WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.074
Volume 7, Issue 11, 124-147. Research Article ISSN 2277–7105

ASSESSMENT OF THE KNOWLEDGE, ATTITUDE AND PRACTICE OF SUDANESE COMMUNITY PHARMACISTS IN KHARTOUM STATE ON THE SAFE DISPOSAL OF LEVFTOVER MEDICATIONS

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Article Received on
14 April 2018,
Revised on 04 May 2018,
Accepted on 25 May 2018

DOI: 10.20959/wjpr201811-12474

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ABSTRACT

Background: Leftover medications include unwanted, expired, unused, damaged, and contaminated substances from households and healthcare activities. Inappropriate disposal of leftover medication medications was recognized as a threat to environmental safety. Main study objective: Assessment of the Knowledge, Attitude and Practice of Sudanese Community Pharmacists in Khartoum State on the safe disposal of leftover medications. **Materials and Methods:** An open to answer, self-administered, pre-piloted questionnaire of (23) questions was used to address 320 community pharmacists from Khartoum State. **Results:** Majority of participants were young 74.1%, females 64.1%, majority 59.15% had in –job experience of 1-5 years. Majority 277(86.9%) of participants' premises generate leftover medications. Minority 139(43.4%) of participant dispose medication waste by handing to services provider. Majority didn't know about take-back programs of leftover medication, but majority 236(73.7%) asserted that they accept to have their premises as sites for it. Correlation between participants' acceptance and their in- job experience is significant (P=00.000). From an attitude perspective, majority 176(55%) of participants preferred to dispose their leftover medications by incineration. Correlation between *community pharmacists' in-job experience and *their opinion that their disposal methods might pose threat to humans, animals, aquatic life or environment proved significant (p=0.000). **Conclusion and recommendations:** participants' premises generate a substantial amount of leftover medications which have multiple sources. Studied community

pharmacists share in the safe disposal of leftover medication is poor. Health authorities in Sudan should enact guidelines of the safe disposal of pharmaceutical waste strictly. Community Pharmacist play an active role in this concern.

KEYWORDS: Sudanese, community, pharmacist, safe disposal, leftover, medications.

INTRODUCTION

Human beings are supposed to protect nature from pollution, so as to enjoy a healthy clean environment.[1]

Pollution, which is simply defined as*: the introduction of contaminants into the natural environments*, is known to causes a diverse of changes that may negatively affect the healthy life of living creatures, including man.[1]

The history of pollutions dates back to prehistoric ages.

"*Soot found on ceilings of prehistoric caves provides evidence of the high level of pollution that was associated with inadequate ventilation of open fires*".[1]

The term pharmaceuticals are synonymously to the term medicines, or medications which is defined in the Pharmacy as *"any medicinal substance, product or substance which is claimed to be useful for treating, diagnosing diseases, and preventing or alleviating disease or symptoms of disease "*.[2,3]

The highly increase in the production of pharmaceuticals and personal care product worldwide has made the world aware of the real problem of pollution, which may represent a real threat to general public health.[4,5]

By definition, ‘’*pharmaceutical waste includes expired, unused, and contaminated or discontinued, drugs (also known as medicines or chemicals) that can no longer be used for humans’’).*[6]

Pharmaceutical waste enters the environment through

1. Manufacturing waste.[7]
2. Being thrown into the trash.[8]
3. Flushed down the toilets.[9]
4. Human and animal excretion.[10]

5. Washed from the body while bathing (topical preparations).[11]
6. Leaching from municipal landfills.[12]
7. Other forms of improper disposal.[13]

The leftover medications mainly include the expired and the unused medications.[14]

The global large volume of leftover medications have many reasons that contribute to this issue. Worth of Billions of dollars was reported to be a global cost of unused medications.[15] Healthcare professionals can prescribe and dispense medication irrationally, unsatisfactory provision of medication information to the patients, changing treatment plans, the use of poly-pharmacy, the escalating self-medication by the public, poor patients' adherence, short expiry dates, patients' apprehension of possible future unavailability (out-of-stock situations) of medications (developing countries), rural village residents suffer from far distance from pharmacy, all these reasons are considered among the main factors contributing to that household storage and leftover medications' growing problem.[16-23]

Pharmaceutical waste cannot be disposed of in the usual way. Special care, techniques, and precautions must be taken when handling and disposing of pharmaceutical waste.[24]

Irrational prescribing and consumption of medicines which may cause a dangerous effect to patients and costly to them and their communities, alike, is abundant globally and is highly prevalent in Sudan and other developing countries.[3,4,21,25-27]

The disposal of leftover pharmaceuticals (unwanted medicines) from household and healthcare facilities is becoming an increasing problem for local, national health and environmental protection authorities.

Leftover or unwanted medications enter the environment in a number of ways through the disposal of unwanted medications. Serious risks of improper disposal of medicines by throwing in dustbin, flushing down to the sink/ toilet and disposing without considering any precautions which has been recognized an environmental concerns, and now receiving prominence.[19, 28] Pharmaceuticals which present in the environment, especially in surface water resources, has been confirmed by several reports,[29] and it is proposed that the living species are exposed to the effects of pharmaceuticals through contaminated food and water. Evidence exists of the toxic effects on aquatic life[30] as well as in vitro human cells.[31] Trace pharmaceuticals, including antibiotics, anticonvulsant, mood stabilizers and sex hormones

was found in the drinking water supplies of 24 metropolitan cities in USA, in an investigation that was carried by The Associated Press in 2008.[32] Even more, Paracetamol, estradiol, codeine, and antibiotics were found in waterways samples in the USA.[33] Mae Wu and coworkers, in their highly informative article titled: Contamination of Our Nation's Drinking Water, pointed to the potential decrease in fertility resulting from trace sex hormones polluting drinking water.[34]

Complete removing of pharmaceutical waste from wastewater cannot be verified by treatment plants. Pharmaceutical products like the B-blockers (Acebutalol, Atenolol, Bisoprolol, Sotalol, Metoprolol), antibiotics like Roxithromycin, Sulphamethoxazole, and asthma medications such as Theophilline, Salbutamol, Terbutaline, were all detected before and after water treatment.[35]

Beside the important role of pharmacists in the use of pharmaceuticals, they also have an active participation in medicines management pathway. Even so, they have the potential to play an even greater role with the environmentally responsible safe disposal of pharmaceutical waste (including Packaging waste) and the education of other health professionals and the general public. As per the US, Food and Drug Administration (FDA), unused, expired or medications returned to pharmacies by patients and/or any specialized organization, require proper disposition and accountability.[36]

The waste pharmaceuticals' is expected to have a higher negative toll on the developing countries over all public health and the environments, as

1. Large quantities of pharmaceutical donations which received by the developing countries when there are conflicts or/and natural disasters, which are quite often happening.[37]

Sometimes pharmaceuticals donations, arrive past or near their expiration dates, or have been sent in abundant and/or unwanted quantities, or labeled in foreign languages ununderstood to consumers. Moreover, the magnitude of the waste can be increased due to improper storage.[38]

2 A potential negative effect on public health and environment due to low public awareness about the magnitude of the problem of unsafe disposal of pharmaceuticals.[39]

Over stocks which may ultimately end into expire and more waste which probably represented because of scarcity or lack of statistical data defining the real country needs of pharmaceuticals.[40]

3 The lack of awareness and clear guidelines on the safe disposal of pharmaceutical waste may magnify the problem, even more.[38]

4 The poor adherence rates and high health illiteracy of the population may complicate the problem even more, as it increases the irrational use of medicines of both prescription and over-the-counter medications.[41]

If leftover or medicines waste in general, is discarded insecurely in landfills, drugs may come into the hands of scavengers or children and be diverted to the market for resale to the general public.[42]

5 Many studies reported that pharmacists' knowledge and practice about safe disposal of pharmaceutical waste, education and advice to patients on how to dispose of unused drugs, and belief that unsafe disposal of medications can negatively affect the environment, are poor.[42-44]

The role of pharmacists in the Quality Use of Medicines, shall aims at reducing the amount of unwanted pharmaceuticals in the community.

Study Rationale

Our country, Sudan lacks awareness, clear strict enactment of the available guidelines and /or defined protocols for the safe disposal of pharmaceutical waste.[45]

Pharmaceutical wastes in the Capital city of Khartoum, are currently delivered to the Khartoum State Cleaning Corporation (KSCC), which deals with it based on its own perception, knowledge, methods, and responsibility. This unclear fate of such a significant health problem with no defined magnitude amid poor public awareness triggered the decision to conduct this study. It was, accordingly, decided to bear the title.

Assessment of the Knowledge, Attitude and Practices of Sudanese Community Pharmacists in Khartoum State, on the safe disposal of leftover medications.

General objective: Assessment of the Knowledge, Attitude and Practices of Sudanese Community Pharmacists in Khartoum State on the safe disposal of leftover medications.

Specific objectives

1. To highlight the importance of guidelines or protocols for the safe disposal of pharmaceutical waste in general, and that of the leftover medications in specific, and the enactment of such guidelines.
2. To assess the Sudanese community pharmacists' awareness of the environmental impact of improper disposal of leftover medications.
3. To assess whether the Sudanese community pharmacists agree to have their pharmacies as collection points for future take- back program of leftover medications.
4. To study and evaluate the current means or methods used in handling and disposal of leftover medications, in Khartoum state, Sudan.

MATERIALS AND METHODS

Study design: This is a descriptive exploratory questionnaire based study.

A pre-structured, open to answer, self-administered and pre-piloted questionnaire consisting of (23) questions was used to collect data.

The first six (6) questions were about the demographic characteristics of the participants.

Twelve (12), of the remaining sixteen questions were closed ended questions, and five (5) multi- choice questions.

Study area (setting)

The study was carried out at (320) community pharmacies in Khartoum State, Sudan.

From Khartoum there were (200) participant community pharmacists, (70) from Omdurman, and (50) Khartoum North (Bahri).

Variables: Gender (sex), Age, Academic degree, years of practice, place of undergraduate studies, post graduate studies, of the surveyed community pharmacists.

Sample size and sampling: The sample size was calculated at 95% confidence level and 5% confidence interval. Three hundred and twenty (320) potential participants' community pharmacists were randomly selected from all the community pharmacies in the three towns comprising the greater Khartoum.

All the potential participants were pre -informed of the main objective of the study and were clearly assured of its anonymity, and kindly requested to participants.

Study subject: selection and definition

Data collection method and tools

The pretested, pre-structured and pre-piloted questionnaire forms were used as the data collection tools. The questionnaire, was handed over and collected back by the researchers, to all the randomly selected potential participant community pharmacists hand-to-hand, in Khartoum State main towns, namely, Khartoum, Omdurman and Khartoum North (Bahri) towns in the period from (January –May/2017). The researchers used to distribute the questionnaire forms and collected them back if immediately filled. If not, then, she usually comes back at the time chosen by the potential participant, him/or herself. All potential participants were informed of the objectives of the study, and they were informed that they have the absolute freedom of decision, to participate or refrain. They were also informed that their participation, by filling the questionnaire form, will be considered as a free informed consent. The questionnaire composed of two main parts:

1. Part one which consisted of six (6) questions was used to collect the demographic characteristics of the pharmacists.
2. Part two, which consisted of seventeen (17) questions, was used to collect participants' community pharmacists' knowledge, attitude, and practice on the safe disposal of leftover medications.

Data management and statistical analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) version (20) for windows. Association between participants' demographic characteristics variables, and variables related to participant community pharmacists' knowledge, attitude, and practices about the safe disposal of leftover medications were assessed using Chi-Square Tests. Values were compared by independent sample t- test and $P<0.05$ was considered as significant.

Ethical Considerations: The entire number of the randomly selected community pharmacists included in the study was informed of the objectives and the nature of the research, and was strongly requested to participate. They were also informed that participation is absolutely free. Verbal informed consent was obtained from all the potential participants' community pharmacists, prior to handing over of the questionnaire forms

RESULTS

Response rate was 320 (100%).

Frequencies and percentages were used in expression of results

Tables and figures were used to ease understanding of results.

Among the (320) participant community pharmacists who completed the survey questionnaire; in Khartoum State, Khartoum town, Omdurman town, and Khartoum North town (Bahri), were represented by 200 (62.5%), 70 (21.9%), and 50 (15.6%) participants, respectively.

Table. 1: Demographic characteristics of the participant community pharmacist.

Demographic data	No.	%
1.Age: (years)		
20-25	125	39.4
26-30	111	34.7
>30	83	25.9
2.Sex:		
Male	115	35.9
Female	205	64.1
3.Academic Degrees -Pharmacist		
B. pharm	213	66.56
M. Pharm	103	32.18
PhD	3	0.93
Fellowship	1	0.003
4.In-job Experience as pharmacist (years)		
1-5	189	59.1
6-10	83	25.9
>11	48	15
5.Country of graduation		
Sudan	314	98.13
abroad	6	1.87
6-Place of practice		
a. Khartoum	200	62.5
b. Khartoum North (Bahri)	50	15.6
c. Omdurman	70	21.9

Table. 2: Practice of participants' community pharmacists towards sorting, sources of leftover medications that are generated or received in pharmacy.

Questions	No.	%
1-Do your premises generate left-over medication?		
Yes	277	86.6
No	43	13.4
2-Do you sort your left-over medication before safe disposal?		
Yes	183	57.2
No	137	42.8
3- Do you document your waste disposal schedules, protocols and processes?		
Yes	107	33.4
No	213	66.6
4- How often do you dispose of leftover medication?		
Daily	17	5.3
Weekly	28	8.7
Monthly	134	41.9
Yearly	141	44.1
5-Do you have a written standard operating procedure for waste disposal?		
Yes	27	8.4
No	293	91.6
6-What are your sources of left-over medication?		
a-Returns from customers	82	-
b-Expiries	279	-
c-Damaged products, contamination or deterioration	145	-
d-Other: specify	13	-
7-What kind of wastes do your premises generate or receive, based on pharmaceutical dosage forms?		
a-Solids, semi-solids and powders	106	-
b-Liquids	54	-
c-Ampoules	32	-
d-Containers and packaging materials	69	-
e-All the above	197	-
8-How do you or your hired services dispose of the waste?		
a-Return to manufacturer, distributor or whole seller	90	-
B-Engineered sanitary landfills.	8	-
C-Sewer disposal.	10	-
D-Burning in the open.	25	-
E-Medium temperature incineration.	2	-
F-High temperature incineration.	16	-
G-Chemical decomposition	1	-
H-Open dumping.	12	-
I-Hand to Khartoum state cleaning company.	139	-

Awareness of participant pharmacists toward environmental hazards due to leftover medications' disposal methods.

Table. 3: Knowledge of participants' community pharmacists.

Table 3:	**No.**	**%**
1-Do you have an idea about the magnitude of the hazardous effects of unsafe medications' disposal?		
Yes	223	69.7
No	97	30.3
Total	320	100%
2-Do you think your disposal methods pose any threats to:		
a-Humans	19	-
b-Animals	12	-
c-Aquatic life	3	-
d-Environment	45	-
e-All above	263	-
3-What are your preferred methods of disposal of unwanted medications?		
a-Throw them	15	-
b-Flush them	12	-
c-Disguise and put in the trash	68	-
d-Incineration	176	-
e-None of the above	89	-
4- Do you know about National take-back programs in other countries for return of unused medicine to pharmacies?		
Yes	47	14.7
No	273	85.3
Total	320	100%
5-Disregarding what others are doing, how much damage will affect the environment if you, as an individual, had thrown away unused medications in the trash?		
Less damage	47	14.7
Serious damage	273	85.3
Total	320	100%
6-Disregarding what others are doing, what extent of damage on the environment if you, as an individual, disposed of unused medications by throwing them away in the sink or toilet (sewage)?		
Less damage	103	32.2
Serious damage	217	67.8
Total	320	100%

Acquaintance and opinion of participant's community pharmacist on Take-back programs and their sense of responsibility towards environmental safety.

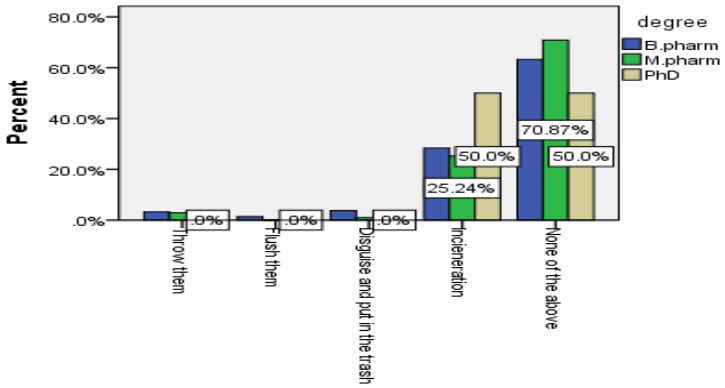
Table 4: Attitude of participant community pharmacists.

Table 4:	**No.**	**%**
1-Do you agree with the opinion for having your pharmacy to take back left-over medicines?		
Yes	236	73.7
No	84	26.3
Total	320	100%
2-If a patient brings to you some left-over medications for safe disposal, would you accept that?		
Yes	257	80.3
No	63	19.6
Total	320	100%
3-Acknowledgment of personal responsibility		
A-Do you agree that it is your professional responsibility to protect the environment, even if others are unconcerned or irresponsible?		
Disagree	38	11.9
Agree	282	88.1
Total	320	100%
B-Do you agree that it is your professional responsibility to be concerned about the safety toward human and other living species on earth?		
Disagree	20	6.25
Agree	300	93.75
Total	320	100%

Correlation

Table. (5): Frequency distribution and correlation of the preferred way to dispose of unwanted medications according to the academic degree of the participants' community pharmacists. Correlation proved non-significant.

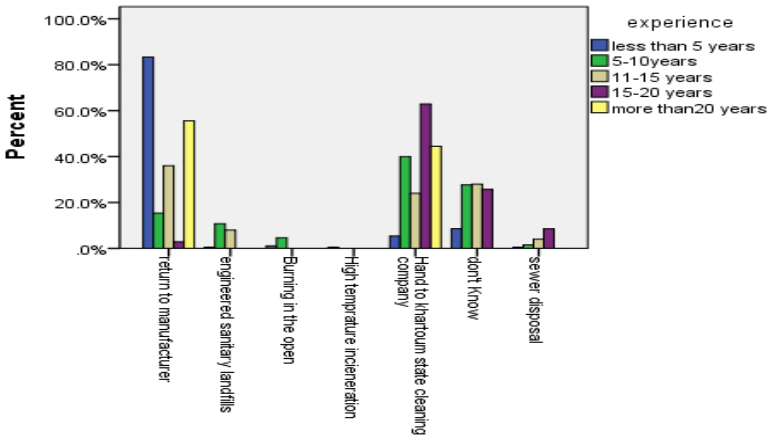
Degree	**The preferred way to dispose of unwanted medication.**									
	Throw them		**Flush them**		**Disguise and put in the trash**		**Incineration**		**None of the above**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
B.pharm	7	70	3	100	8	88.9	61	69.3	136	64.8
M.pharm	3	30	0	0	1	11.1	26	29.6	73	34.8
Ph.D	0	0	0	0	0	0	1	1.1	1	0.4
Total	10	100	3	100	9	100	88	100	210	100
p-value	0.163									



Correlation between *participant community pharmacists' academic degree, and their *preferred way to dispose unused medications, proved non- significant differences. (p=0.163) unwanted medication.

Table. (6): Frequency distribution and correlation. How do community pharmacists or their hired services dispose of the waste pharmaceuticals according to their experience?.

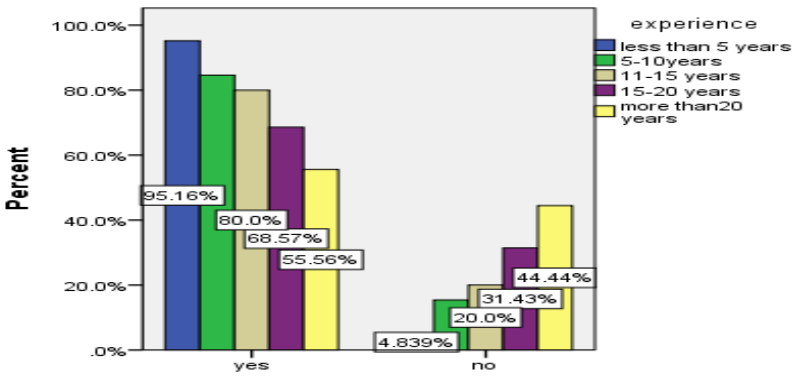
Experience	How do you or your hired services dispose of the medications' waste													
	Return to manufacturer		Engineered sanitary landfills		Sewer disposal		Burning in the open		Medium temperature incineration		Hand to Khartoum state cleaning company		Do Not Know	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Less than 5 years	155	86.1	1	10	2	40	1	100	10	14.7	16	32	1	16.7
5-10 years	10	5.6	7	70	3	60	0	0	26	38.2	18	36	1	16.7
11-15 years	9	5	2	20	0	0	0	0	6	8.9	7	14	1	16.7
15-20years	1	0.5	0	0	0	0	0	0	22	32.3	9	18	3	49.9
More than 20 years	5	2.8	0	0	0	0	0	0	4	5.9	0	0	0	0
Total	180	100	10	100	5		1		68	100	50	100	6	100
p-value	0.000													



*Test showed highly significant differences (p=0.000) between *community pharmacists in – job experience and *how they or their hired services dispose of the pharmaceutical waste.*

Table. (7). Correlation between *community pharmacists agreement with the opinion for having their pharmacies as take back sites for left-over medicines, and *their in-job experience status. Result showed highly significant correlation (0.000).

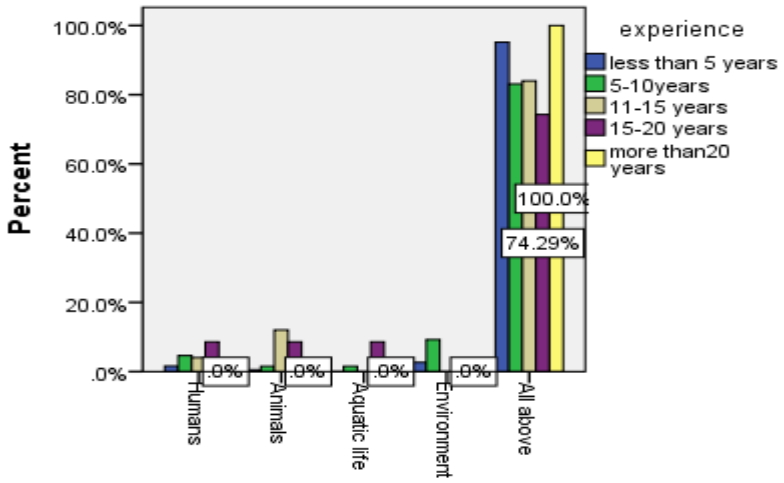
Experience	Do you agree with the opinion for having your pharmacy to take back left-over medicines			
	Yes		No	
	N	%	N	%
Less than 5 years	177	63	9	23
5-10 years	55	19.6	10	25.6
11-15 years	20	7.1	5	12.8
15-20years	24	8.5	11	28.3
More than 20 years	5	1.8	4	10.3
Total	281	100	39	100
p-value	0.000			



Result showed highly significant correlation (p=0.000) between community pharmacists in-job experience and their agreement with the opinion for having their pharmacies as take back left-over medicines sites.

Table. (8): Correlation between *participant community pharmacists' experience and *their opinion that their disposal methods might pose threats to.

Experience	Do you think your disposal methods posed any threats to									
	Humans		Animals		Aquatic life		Environment		All above	
	N	%	N	%	N	%	N	%	N	%
Less than 5 years	3	30	1	12.5	0	0	5	45.4	177	61.7
5-10 years	3	30	1	12.5	1	25	6	54.6	54	18.8
11-15 years	1	10	3	37.5	0	0	0	0	21	7.3
15-20years	3	30	3	37.5	3	75	0	0	26	9.1
More than 20 years	0	0	0	0	0	0	0	0	9	3.1
Total	10	100	8	100	4	100	11	100	287	100
p-value	0.000									



*Correlation test showed highly significant differences (p=0.000) between *community pharmacists' in-job experience and *their opinion that their disposal methods might pose any threats to humans, animals, aquatic life or environment.*

DISCUSSION

As of the year 1993, Sudan witnessed the establishment and opening of a big number of new pharmacy schools, both public and private, with quite a bigger intake and reasonable study fees. That allowed many of those who are interested to study pharmacy to stop thinking of going abroad, as they used to do before. This may be the reason why the majority of community pharmacist' participants 314 (98.1%) had their undergraduate pharmacy studies in Sudan. Moreover, this ease of admission and its economy was more convenient to females who according to the dominating oriental and Islamic culture, are supposed and preferred to be under their family supervision. Accordingly, the majority of pharmacy students were, and are still, females. Moreover, it seems that female as of their secondary school terms, are more

serious than males in their academics, which made their intake into pharmacy schools and graduation higher than their male student counterparts.[46]

This might explain why females constituted 205 (64.1%) of the total number of community pharmacist' participants, while males were only 115 (35.9%), just slightly over one third of the total number. Among the community pharmacist' participants, those with only B. Pharm degree were a majority 213 (66.56%), M. Pharm 103(32.18%), PhD and Fellowship were a very small number 4 (1.26%).

That may be due to the recently allowed and availed postgraduate departments, staff and premises in almost all the Sudanese pharmacy schools, compared to the older times when that was only available abroad.[47]

A big majority of the community pharmacist participants 277(86.6%) stated that their premises often generate left-over medications. Their majority 279 (87.2%) asserted that the biggest contributing source of leftover medications in their pharmacies were the expired medications.

This phenomenon may be referred to the following main reasons

1. The improper or poor need assessment by the responsible community pharmacist.
2. When the community pharmacists is lured by the relaxed payment terms and free goods offers (bonus) by the whole sellers.
3. When the pharmaceutical sales representative convinces the community pharmacist that the prescribers around strongly promised to prescribe the subject medication(s), and requested them to hold a big stock.

Moreover, the quite rampant credit facilities, cash discounts and free good offers, lure the community pharmacies to hold extra stocks.

4. When they defect from the common rule of dispensing : First in, first out (poor experience or management).
5. Inefficient stock tracking system.

Damaged and contaminated medications, were the second most common sources of leftover medication 145 (45.3%). This is probably due to poor medications' stocks handling, improper storage, and/or unfit premises. Only 82 (25.6%) of the participant community pharmacist' reported that they quite frequently receive returns of medications from customers. This might

be because customer's awareness about returning back their leftover medication to the nearest community pharmacies is poor. Moreover the uneven geographical distribution of community pharmacies, especially in big towns' peripheries may represent a real difficulty for customers. Add to that, many customers, especially the poor; prefer keeping their unused or surplus amounts of unused medications at home, for possible future unforeseen needs.[48]

A big majority 279 (87.2%) of the community pharmacist' participants reported that expiries were the highest source of leftover medication more than other waste, damage, contamination and/or spoilage.

From the other hand, a small percentage 43(13.4%) of the participant community pharmacists asserted that their pharmacies don't usually generate waste. This might mainly be attributed to their highly efficient stock tracking system that enables easy detection of short expiry products which they return to suppliers before expiring to handle it their way.[49] The types of the leftover medications with different dosage forms in community pharmacies are; liquids, solids, injectable (ampoules), semisolids and powders, and packaging materials.

A big number of pharmacies 197(61.56%) had all the above mentioned types of pharmaceutical waste. Solids, semisolids and powders being generated in 106(51.56%) of studied pharmacies. This could be due to the fact that most of the pharmaceuticals come as solid, semisolid or liquid dosage forms.[50]

About 183 (57.2%) of the pharmacies sort their left over medications before disposal, while 137 (42.8%) do not. The importance of sorting out pharmaceutical waste in their pharmaceutical dosage forms is to separate the pharmaceuticals into separate categories for which different disposal methods are required, so as to choose and facilitate their appropriate and safe disposal methods. Segregated temporary storage areas or receptacles must be provided for each sorted category. The top priority of the sorting process is to separate out the pharmaceuticals that are categorized as controlled substances (e.g. narcotics, antineoplastic (cytotoxic-anti-cancer) drugs, and the remaining unwanted pharmaceuticals must be further sorted into different categories based on dosage form, (capsules, powders, solutions, suppositories, syrups, tablets). Storing in separate, secure designated areas prior to their separate safe disposal, greatly eases their safe disposal.[51]

Disposing leftover medication was practiced by 141 (44%) of pharmacies yearly, and 131 (41%) monthly. That reflects the lack of regular (routine) disposal system for the leftover medication in Khartoum state studied community pharmacies.

Avery small number of screened community pharmacies 27 (8.4%) has a written standard operating procedure for waste disposal, and only a third of the participants 106 (33.4%) used to document and schedule waste disposal. That shows both knowledge and interest to enhance arrangement to estimate the exact stock that the pharmacy needs.

A bare majority of 139(52.45%) of the participant community pharmacists in Khartoum state asserted that they dispose of their pharmaceutical waste by handing it over to Khartoum State Cleaning Company, while 90 (33.9%) of pharmacies return the unused medication to the manufacturer, distributor or wholesaler. Participants are supposed to have a follow up scheme to trace and validate the disposal methods used by the service provider, and verify their efficiency and safety to the public and the environment, in general.

The importance of availability of national guidelines for disposal of left over medications radiates a great recognition on the importance of clear guidelines for medication safe disposal.

Therefore, in the absence of awareness of guidelines or their proper enactment of the available guidelines, on what to do with returned medications from the public, community pharmacists may use trash to dispose of them without considerations to any cautions. In general, disposal of leftover medications by trash, sink or toilet is not the ideal safe method.[52]

Majority 273 (85.3%) of the participant community pharmacists recognized that throwing leftover medications into trash configures a serious and dangerous act. While 217 (67.8%) of the participant pharmacists configured that disposal of leftover medications via sewage /sink might lead to serious damage on the environment.

The onus for preventing pharmaceutical waste does not lie with physicians or government agencies alone. By the proper and comprehensive counseling of patients on proper medication use and safe disposal of leftover medication, pharmacists can educate patients on the importance of taking their medications as directed (adherence), which will greatly minimizes the need and quantities due for disposal. More than half of the community

pharmacist' participants 176 (55%), preferred to dispose the leftover medications by incineration rather than the other methods of disposal. Incineration is considered as the safest, since even post incineration ashes can be deposited in leak- proof containers bound for special landfills dealing in pharmaceutical waste.[43]

Results showed that about one fifth 68 (21.25%) of community pharmacist' participants considered disposal via disguising and/or throwing into trash to be the second best disposal method. However, that is not a preferred method, as throwing pharmaceutical waste into the trash will create a potential risks for children, the mentally incompetent individuals, and scavengers, and even other living animal species.

A big majority of participant community pharmacist 273 (85.3%) were not aware of the take-back programs in other countries for return of unused medicine to pharmacies. Community pharmaceutical take-back programs are periodic or ongoing events that allow consumers to bring unconsumed or unused pharmaceuticals to an organized collection site, such as a local community pharmacy, for proper management and safe disposal.[51]

In Pennsylvania Prescription Drug Take-Back Program is concentrate on upgrade health and safety concerns from the diversion and abuse of prescription medicines by helping people properly dispose of unused prescription medications.[53]

Pharmacists have a great role to promote and influence the success of this take-back program, as they are directly interacting with the patients. They can, accordingly, educate and advise them on the safe and proper usage of the medications, as well on the safe disposal.**[54,55]** According to the new responsibilities put on pharmacist by the pharmaceutical care mode of pharmacy practice, the pharmacist is responsible for a big role to play in public health promotion and overall education.[43,56,57]

In Australia, the public individuals are encouraged to return unwanted medicines to their local community pharmacy for disposal as part of the Return of Unwanted Medicines (RUM) Project (2011). These Returned medicines are collected free of charge from each participating community pharmacy and taken to central locations for incineration.[58]

One of the bright things noticed in this study is that a big majority of the community pharmacist' participants 257 (80.3%), reflected high willingness to have their pharmacies as collection points for leftover medications.

Almost one fifth 63 (19.7%) of the community pharmacist' participants who did not accept to receive returned leftover medications from the public, reported that they were concerned about what to do with these leftover medications in the absence of policies mandating pharmacists to accept returned leftover medications from the public. They might be apprehensive of the extra load of proper tracking inside their pharmacies premises, and also the extra cost of storage areas for the returned amounts. In Kuwait, before application of an efficient and effective drug take-back program, several barriers were reported such as lack of information about the usually estimated quantities and types of the returned leftover medications from the public.[52]

Avery big majority of community pharmacist' participants 282 (88.1%) in this study, indicated that they personally, feel professionally responsible for protecting the environment from such risks, and also 300 (93.75%) of community pharmacist' participants showed a great concern about safety from expected hazards towards human and other living species in the environments.

CONCLUSION AND RECOMMENDATIONS

Community pharmacy outlets in Sudan generate a substantial amount of leftover medications which have multiple sources.

Expired medicines are the biggest source of waste rather than other sources.

Solids, semisolids, powders, are the commonest constituents of leftover medications generated in Sudan's community pharmacy outlets.

Majority of community pharmacists, with different years of practice experience, are well aware with risk and the dangers of improper disposal of leftover medications that threat humans, living species, and environment in general aspect.

Studied community pharmacists lack knowledge on proper steps of sorting of the leftover medications and its safe methods of disposal, according to their categories.

The willingness of high percentage of Sudanese community pharmacists to designate their pharmacies as collection sites for take back leftover medications, though not mandated by the concerned Sudanese health authorities, reflects community pharmacists' good intention to participate and help in the proper and safe disposal of leftover medications.

We recommend the following: Health authorities in Sudan should have clear guidelines about the safe disposal of pharmaceutical waste including the leftovers, and take the appropriate measures to enact them strictly.

Pharmacist should be aware and have good knowledge on the need and importance of this guidelines and how to implement this guidelines by choosing and scheduling the safe disposal methods in details.

Healthcare providers rational prescribing and dispensing of medication, and promotion of patients adherence to their medication use regimens and over all handling, would greatly minimize the magnitude and consequent risks of leftover medications problem**.**

In Sudan, such program can be very successful in urban areas and rural towns. But, in rural villages where both public and private sector pharmacies are difficult to reach, only primary care health centers can be suggested and used as collection points.

The Ministry of Health (MOH), National Medicines and Poisons Board (NMPB), Pharmacists' Union, and the various public media, should:
Instruct both the community and hospital pharmacists to accept any returned leftover medications from the public to reduce the crisis risk of improper disposal.

Involve awareness campaigns that raise the public and healthcare professionals' awareness about the hazards of leftover medications.

Proper pharmacy undergraduates training and continual educations of pharmacist on methods, guidelines and polices that related to general medications management, and safe disposal of leftover medications shall become part of routine good pharmacy practice.

Most of pharmacies need to use more efficient stock tracking system to avoid over stocking and facilitate detection of short expiry products and allow exchange for longer expiry products from suppliers. Careful handling and proper storage also can greatly reduce generation of left-over medications.

AKNOWELEDGMENT

The authors like to thanks all the community pharmacists participants in this study for their cooperation and the valuable information they provided.

CONFLICT OF INTEREST

Authors have no conflict of interest to declare.

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