamsy M, El-hamamsy APM, Pharmacy F. Unused Medications: How Cost and How Disposal of in Cairo, Egypt. Int J Pharm Stud Res. 2011;2(1):21–7.
9. West LM, Diack L, Cordina M, Stewart D. A systematic review of the literature on 'medication wastage': an exploration of causative factors and effect of interventions. Int J Clin Pharm. 2014;36(5):873–81.
10. Ma CS, Batz F, Juarez DT air., Ladao LC. Drug take back in Hawai'i: partnership between the University of Hawai'i Hilo College of Pharmacy and the Narcotics Enforcement Division. Hawaii J Med Public Health. 2014;73(1):26–31.
11. Perry LA, Shinn BW, Stanovich J. Quantification of ongoing community-based medication take-back program. J Am Pharm Assoc [Internet]. 2014;54(3):275–9. Available from:
12. Gray-Winnett MD, Davis CS, Yokley SG, Franks AS. From dispensing to disposal: The role of student pharmacists in medication disposal and the implementation of a take-back program. J Am Pharm Assoc [Internet]. 2010;50(5):613–8. Available from:
13. Stewart H, Malinowski A, Ochs L, Jaramillo J, McCall K, Sullivan M. Inside Maine's medicine cabinet: Findings from the Drug Enforcement Administration's medication take-back events. Am J Public Health. 2015;105(1):e65–71.
14. Jaramillo-Stametz JE, Stewart H, Ochs L, Payne K. Multi-state medication take back initiative: Controlled substances collected from 2011 to 2015. J Subst Use [Internet]. 2018;23(1):36–42. Available from:
15. Fleming E, Proescholdbell S, Sachdeva N, Alexandridis AA, Margolis L, Ransdell K. North Carolina's Operation Medicine Drop: Results From One of the Nation's Largest Drug Disposal Programs. N C Med J. 2016;77(1):59–62.
16. Moustarah F, Desai JP, Blebea J. Removing abuse-prone prescription medication from fueling the national opioid crisis through community engagement and surgeon leadership: results of a local drug take-back event. Surg Open Sci [Internet]. 2020;2(1):34–41. Available from:
17. Shealy KM, Ritter MS, Wyatt AS, Eagerton DH. Trends in potentially abused medications returned during

medication take-back days. J Am Pharm Assoc [Internet]. 2019;59(4):575–8. Available from:

18. Bergen PJ, Hussainy SY, George J, Kong DCM, Kirkpatrick CMJ. Safe disposal of prescribed medicines. Aust Prescr. 2015;38(3):90–2.
19. Vella V, West L-M. Analysis of Disposed Unused Medications at a Village Community Pharmacy. Vol. 7, Pharmacy. 2019. p. 45.
20. Gracia-Vásquez SL, Ramírez-Lara E, Camacho-Mora IA, Cantú-Cárdenas LG, Gracia-Vásquez YA, Esquivel-Ferriño PC, *et al*. An analysis of unused and expired medications in Mexican households. Int J Clin Pharm. 2014;37(1):121–6.
21. Yang SL, Tan SL, Goh QL, Liau SY. Utilization of Ministry of Health Medication Return Programme, Knowledge and Disposal Practice of Unused Medication in Malaysia. J Pharm Pract Community Med. 2018;4(1):07–11.
22. Akici A, Aydin V, Kiroglu A. Assessment of the association between drug disposal practices and drug use and storage behaviors. Saudi Pharm J [Internet]. 2018;26(1):7–13. Available from:
23. Martin K, Martin N, Hanzooma H, Davies K, Christabel NH. Assessment of household knowledge, attitude and practices on disposal methods of expired and unused medicines among residents of Lusaka City, Zambia. African J Pharm Pharmacol. 2020;14(7):221–8.
24. Kachhap S, Singh GK, Soreng EA, Beck RK, Kumar U. A study to assess the knowledge and awareness regarding safe disposal of pharmaceutical wastes among 2nd year medical and para-medical students in a tertiary care teaching hospital in North India. Int J Basic Clin Pharmacol. 2020;9(3):493.
25. Tanabe P, Paice JA, Stancati J, Fleming M. How Do Emergency Department Patients Store and Dispose of Opioids After Discharge? A Pilot Study. J Emerg Nurs. 2012;38(3):273–9.
26. Lystlund S, Stevens E, Planas LG, Marcy TR. Patient participation in a clinic-based community pharmacy medication take-back program. J Am Pharm Assoc [Internet]. 2014;54(3):280–4. Available from:
27. Dijk KH and L Van. The world medicines situation: rational use of medicines. World Med Situat. 2011;2(2):24–30.
28. Auta A, Banwat SB, Sariem CN, Shalkur D, Nasara B, Atuluku MO. Medicines in pharmacy students' residence and self-medication practices. J Young Pharm [Internet]. 2012;4(2):119–23. Available from: