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Reverse Logistics of Postconsumer Medicines: The Roles and Knowledge of Pharmacists in the Municipality of São Paulo, Brazil

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Abstract: Environmental contamination due to the disposal of expired or obsolete drugs is a concern, since there is no specific Brazilian legislation, regarding disposal by the final consumer, thus reflecting the need for reverse logistics of medicines, after their consumption. The objective of this study was to survey the knowledge of pharmacists regarding their role in the reverse logistics of medicines and to understand the contribution of reverse logistics, aimed at the appropriate disposal of Group B waste, on a voluntary basis, by the population, in the municipality of São Paulo. A survey conducted through interviews with a hundred and sixty-one pharmacists demonstrated that 35% have partial knowledge of the postconsumer reverse logistics of their place of work and 16.8% have complete knowledge of the environmental harm resulting from the contamination of medicinal waste. The pharmacists also reported (10%) that there should be an educational plan for clients, and 50% of them agreed that incentives and disclosure, regarding the importance of reverse logistics for medicines, should be provided to consumers.

Keywords: reverse logistics; disposal; postconsumer; pharmaceuticals; medicines

1. Introduction

Health service waste (HSW) is any waste resulting from patient care, at home or in public and private institutions. In Brazil, 149,000 tons of domestic and commercial waste are produced each day, and 1–3% is HSW that is of a heterogeneous nature. The implementation and improvement of the segregation processes, at their source and during their generation, for the different kinds of waste, allows for waste minimization, especially for waste that requires special treatment [1,2]. It is necessary to classify the differentiated segregation of these wastes, according to the guidelines of the National Council of the Environment (known as *Conselho Nacional do Meio Ambiente* or CONAMA in Brazil) and the National Health Surveillance Agency (called *Agência Nacional de Vigilância Sanitária* or ANVISA) [3,4]. The management of HSW, from its generation to its final provision, is the responsibility of the health establishment; for example, incineration is determined by the resolution of the Collegiate Board No. 222 of ANVISA, which produces the technical regulations for the management of HSW, with the aim of minimizing production, insuring safety and efficiency, protecting workers, and preserving public health, natural resources, and the environment [5].

The terms end-of-life (EOL) and end-of-use (EOU) are used to indicate that a product has completed its service lifetime and has reached the end of its useful life [6,7]. According to Kongar et al. [6], several events can cause a product to complete its service life time, including deterioration or obsolescence.

The gap between the shelf life and the actual obsolescence date leads to the storage or disposal of a growing number of EOL pharmaceutical products. This fact, coupled with the significant potential hazard posed by these products, has led to the development of a well-established reverse logistics system capable of handling EOL operations, such as take-back, reuse, recycling, and proper disposal of these products. Inadequate dispersion of these health wastes can contribute to impacts on nature and public health, according to the Brazilian Industrial Development Agency. Among HSW, medicines are classified as Group B waste, which encompasses chemical substances that may present a risk to public health or the environment, due to their characteristics of flammability, corrosivity, reactivity, and toxicity [8].

However, residual medicines, such as leftovers resulting from disuse or expiration, are usually disposed of directly in common waste or in the sewer network. Medicinal products are considered "special micropollutants" because they are introduced into the environment in small quantities and possess physicochemical and biological characteristics, which make them contaminants that are differentiated from other industrial chemical compounds [9]. The degradation that pharmaceutical compounds undergo during sewage treatment and natural degradation, lead to the attenuation of these micropollutants but do not guarantee their complete removal and may even generate unknown metabolites that may continue to contaminate the environment [10]. The conventional treatment of effluents, which utilizes the activated sludge systems, bioreactor membranes, and oxidation processes, reduces the concentrations of the drugs but is unable to remove them completely [11]. Similarly, most methods of water treatment also do not completely remove pharmaceutical products and their derivatives, including that of aeration, coagulation, flocculation, sedimentation, filtration, ozonization, chlorine treatment, and adsorption in activated carbon [12].

The irrational use of medicines (including self-medication), as well as the lack of awareness in the population regarding their disposal, is not just a problem in Brazil. Small concentrations of antibiotics (from human and animal use) have been found in samples of sludge or effluents from sewage treatment plants, in urban centers around the world [13]. In a survey conducted in London, 80% of respondents considered the final disposition of medications a problem when they are discarded into the waste and domestic sewage systems. According to the World Health Organization [14], this occurs in many countries due to the following occurrences—medical consultations that generate drug prescriptions (50–70%); medicines prescribed or dispensed in an inadequate manner (50%); prescription of erroneous antibiotics (75%); sale of antibiotics without a medical prescription (75%); and the use of medications for only a single day of treatment (50%). Similarly, according to Kongar et al. [6] research shows that many patients discontinue drug treatment and even self-medicate with other drugs, which further increases the generation of drug waste.

On the other hand, concern about the impact of medicinal waste upon the environment has been increasing. In a Dutch survey, Arkaravichien et al. [15] found that 80% reported concern about the effects of medicinal waste on the environment and, as a result, returned medications to pharmacies or chemical waste facilities.

Pharmaceuticals of various therapeutic classes, including antibiotics, hormones, and anti-inflammatory medications, have been detected in domestic sewage, surface water, and groundwater, in concentrations that range from nanograms to milligrams per liter [13]. There are intriguing reports in the literature that have documented the ecologically-relevant effects on a range of target organisms, due to exposure to sublethal concentrations of pollutants, including antibiotics. The occurrence of such residues in the environment contribute to the resistance of microorganisms to antibiotics, in addition to resulting in toxicological problems for certain living organisms [16]. Twelve pharmaceutical products that included antibiotics, painkillers, antiepileptics and lipid regulators, were detected and analyzed in water samples, from three major urban rivers in China, and an algae growth inhibition test was conducted as part of a preliminary evaluation of the ecotoxicology, induced by pharmaceutical products in the rivers. The concentrations of caffeine and paracetamol were relatively

high; the preliminary assessment of ecotoxicological risk found that the presence of azithromycin, clarithromycin, and caffeine may create an ecotoxicological risk for urban rivers [17].

A study that evaluated the destination and ecotoxicity of various cytostatic compounds in the environment, revealed that urinary excretion was the main contributor to various cytostatic wastes, within the water cycle [18,19]. Another study that was conducted by Gabet-Giraud and collaborators [20], evaluated the occurrence and treatment of five estrogenic hormones and ten beta blockers in wastewater treatment plants, in fourteen rural and urban areas, in France. According to the authors, the analysis of free and total estrogens showed that more than 84% of the estrogens, in the dissolved phase of the samples, were in the free form.

According to El-Hamamsy [21], the significant levels of waste are due to the high consumption of medication in the USA, as demonstrated by an increase in prescriptions (from US $2.9 billion in 2000 to 3.4 billion in 2005) and an increase in the sales of pharmaceutical products (from US $79 billion in 2000 to US $116 billion in 2005). The increase in the consumption of medicines in Brazil is related to the emergence of the generic drugs program, which has also increased the amount of packaging and leftover medicines [22]. According to the Brazilian Association of Generic Drug Industries, there are a hundred and twenty generic drug manufacturers in Brazil that are responsible for more than three thousand and eight hundred recorded medicines that derive from more than twenty-one thousand and seven hundred commercial presentations [23]. Another factor that led to the increase in the consumption of generic drugs was the affordability of medicines for the general population. In 2014, it was already possible to treat the most prevalent diseases in the country with generic drugs, which cost up to 35% less than the brand-name products. The statistical yearbook for the 2016 pharmaceutical market that was published by ANVISA showed that 1.46 billion generic drugs were marketed in Brazil. Sales generated a turnover of R$8.58 billion, which was equivalent to 13% of the market [24].

According to Ueda et al. [25], in Brazil, there are inadequate numbers of landfills and licensed incinerators, which compromises the measures made to reduce the problem. According to ANVISA data, 5000–34,000 tons of expired drugs are produced annually in the country. Using the median per capita to estimate the volume of medicines collected in Brazil, based on a population approximately of 190 million of inhabitants, a volume of 10,300 to 13,800 tons per year, is estimated [8].

The idea of adopting reverse logistics (RL), for several production chains, gained interest in 2010, when the National Policy of Solid Waste (NPSW) was implemented as the Brazilian Federal Law No. 12,305 [26], which forced the implementation of RL in specific sectors, such as pesticide, battery, and tire manufacturing. For products not mentioned in the law, NPSW determined that a system should be established through regulation, or in sectoral agreements and terms of commitment made between the government and companies [27]. ANVISA organized discussions to prepare a proposal for the implementation of RL in the drug chain and thereby to establish the correct destinations for medicinal products [28]. There is no specific legislation regarding the handling and disposal of discarded medicines that addresses the generation of waste in households [29]. In Brazil, since 2008, the establishment of an appropriate drug disposal program has been part of the regulatory agenda of ANVISA, without a consideration of the disposal of drugs by the population [30]. For the Brazilian Association of Pharmaceutical Trade (ABC Farma), the RL of medicines or Group B waste is a subject of continuous discussion, but there has been no elucidation on the disposal of unused medicines, the appropriate disposal by the consumer, and the responsibilities envisaged for entrepreneurship, such as the case of storage at the points of collection of products discarded by consumers; the logistical costs and training of employees are the most important considerations for retailers [31].

Since 2011, the government has been trying to establish a sectoral agreement between industry, distributors, and pharmacies to implement RL for the management of medications intended for domestic consumers. The Steering Committee of the Reverse Logistics System involves five ministries, and after two years of debate, the committee has endorsed the technical and economic viability of the system. In October 2013, an edict was published that convened the segments for the submission of proposals. The problem is that the pharmaceutical industry, drug distributors, and pharmacy

representatives have been in disagreement. For the Ministry of the Environment, which evaluated the suggestions along with ANVISA, each member of the chain attributed to the other members the main responsibilities for the system, giving pharmacies (considered the weakest link in the chain) the greatest responsibility for RL [27].

According to the Regional Pharmacy Council of the São Paulo State (CRF-SP), the pharmacist has knowledge and should be able to identify and recognize residues that have the potential to cause harm to the environment [32]. It is up to the Council to ensure that waste disposal is conducted using effective, safe, and environmentally correct means. The pharmacists are to be involved in all the actions related to medicines and must include in their responsibilities the consideration of the end of the life cycle of medicines, to ensure the safety of, both, the patients and the environment [33].

The fact that pharmacists act in a multitude of segments, especially those that generate HSW, makes it necessary for them to have minimal knowledge of the NSWP, Collegiate Board No. 222 [5] and CONAMA Resolution No. 358, as well as municipal and state laws that deal with the subject [32].

As discussed, many actors exist in the RL complex that share responsibility, but it is important to note that the participation of responsible pharmacists (RP), in the education of the population and their knowledge on the subject, are fundamental to this process. The search for models of partnerships, in the retail sector, that facilitate the assistance of consumers is also important. This study sought to explore the following question: What is the extent of the knowledge of RPs, regarding the reverse logistics of drugs, post-consumption, as well as the National Policy of Solid Waste in the municipality of São Paulo, Brazil?

2. Brazilian Legislation on Waste B

In 1993, the CONAMA Resolution No. 5 was published [34], which classified HSW into four groups: A, B, C, and D. Group B residues or chemicals were defined as chemical substances that may present risks to public health or the environment, based on their features; medicines are included in this group. In 2001, the CONAMA resolution No. 283 established that the legal guardian of the generator of waste was responsible for it, from generation to the final disposition [35]. In 2004, as a complement to the aforementioned resolutions, ANVISA published the resolution of the Collegiate Board No. 306, which implemented a Waste Management Plan of Health Services (WMPHS), for the health services establishments only [4]. It should be noted that all resolutions refer to the generating establishments, supervised by the aforementioned organizations.

Only since 2009, when the ANVISA Collegiate Board No. 44 was published, have good pharmaceutical practices (GPP) been applied to the operation of pharmacies and drugstores, which were allowed participate in drug collection programs for community disposal, in order to preserve the public health and the quality of the environment [36]. In 2010, the Collegiate Board No. 17 updated the guidelines for good drug manufacturing practices and replaced the term "disposal", which was used in the Collegiate Board No. 210 [37,38], with "management", which reinforced standards for health establishments [38].

According to Brazilian Industrial Development Agency (ABDI), the legal focus of the discussion regarding the RL system, in the different productive chains, came about due to the National Solid Waste Policy (NSWP), which was sanctioned by Law No. 12,305 and defined the principles, guidelines, objectives, instruments, and distribution of responsibilities, for the management of solid waste in the country. It is important to note that the RL system is based on the principle of shared responsibility (which includes consumers) for the life cycle of the products [8].

The NSWP represents an innovative approach with regards to the implementation of RL. Producers, importers, retail companies and even consumers have become responsible for the development and implementation of an RL model, independent of the public waste management system [39]. Article No. 33 of the NWSP refers to the obligation of the business sector (importers, distributors, and traders) to address the issue by considering the impact on public health and the environment, due to waste generation (including packaging), as well as structuring and implementing

the RL systems, independent of the public services that perform urban cleaning and the management of solid waste [28].

In 2018, a new resolution, the Collegiate Board No. 222, was published on March 28, that replaced Resolution No. 306, which regulated and established the best practices in waste management, within health services. Article No. 59 established that residues of medicinal products containing hormones and antimicrobial products, cytostatic antineoplastic immunosuppressants, digitalis, immunomodulators, and anti-retrovirals shall be subjected to treatment or disposal as Class I hazardous landfill waste, when discarded by or seized from health care services, pharmacies, drugstores, and distributors of medicinal products [5].

For RL, the priority for medicinal products should be the recollection and transport of the out-of-use medicines from the households of consumers to an environmentally-appropriate destination [8]. However, the RL system is commonly utilized for the transport of unsold or expired drugs between pharmacies and their suppliers [40]. For this matter to be resolved, a sector agreement between the stakeholders should be signed, but the representatives of the pharmaceutical Brazilian association called *Associação Brasileira das Redes de Farmácias e Drogarias* (ABRAFARMA) have stated that the delay in the establishment of a sector agreement is due to issues with the financing of the logistics and the selection of adequate destinations, which is the responsibility of the manufacturer. In several countries where RL was adopted, such as Spain and Portugal, manufacturers now finance the process by allocating several Euro cents, for each medicine box. The problem in Brazil is that the prices of medications are controlled and established by the government [27].

3. Materials and Methods

This is an exploratory study that was structured as a quantitative research in which a convenient, non-probabilistic sample of two hundred and forty-two pharmacists was used from the registration data of the annual meeting of the CRF-SP. However, the selection criteria resulted in a sample consisting of a hundred and sixty-one responsible pharmacists (RP) who had worked for more than six months, in pharmacies located in the municipality of São Paulo, and were chosen randomly from the northern, southern, eastern, western and central regions of São Paulo, during the year 2016. Based on a bibliographic survey and Brazilian legislation, important topics that were chosen to be addressed included the management of solid residues in the postconsumer drug productive chain, the costs and shared responsibilities of stakeholders, and educational information provided to consumers (Figure 1).

For the survey, an evaluative matrix was constructed with five dimensions of analysis of the RL of expired medicines, according to the objectives; each dimension and objectives, were composed of fifteen indicators (Table 1).

After the first contact with the pharmacists in the annual meeting, all these surveys were conducted in person and consisted of ten questions regarding the knowledge of legislation, management, NSWP, and RL, pertaining to medications, with 45 min allocated for each respondent. The survey was previously pretested with forty-five pharmacists, for validation, and approved by two experts in the qualification test; however, the results of pretested survey were not included in the final data.

The data collection instrument was a scaled-out, printed questionnaire that used the Likert scale, for eight questions, and contained items presented in the form of affirmations, for which the subject was asked to choose one of five points on a scale [41]. To determine the degree of knowledge of each RP regarding the RL of prescription drugs, post-consumption, the response scale varied from 1 to 5 points (Figure 2). Two open-ended questions were included at the end of the Question 9 ("Do you have any suggestions for methods of collaboration with RL of postconsumer drugs in ways that support the client?") and Question 10 ("What are your personal observations about postconsumer RL?").

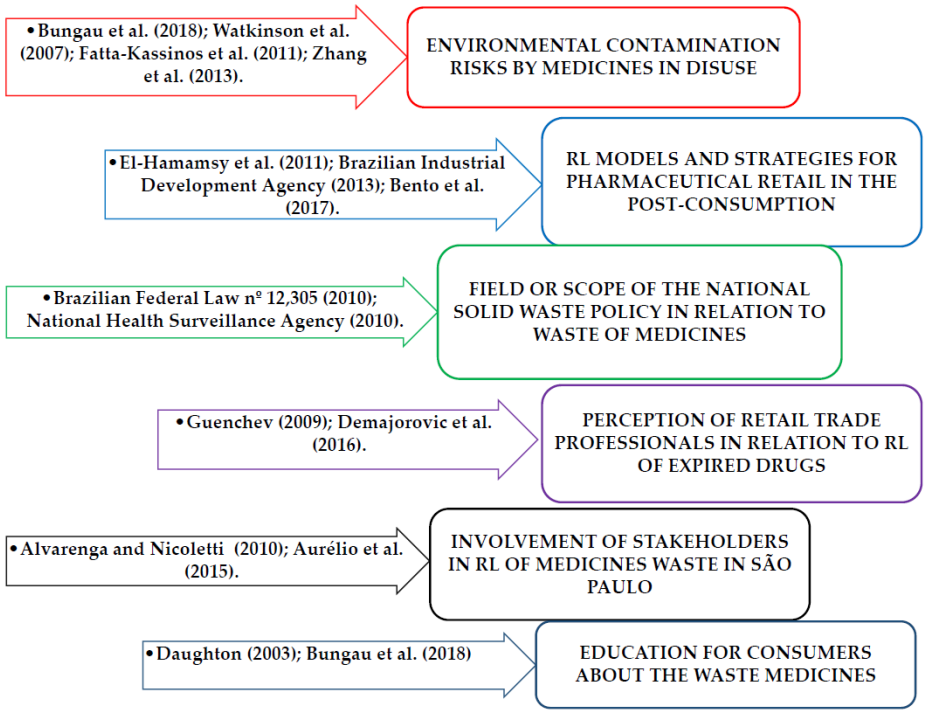

Figure 1. The bibliographic search regarding the issues in the management of solid residues present in postconsumer drug waste.

Table 1. Dimensions, objectives, and indicators to assess the reverse logistics (RL) of medications that have expired in pharmacies.

Dimensions	Objectives	Indicators	References
Environmental contamination by medicines	Verify if the medications in disuse are being collected instead of being discarded in the environment	Harmful to the environment due to irregular disposal	Bungau et al. (2018); Watkinson et al. (2007); Fatta-Kassinos et al. (2011); Kosma et al. (2014); Zhang et al. (2013).
		Knowledge related to RL in the company where the RP work.	
Brazilian Federal Law No. 12,305	National Solid Waste Policy (NSWP)	Field of NSWP to chemical residues	Brazilian Federal Law nº 12,305 (2010); El-Hamamsy (2011); Brazilian Industrial Development Agency (2013); Bento et al. (2017).
		Scope of NSWP in relation to medicines	
		Reverse Logistic (RL) of medicines waste	
Pharmaceutical role in postconsumption	Appropriate physical and organizational structure and procedures to guide consumers	Adequate physical and organizational structure	Medeiros et al. (2014); Regional Pharmacy Council of Rio Grande do Sul (2018); Kongar et al. (2015); Campos et al. (2017).
		Existence of standard operating procedures	
		Employee training on the subject	
Reverse Logistic to expired drugs	Collect medicines in post-consumption	Pharmacist's perception about RL of medications after sale	Guenchev (2009); Demajorovic et al. (2016); Alvarenga and Nicolleti (2010); Aurélio et al. (2015).
		Drug collection program in disuse	
		RL implanted in pharmacy for disposal of consumers	
Education about the waste medicines	Provide clear and accurate information about RL of expired drugs.	Education for pharmacists about NSWP and RL of used medicines	National Health Surveillance Agency (2010); Daughton (2003); Bungau et al. (2018); CRF-SP (2015).
		Stakeholder' engagement at RL of expired or disused medications	
		Education for consumers about the waste medicines	

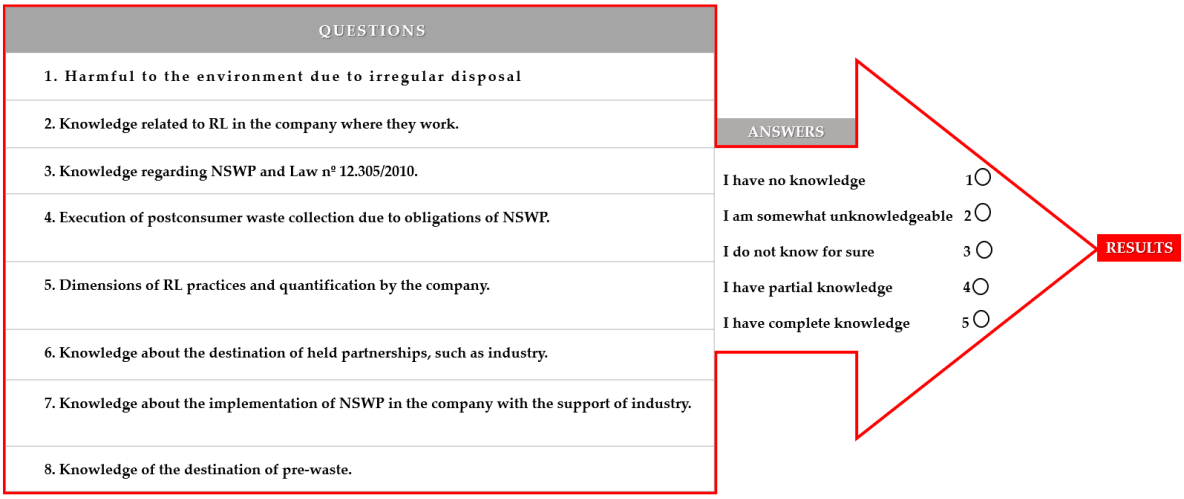

Figure 2. Questions about the knowledge of the responsible pharmacists (RPs), regarding the RL of expired drugs, post-consumption.

The statistical analysis included variance analysis (ANOVA) and tests that evaluated the relationships between the service time of the interviewed RP, the size of the company where they worked, and the location of their work establishment in the municipality of São Paulo. The analyses were carried out using the *Software Statistical Package for the Social Sciences* (SPSS, 2015), with a significance level of $p = 0.05$.

The interview is a technique used to obtain data that cannot be found in records and documentary sources and that can be provided by certain persons [42]. The versatility and value of this technique in commercial social research has become evident, and it is certainly the most flexible of all techniques of data collection used in the social sciences [43]. The interview technique favors not only the description of social phenomena but also its explanation and the understanding of it, in its entirety [44]. The data were recorded, transcribed and analyzed using content analysis, which, according to Bardin [45], is a research technique that has the aim of obtaining objective, systematic, and quantitative descriptions of the manifest content of communication.

4. Results and Discussion

4.1. Characteristics of Pharmacies

The total registered number of pharmacies in the municipality of São Paulo, according to the Regional Pharmaceutical Council of the São Paulo state (in 2016) was four hundred and eighty-two, and their distribution in the different regions, were as follows: North (61); South (164); Central (58); East (136); and West (63) [32]. Therefore, the data obtained during this study was derived from 33% of the establishments in São Paulo. The results obtained from the ANOVA statistical tests that evaluated the relationship between the RP's responses regarding the RL of expired drugs, the size and location of the pharmacy, and service time of the RP were not statistically significant ($p > 0.05$). The largest proportion of RP respondents who worked in large-scale pharmacies (n = 72, 44.7%), were located in East-side pharmacies (n = 41, 25.4%) and had a service time of 2–5 years (n = 64, 39.5%). The location, time, and size data for the companies are represented in Figure 3.

According to the results, the concentration of pharmacies belonging to large networks decreased as distance from the center decreased, and there was a predominance of small and medium-sized pharmacies, in the periphery. One limitation of the study was that there was no survey of all the stores in the same drugstore network, which could have uncovered managerial differences in the subsidiaries of a single company.

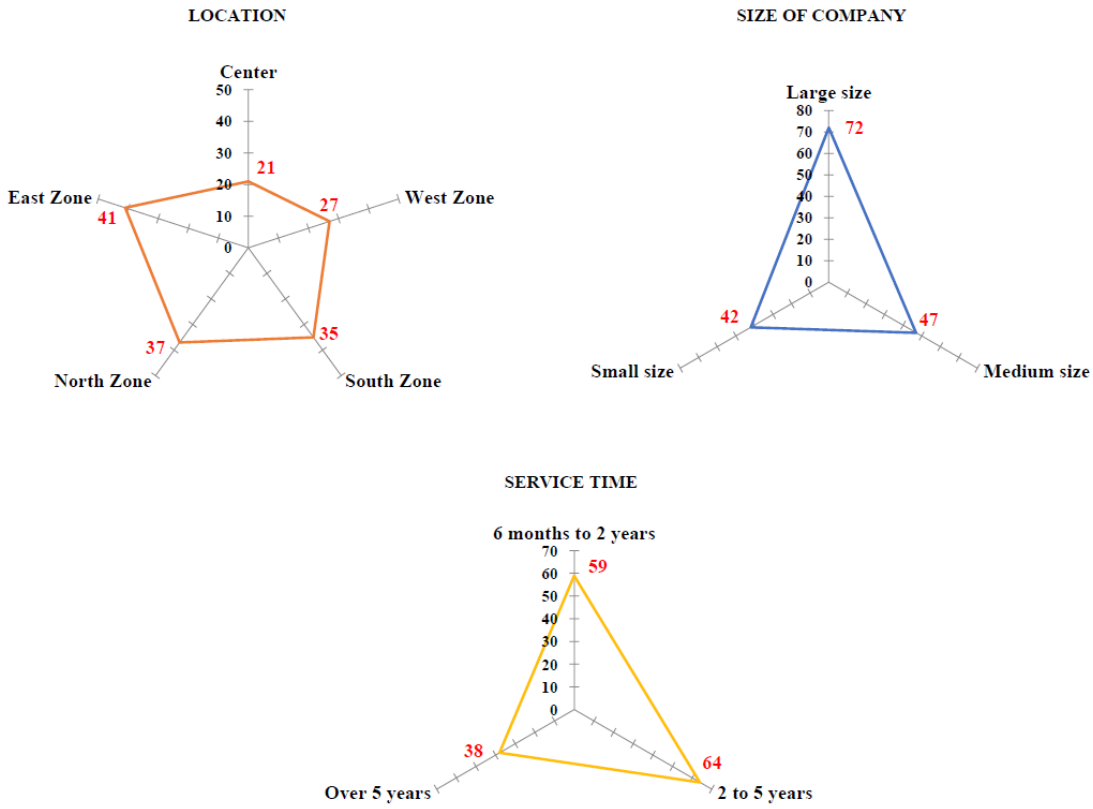

Figure 3. Location, size of pharmacies, and service time of RPs in the companies.

The minimum cost of the RL program could be serving as a barrier to the implementation of RL in small pharmacies. As in Brazil, conflicts over role assignments in RL were observed in other countries, due to the implementation of shared responsibility [46]. According to Demajorovic et al. [39], many conflicts still exist due to issues in splitting costs and responsibilities, in areas such as the determination of the value to be paid for transport. The private sector accuses the government of not stipulating well-defined roles in the reverse chain and complains about the lack of incentive policies, for the deployment. On the other hand, the government accuses the private sector of emphasizing challenges with the objective of postponing implementation [39].

There are two categories of costs in relation to RL for Group B waste—collection space and transport. Such costs depend on the return volume of products, modes of transport, and the desired level of service. In an RL system, economic aspects are directly related to decision making. The manager needs to know the costs of different alternatives to inform his decision making [47]. Shaik and Abdul-Kader [48] point out that the performance of an RL system, in terms of the efficiency and effectiveness of its actions, should be viewed from six perspectives—finances, internal and external processes, involved stakeholders, innovation, environment impacts, and social requirements.

Measures to recollect unused drugs should be focused on the inevitable occurrence of leftover medicines. The handling of these wastes generates costs, and the final disposal in the form of incineration, even when controlled, results in energy expenditures and generates pollutants, resulting from the burning of the residues [33]. It is noted that one of the major challenges is the dispute over the responsibility for assuming the costs of the appropriate disposal of these wastes (transport and appropriate final disposal in a landfill or an incinerator).

Other costs incurred as a result of RL steps, such as collection, segregation, and wrapping, even if irrelevant, lead the stakeholders in small and medium-sized retail establishments to avoid compromise, as these costs are in addition to the costs of collection and incineration, which is carried out by specialized companies. The costs of collection programs and the final disposition of discarded medicines is an important issue to consider in a country such as Brazil, which is a large continental

country with many regions that have distinctive characteristics. Public grants may be necessary to promote the RL process in some localities or regions [33].

In Brazil, scientists, industries, governments, and the general population have been concerned about the topic and has taken various stances [49]. According to Medeiros and collaborators [33], since 2011, ANVISA has been trying to promote a debate on the topic of the correct disposal of medicines by instituting a discussion forum on the topic and outlining guidelines for the correct disposal of medicines in Brazil. However, until the year 2013, a national program for the collection of leftover medicines from the population had not yet been implemented. Until recently, the discussion regarding the implementation of an integrated collection system did not result in an agreement between the various actors.

The role of the pharmacist in the resolution of this issue is not only related to the RL of expired drugs, as the pharmaceutical professional also plays a fundamental role in promoting the rational use of medications, avoiding inappropriate self-medication, and minimizing the generation of drug waste, in addition to advising the population on the correct disposal of unused or expired medications [50].

The pharmacist may act in tandem with the population to implement other measures that seek to avoid or circumvent pollution caused by unused drugs. The application of the principle of pollution prevention, through the control of the sources of waste, results in benefits not only for the environment but also for the society and for health services, because it leads to better administration of resources, decreased spending due to the consequences of pollution, and benefits for patients who use medicines in a rational manner [33].

4.2. Knowledge of RPs about RL of Medicines

The data regarding the answers given by the RPs to questions concerning their knowledge of RL, demonstrated that of the total number of pharmacists, 35% have partial knowledge of postconsumer reverse logistics of their place of work and approximately 70% of the RPs said that they have partial knowledge of the harm caused to the environment by the irregular disposal of medicines. Only 16.8% claimed to have complete knowledge of the hazards of medicinal waste in the environment. However, approximately 40%–50% of interviewees had partial knowledge of NSWP, RL, and the management of postconsumer medicines, as demonstrated in Table 2.

However, the present study revealed that RPs in the municipality of São Paulo still do not know their role in a postconsumer RL system or how to act as an advisor in this matter, in order to meet the obligations of the NSWP.

In relation to Question 9 ("Do you have any suggestions for methods of collaboration with RL of postconsumer drugs in ways that support the client?") and Question 10 ("What are your personal observations about postconsumer RL?"), the results were grouped based on the similarities in the open responses (Figure 4).

About 25% of the respondents agreed that the RL depends on the involvement of the upper management of the establishment, where they operate, while 10% reported that there should be an educational plan for clients and 50% state that there should be incentives for and disclosure to the consumers themselves. It is noteworthy that only 4% agree that the responsibility lies with themselves in their orientation to consumers, which indicates that it is necessary to increase the knowledge of the RL.

Comparing these results in the São Paulo city to the literature data about the knowledge or the challenges in the RL of postconsumer drugs, the topic tends to be observed by the pharmaceutical professional, as a punctual or individualized form, according to institutions in Brazil. The Hospital of the Clinics, which is part of the Faculty of Medicine of the University of São Paulo (Brazil), has a program called the Safe Return of Medicines, where medicines are received and evaluated by pharmacists. If the medicines are in perfect condition, they are dispensed to other patients [33].

Table 2. Answers of the RPs to questions 1–8.

	Answers in Likert Scale	Frequency	Valid Percent
1. Harmful to the environment due to irregular disposal.	I have no knowledge	8	5
	I am somewhat unknowledgeable	5	3.1
	I do not know for sure	8	5
	I have partial knowledge	**113**	**70.2**
	I have complete knowledge	27	16.8
	Total	**161**	**100**
2. Knowledge related to RL in the company where they work.	I have no knowledge	20	12.4
	I am somewhat unknowledgeable	9	5.6
	I do not know for sure	39	24.2
	I have partial knowledge	**57**	**35.4**
	I have complete knowledge	36	22.4
	Total	**161**	**100**
3. Knowledge regarding NSWP and Law nº 12.305/2010.	I have no knowledge	16	9.9
	I am somewhat unknowledgeable	15	9.3
	I do not know for sure	47	29.2
	I have partial knowledge	**71**	**44.1**
	I have complete knowledge	12	7.5
	Total	**161**	**100**
4. Execution of postconsumer waste collection due to obligations of NSWP.	I have no knowledge	34	21.1
	I am somewhat unknowledgeable	5	3.1
	I do not know for sure	**69**	**42.9**
	I have partial knowledge	29	18.0
	I have complete knowledge	24	14.9
	Total	**161**	**100**
5. Dimensions of RL practices and quantification by the company.	I have no knowledge	9	5.6
	I am somewhat unknowledgeable	10	6.2
	I do not know for sure	43	26.7
	I have partial knowledge	**83**	**51.6**
	I have complete knowledge	16	9.9
	Total	**161**	**100**
6. Knowledge about the destination of held partnerships, such as industry.	I have no knowledge	17	10.6
	I am somewhat unknowledgeable	24	14.9
	I do not know for sure	**79**	**49.1**
	I have partial knowledge	38	23.6
	I have complete knowledge	3	1.9
	Total	**161**	**100**
7. Knowledge about the implementation of NSWP in the company with the support of industry.	I have no knowledge	18	11.2
	I am somewhat unknowledgeable	16	9.9
	I do not know for sure	**69**	**42.9**
	I have partial knowledge	41	25.5
	I have complete knowledge	17	10.6
	Total	**161**	**100**
8. Knowledge of the destination of pre-waste.	I have no knowledge	13	8.1
	I am somewhat unknowledgeable	17	10.6
	I do not know for sure	52	32.3
	I have partial knowledge	**64**	**39.8**
	I have complete knowledge	15	9.3
	Total	**161**	**100**

The Brazilian pharmacists in this present study (10%), pointed that is important to have an educational plan for customers. As an example of the Food and Drug Administration (FDA), that advises that if a drug withdrawal program is not available, in consideration of the impact on the environment and human health, it is recommended that some medications be disposed of in a sink or domestic bathroom. The active ingredients in the list, published by the FDA in 2017, that presented low

or negligible risk to the environment and to human health included acetaminophen, aspirin bitartrate of hydrocodone, buprenorphine, citrate fentanyl, buprenorphine hydrochloride, hydromorphone hydrochloride, meperidine hydrochloride, methadone hydrochloride, naloxone hydrochloride, naltrexone hydrochloride, oxycodone hydrochloride, oxymorphone hydrochloride, diazepam fentanyl, methylphenidate sodium oxybate, oxycodone, morphine sulfate, and tapentadol [51,52].

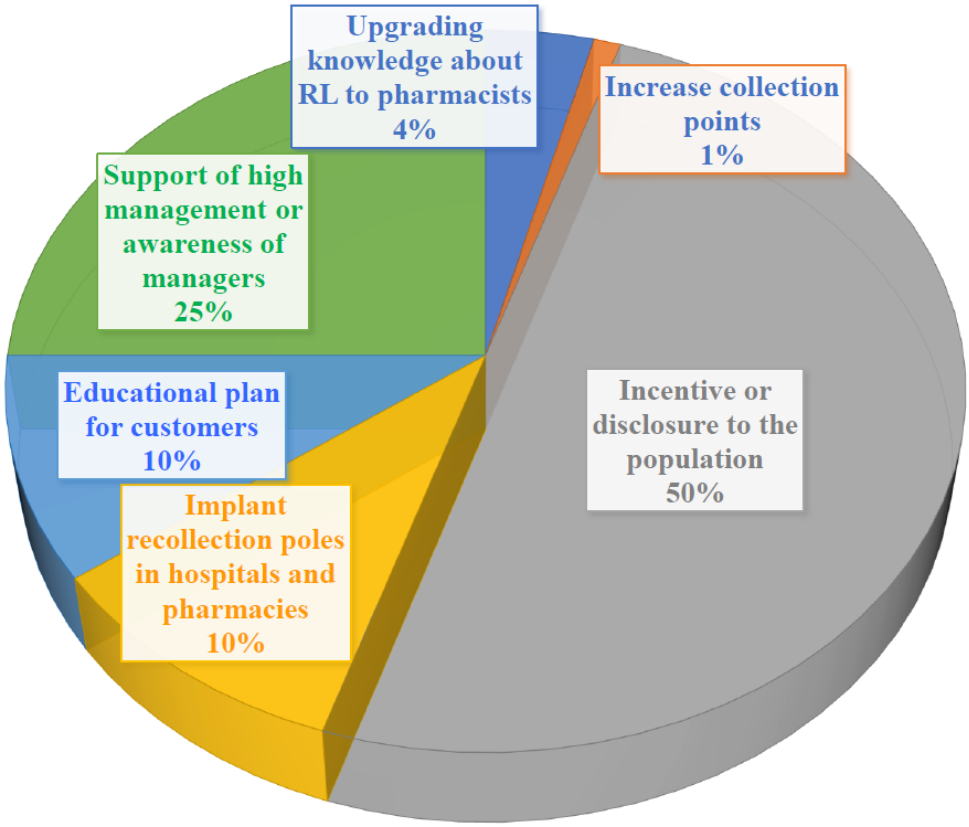

Figure 4. Responses of the RPs to Questions 9 and 10.

To guide the consumer in the disposal of medicines, such as those belonging to the FDA list, by means of domestic discharge, a pharmacist can provide guidance in the disposal of expired drugs, by providing an alternative, in the absence of an RL program in the establishment where they operate (mainly in small pharmacies).

The Brazilian data showed that there is no integrated system for the RL of expired medicines, post-consumption, and the RPs have a minimum knowledge about the waste management to support the customers. As already pointed out, the role of the RP extends beyond the pharmaceutical assistance to the patients to guidance related to the rational use of drugs and concern with the final life cycle of medicines, to ensure the safety of both patients and the environment [33].

The RPs (42.9%) interviewed were not sure about the execution of postconsumer waste collection due to obligations of the NSWP. These results found in the São Paulo city were in accordance with those of Bungau et al., who interviewed five hundred and twenty-one pharmacists regarding their opinions and attitudes regarding the system of collecting and disposing off pharmaceutical wastes from the consumers, in Romania. According to the authors of the surveyed pharmacists of Romania, 16% worked in pharmacies that did not collect unused/expired drugs from the population, and 33% have refused, at least once, to take the unused medicines from the consumers [53]. The most important reasons given by the pharmacists, for refusing to collect pharmaceutical waste, were the lack of procedures, incomplete legislation, the amount that were contracted for with the operators, and the high costs. The results showed that pharmacies in Romania have several deficiencies in

pharmaceutical waste collection services, like in Brazil. The lack of implemented programs has contributed considerably to the lower standards found in pharmaceutical waste management in Romania [53].

A study in Thailand determined how villagers stored and disposed their medicines and showed that 89.4% of people kept some kind of drugs in their houses [15]. Huang and colleagues [54] reported that, in China, 78.6% of families keep unused drugs in case of emergency, which has resulted in a dramatic increase in the number of expired drugs (15,000 tons per year).

Therefore, the implementation of an RL system implies not only a recognition of responsibilities carried by responsible pharmacists but also the establishment of partnerships. It presupposes the involvement of manufacturers, distributors, consumers, and public authorities in a participative dimension. Government, customers, and the competition, exert positive pressures on the position of companies regarding the implementation of the reverse logistics systems [55].

Given the high competition and challenges faced by the pharmaceutical industry, to attempt to constantly improve traditional logistics systems and the RL, there is a need to take action and adopt strategies for the reverse flow of drugs. Often, stringent regulations may affect the supply chain performance, but not enough to meet the demands of the direct logistics or the RL. The industries require that the supply chain operate highly sophisticated circuits to remain competitive and focus on measures that ensure that medicines will not be incorrectly disposed of in the environment [56,57].

Thus, public policies, the consumer population of medicinal products and the pharmaceutical market can stimulate the implementation of medicinal RL programs. Bellan et al. [29] also highlighted the fundamental participation of the society, the government agencies, and the actors in the production chain, since they participate directly, as protagonists, in this context [30]. According to Huang et al., in order to recycle and dispose off expired drugs, the government should design a subsidy policy that would stimulate users to return their expired drugs, and drugstores should be responsible for recycling the expired drugs and should serve as recycling stations [54].

According to Campos et al. [7], the practices of pharmaceutical waste management (WM) can be arranged into three groups, as shown in Figure 5.

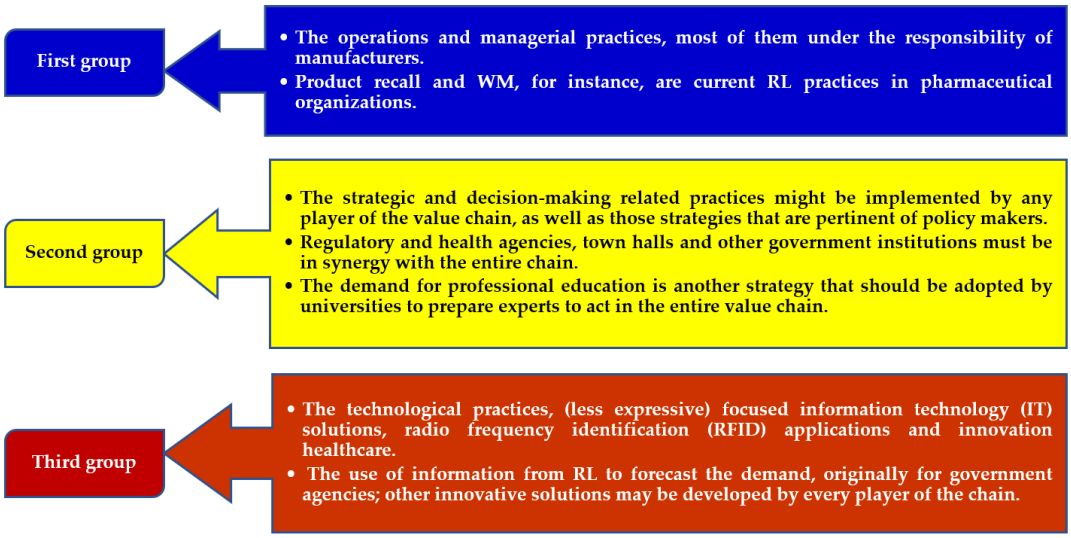

Figure 5. The three groups of solutions in terms of practices related to pharmaceutical WM. Adapted from Campos et al. [7].

Managers in charge of developing and deploying the reverse logistics programs should account for the expectations and demands of customers, during which it is vital to highlight customer concerns and provide complete solutions for product return [58,59]. In an RL program, the consumer's role is highlighted as a starting point for the reverse flow, and the success of RL programs depend upon consumer behavior, which enables the process of the return of postconsumer products [39,59].

Aurélio et al. pointed out that the repercussions of the disposal of drugs in the environment have motivated the search for solutions for more appropriate disposal of this type of waste. The authors studied RL in drugstores belonging to a retail chain in the city of São Paulo. Four drugstores located in the central region of the city were selected, which represented the pharmaceutical retail networks that occupied the first four positions in the 2012 ranking of the largest pharmacy networks in Brazil. It was found that the RL of medicines was practiced by three of the four major pharmaceutical retail networks studied. In Table 3, the main actions related to the RL of medications in the drugstore networks, surveyed by the authors, are highlighted [30].

Table 3. Structure for the RL of medicines in the studied drugstore networks.

Structure for RL of Drugs		Drugstores		
		A	**B**	**C**
Studied Topics	**Operations**	Receives the medicines	Volunteer delivery post available	Receives the medicines
	Education	Information available, but should be sought by the consumer		
	Economic issues		Partnerships with pharmaceutical laboratories	
	Institutional policies		Volunteer delivery post available	Annual sporting event

Source: Adapted from Aurélio et al. [24].

It was observed that this practice was not universal, as it was not always implemented in all the drugstores, in the network. There was a shortage of equipment available that could be used for the specific disposal of these wastes, and the availability of environmental educational information for the population was deficient. There was a lack of knowledge about this information for most of the employees in the drugstores, where only the pharmacists demonstrated this knowledge. At the point of sale of the medicinal products, the guidelines for the disposal of these medicines were not communicated. The environmental education campaigns for the population were punctual [30].

5. Conclusions

The nonobservance of the legal obligations in terms of the RL related to disuse by the population (postconsumer), hinders the consumer's adherence to the implementation of a waste management plan for Group B waste. In pharmaceutical retail, the existing legislation only addresses waste generated in health establishments, which makes it difficult to understand the impacts arising from the domestic disposal of medicinal products.

Until federal legislation or a definitive proposal in the form of a sector agreement is established between the stakeholders in the pharmaceutical sector, regarding the sustainability of postconsumer drugs, it is the responsibility of the RPs to convey the guidelines to consumers who are unaware of the best way to dispose off the disused medicines.

On the other hand, partial knowledge of the NWSP and the lack of awareness of the role of pharmacists in the RL of disused or expired medicines, in the municipality of São Paulo, still represents an obstacle. Such difficulties should be discussed with the Regional and Federal Pharmacy Councils and addressed by expanding the training of professionals in the continuing education of consumers on the subject.

The strained relationships between pharmacies in the municipality, the industry, and the government, mainly in relation to costs, incentives, and investment in the infrastructure needed for collection and final disposition of used or expired drugs, are far from emulating the partnerships found in other cities or countries that are managed and funded through a system that is shared by the government, the industry, pharmacies, and other nonprofit sectors.

The results demonstrated the potential for the RPs to be important actors in the post-consumption medicine supply chain and contribute to the environmental education of the population and

environmental preservation. Collection posts, waste-receiving services, and the disclosure of information to consumers, are fundamental to the implementation of a drug disposal system. Another essential point is the cooperation of producers, distributors, government managers, and consumers as stipulated in the NSWP, which promotes the inclusion of all social actors with regards to a shared responsibility for the management of Group B waste.

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