Evaluation of Medicine Reverse Logistics Practices in Hospitals

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Abstract: Initiatives related to reverse logistics are increasingly common in companies that produce tires, lubricating oils, batteries, and electronic equipment, among others. In the pharmaceutical sector, reverse logistics is also relevant, contributing to reduce medication exposure to other people and the environment. Thus, this research seeks to find out which practices related to reverse logistics are used in 13 hospitals in the state of Rio de Janeiro. Regarding the methodological procedures, this research is supported by interviews with those responsible for disposing of medicines from hospitals, and the best practices were ranked using the analytic hierarchy process (AHP) method. Among the main difficulties for performing Medicine Reverse Logistics practices in hospitals, the absence of a standard process for medicine disposal and medications held by nurses or satellite pharmacies—for being out of control—stand out.

Keywords: supply chain management; reverse logistics; pharmacy; hospital; medicines; contamination

1. Introduction

Supply chain management (SCM) has led pharmaceutical companies to explore economies of scale in manufacturing and the improvement of resource management, such as facilities, equipment, materials, human resources, information, and finance [1], thus giving rise to the Pharmaceutical Supply Chain Management. The pharmaceutical supply chain (PSC) affects economic, environmental [2], social and political perspectives [3]. Regarding the economic perspective, the world’s pharmaceutical financial revenue stands out, reaching one trillion US dollars [4]. From an environmental perspective, studies in Brazil [5], Germany [6], Spain [7], Switzerland [8], and United States [9] show pharmaceutical compounds in the aqueous environment of sewage treatment plants (STPs), in water distribution systems, and even in rivers and lakes. Drug disposal should be considered a problem for health security [10], since many drugs are still discharged as contaminants in the receiving waters [6].

Despite the creation of the National Solid Waste Program in Brazil [11], it is estimated that the generation of waste from domestic medicines is 56.6 g/per capita or 10,800 t/year. Thus, some studies have discussed the relevance of legislation that regulates the collection and treatment of drug residues [12], as decree 10.388 [13]. Along the same lines, Schroder et al. [14] emphasize the importance of investigating the environmental destination of medicines.

Regardless of the relevance of the theme [15], studies on medicine reverse logistics (MRL) are scarce [2,6,16–19], especially concerning hospital pharmacies [18]. In addition, until recently, it was observed that, for various reasons, health-related supply chains were, to some extent, lagging behind commercial supply chain operations [20]. To reduce this gap, the main objective of this study is to find out which MRL practices are used in 13 hospitals in the South of the State of Rio de Janeiro.
This research is in line with current studies, since, in recent years, there has been an increasing number of studies dealing with the environmental sustainability issue [21], especially in Supply Chain Management, mainly because the adoption of green initiatives can play a key role in implementing environmental sustainability strategies that affect all links in the chain [22].

In this context, this study raised the following questions: “what previously reported RL practices could help MRL in hospitals?”, “what MRL practices are adopted in Brazilian hospitals?”, and “what difficulties do Brazilian hospitals face in implementing MRL practices?” These are relevant questions to be answered, as, according to Drobyazko et al. [23], at the current stage of global, regional, national, and local development and in all spheres of the economy, the improvement of management approaches and tools act as an important and necessary condition to guarantee sustainable development and this too applies to PSC. According to these authors, changes in the growth prospects of companies, which are formed under the influence of a combination of internal and external variables, must consider factors that influence the sustainable development of their operations.

This study is structured in six sections. The second section presents a literature review, contextualizing subjects that provide a theoretical basis for the theme; the third presents the methodology, which details the use of the AHP method with those responsible for medicine disposal in 13 hospitals; the fourth section shows the organization and the fifth details the analysis of the results of the empirical research. Finally, the last section addresses the final considerations.

2. Literature Review

2.1. The Pharmaceutical Supply Chain

A supply chain (SC) is a network of facilities that encompasses all activities related to the movement of items and the flow of information necessary for the transformation of raw material into finished products by manufacturers and the distribution of these products by wholesalers until the sale by retailers to the end-user [24]. In the broadest sense, a supply chain includes all activities related to manufacturing, extraction of raw materials, processing, storage, and storage and transportation [25]. It is an integrated process, in which a group of organizations (suppliers, producers, distributors, and retailers) work together to convert raw materials into final products and distribute them to final customers [26].

Supply chain management (SCM) involves relationships, networks of organizations, and multifunctional processes [27]. The implementation of SCM strategies must guarantee strict visibility of the flow of data and information among suppliers, distributors, manufacturers, and customers [28]. Thus, SCM focuses on procurement and contract management based on a material management mindset [28]. Therefore, an adequate information flow is needed, in which information systems play a significant role [3].

Regarding the structure of the Brazilian PSC, ABDI [29] observes that the value flow begins in the chemical industry, continuing through the pharmochemical industry, proceeding to the distribution centers, and ending with the delivery of the finished product to hospitals and retailers. However, Zahiri et al. [30] present this structure in five levels (primary manufacturer, secondary manufacturer, main distribution center, and local distribution center and demand point). Figure 1 illustrates a PSC.

2.2. Medicine Reverse Logistics

Reverse logistics (RL) enables the ecological behavior of industries [19]. In RL, the manufacturers are responsible for collecting their products that have already completed their life cycle, providing them with a correct destination. Materials used in packaging, such as plastic, metal, and glass, can be collected, fixed, and transformed into new products that would return to the same market, or to other markets [2]. This flow of returned materials is also known as the reverse supply chain [32].
The life cycles of some products are extended by reuse or recycling. Other products must be discharged, and only a limited part of their packaging can be reused; thus, reusing or reselling the product is not an option. Knowing the residual value of the returned product can improve the involvement in the recycling processes [33].

RL is also identified in the literature as an active component of green supply chain management (GSCM) practices [17,34,35]. GSCM consists of reactive monitoring of general environmental management programs and moving towards more proactive practices, such as recycling, recovery, RL, and remanufacturing, in addition to implementing innovative practices [35]. GSCM practices are integrative, not being oriented towards a single function or department, thus supporting the incentive and cooperation among the participants in the chain. According to Zhu and Sarkis [35], although it plays a fundamental role in GSCM, RL is studied separately, in terms of the problems studied, the methodologies applied and the context addressed.

MRL includes the collection and recycling of medicines sent back to manufacturers to ensure an environmentally safe recovery method. Unlike products in other chains, such as the electronic product chains, whose market value can be recovered [32], there is no recovery value for expired medicines [17]. This fact makes MRL unique. However, some medicines recovered from the internal SC, before the end of life, can be returned to stock and reimplanted for use before their expiration. These products can have a "second chance of use", in opposition to a "second life" through remanufacturing [18].

Another fact that makes MRL difficult is the conflict between returning products and the absence of medicine recovery and redistribution system [19]. Customers are not willing to return medicines before their expiration if they know that there is a chance of future use. Hua et al. [36] suggest that customers could receive financial incentives that encourage them to return unwanted medicines. Weraikat et al. [37], in turn, suggest that the producer could resell these returned medicines in a subsidiary market at a lower price.

These considerations are consistent with the recommendations of Xie and Breen [17]. The authors point out RL improvements in PSC by benchmarking with the RL system for household battery waste. According to the authors, the battery RL system is structured and effective, with the active involvement of interested parties. Thus, Xie and Breen [33] propose that end of use (EoU) products can be reused or resold, also creating value recovery options for those considered to be in end of life (EoL) (remanufacturing, parts recovery, and material recycling). The options for recovery of products at EoU are simpler when compared with products in EoL, also having a more direct return. According to the authors, for medicines, the recovery of chemical components is zero.
2.3. Reverse Logistics Practices for the Pharmaceutical Supply Chain

Xie and Breen [17] designed a green PSC for UK community pharmacies capable of reducing waste and ensuring efficient disposal of unavoidable waste. The authors created an RL network for the PSC, in which costumers return medication to pharmacies, which, in turn, are responsible for returning it to the manufacturers. Then, they suggested that PSC adopt GSCM environmental practices for each participant in the chain.

De Campos et al. [2] observed an evolution of practices, from financial assessments and management practices to mathematical and technological solutions. Operational practices are widely implemented, such as product recall, waste management, wastewater treatment, reuse, recycling, donation, and incineration, among others.

Table 1 shows practices identified in the literature that have the potential for being applied in hospitals. The table is divided into internal practices (practices of exclusive hospital operation), external practices (depending on the action of figures external to the hospital, such as suppliers, manufacturers and the government), and practices aimed at products both in End of Life (EoL) and End of Use (EoU).

| Practices                          | Internal/External | EoL or EoU             | Researchers                                                                 | Observations Pointed out by the Researchers                                                                 |
|-----------------------------------|-------------------|------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Sending to incineration/Landfill   | Internal          | EoL                    | De Campos et al. [2]; Hua et al. [36]; Xie and Breen [33]; Narayana [19]   | The practice most used and required by Brazilian legislation.                                               |
| Waste Management Plan             | Internal/External | EoL                    | De Campos et al. [2]                                                        | It focuses on the collection and treatment of waste that has no other use, which includes the traditional    |
|                                   |                   |                        |                                                                             | incineration of EoL products.                                                                            |
|                                   |                   |                        | Xie and Breen [33]                                                           | Plan to Reduce, Reuse and Properly Dispose of by incineration and in landfill                              |
|                                   |                   |                        | Xie and Breen [17]                                                          | Goal of Reduction, generation and disposal of waste; Separation of allocated costs; Monitoring of Waste Levels |
| Professional Education            | Internal/External | EoL or EoU             | De Campos et al. [2]; Xie and Breen [33]; Xie and Breen [17]               | Awareness and education programs that alert people about the environmental impact generated by medical    |
|                                   |                   |                        |                                                                             | waste and the correct way to dispose of leftover or expired medicines.                                     |
| Government Incentives and Policies| External          | EoL or EoU             | De Campos et al. [2]; Narayana et al. [19]; Hua et al. [36]                | Regulations and government oversight are crucial for decision-making in a pharmaceutical supply chain.    |
| Financial Incentive               | External          | EoU                    | Hua et al. [38]; Weraikat et al. [39]                                      | The producer pays a retailer to collect medicines in customer zones.                                        |
| Medicine Reuse                    | Internal/External | EoU                    | De Campos et al. [2]                                                        | Operations related to end-of-use products.                                                                 |
|                                   |                   |                        | Hua et al. [36]                                                            | Medication from: patients that recover before taking all medications; interrupted or altered therapies;    |
|                                   |                   |                        |                                                                             | patients' death; and others.                                                                                |
|                                   |                   |                        | Weraikat et al. [39]                                                       | If they are returned to the pharmaceutical producer before they expire, they can be sold at subsidized     |
|                                   |                   |                        |                                                                             | prices.                                                                                                    |
| Medicine Donation                 | Internal/External | EoL or EoU             | De Campos et al. [2]                                                        | Operations related to end-of-use products.                                                                 |
|                                   |                   |                        | Hua et al. [36]                                                            | The medicine collected are transported to the recycler and classified according to their expiration dates. |
|                                   |                   |                        |                                                                             | Weraikat et al. [39]                                                                                        | If they are returned to the pharmaceutical producer before they expire, they can be donated in           |
|                                   |                   |                        |                                                                             |                                                                                                              | underdeveloped countries.                                                                                 |
| Information Sharing               | Internal/External | EoU                    | Weraikat et al. [39]; Narayana et al. [19]; Lainez [40]; Kumar et al. [16]| Accurate inventory information reduces costs by facilitating the internal and external activities of       |
|                                   |                   |                        |                                                                             | members involved in the RL process.                                                                         |

Source: Author’s own elaboration.
De Campos et al. [2] observe that waste management (WM) differs from RL, since WM focuses on the collection and treatment of waste products that have no other use (EoL), which would include their incineration. On the other hand, the RL concept focuses on adding value to a product to be recovered as indicated in the EoU products, which can be reused and that offers the user an opportunity to return the product.

3. Materials and Methods

Research was conducted in hospitals in three neighboring cities in the southern region of the state of Rio de Janeiro: Barra Mansa, Resende, and Volta Redonda. These cities stand out in the region for representing almost 50% of the population. Since they are the largest cities in the region, they end up helping in the hospital care of neighboring cities, totaling almost one million inhabitants. Table 2 contains information about the 13 hospitals that participated in the research.

Table 2. Studied hospitals.

| Hospital  | Sector | Municipality   | Beds | Appointments per Month | Employees |
|-----------|--------|----------------|------|-------------------------|-----------|
| 1 HSJB    | Public | Volta Redonda  | 180  | 45,000                  | 1000      |
| 2 SCR     | Mixed  | Resende        | 50   | 2500                    | 50        |
| 3 SCBM    | Mixed  | Barra Mansa    | 218  | 7000                    | 150       |
| 4 CSSM    | Private| Barra Mansa    | 60   | 8000                    | 130       |
| 5 SMR     | Private| Resende        | 120  | Not reported            | 400       |
| 6 HCL     | Private| Volta Redonda  | 128  | Not reported            | 250       |
| 7 HRG     | Public | Volta Redonda  | 80   | 140 (hospitalizations only) | 500       |
| 8 HUVR    | Private| Volta Redonda  | 134  | Not reported            | 2000      |
| 9 HUR     | Private| Resende        | 70   | 4600                    | 328       |
| 10 HEM    | Public | Resende        | 75   | 1000                    | 800       |
| 11 APM    | Mixed  | Resende        | 60   | 900                     | 150       |
| 12 HML    | Public | Barra Mansa    | 40   | 120 deliveries          | 70        |
| 13 HMR    | Public | Volta Redonda  | 70   | Not reported            | 500       |

Source: Author’s own elaboration.

The research is limited to the hospital sector, not involving commercial pharmacies or pharmacies in emergency care units (health centers), and does not include other actors in the chain. In total, the survey covered 81.25% of operating hospitals in the surveyed region.

Figure 2 shows the steps of the method followed by this study.

Figure 2. Methodological procedures. Source: Author’s own elaboration.

The steps described in Figure 2 can be divided into two major blocks: theoretical research and empirical research.

3.1. Theoretical Research

The theoretical research covered the first two stages of the scheme outlined in Figure 2, which aimed to raise MRL practices in PSC, focusing on hospitals. However, it was necessary to focus on topics such as SCM, RL, GSCM, and PSC, whose outcome culminated in the survey of such practices (Table 1).

The theoretical research used the Web of Science (WoS) database. This choice was based on Zhou et al. [41], who claim that WoS is the main database of citations in the world due to the multidisciplinary coverage of high-impact journals in science and social sciences. Abrizah et al. [42], Chadeegani et al. [43], and Mongeon and Paul-Hus [44] also consider that WoS is one of the main databases used in bibliographic research and bibliometric analysis.
Once the base was chosen, the search was filtered by the field “topic”, since it searches for documents containing the term established in its title, abstract, or keywords. Moreover, the search was filtered by the language “English”, document type “article”, and period “every year”, which resulted in 72 articles. The search was performed with the string “pharmaceutical supply chain*” and management. The wildcard character (*) was used to include the studies with the word “chain”.

Other documents were also used for the development of the research, as can be seen in the references. However, the 72 articles initially selected formed the basis for the construction of knowledge used in the empirical research.

3.2. Empirical Research

To achieve the main objective of this research, those responsible for disposing of medicines from hospitals were interviewed to verify (i) which MRL practices in the literature are used in their organizations and (ii) unused MRL practices, which have the potential to improve their RL process. This phase was elaborated based on a comparison matrix among unused practices; this comparison was conducted by the Analytic Hierarchy Process Method (AHP), which has proven to be appropriate in several studies related to PSC. As an example, Elleuch et al. [45], when conducting a study on the risks in managing a hospital’s PSC, used the AHP to assess risk management scenarios. Hospital managers were asked to classify the scenarios based on the Saaty scale and also had to perform peer comparisons. Jaberidoost et al. [46] and Raka and Liangrokapart [47], also conducted studies on risk management at PSC. However, Jaberidoost et al. [46] used the AHP to prioritize functions in the chain and found that financial and supply management are the biggest challenges for PSC. Raka and Liangrokapart [47] used AHP to prioritize risk factors, revealing that the most important criterion is regulatory risk, followed by information risk, operational risk, financial risk, and intellectual risk.

Outside the scope of risk management, Mehralian et al. [48] used AHP to identify and prioritize the factors that affect the coordination of PSC. These factors were composed of six criteria and 26 sub-criteria. The results show that, among these factors, the organizational structure is perceived as the most important factor, followed by information technology, relationship and decision making, mutual understanding, managerial commitment, and regulatory issues.

During the interviews, Table 1 (see Section 2.3) was shown to the interviewees and each practice was explained. Some practices were reported to be exclusively operated by the hospital (internal) and others depended on the action of external figures such as suppliers, manufacturers, and the government (external). The difference between medicines in EoL and in EoU was also elucidated.

The AHP method was used to prioritize practices that can improve the medicine RL. AHP is a method of measuring judgment by paired comparisons to obtain priority scales. Comparisons are made using a judgment scale that represents how much more one element dominates another regarding a given attribute [49].

The analysis included 26 matrices for comparison between practices of product in EoL and in EoU (two matrices for each hospital). Due to space limitations, the matrices’ content was summarized (see next section). The full version of the content can be found in Ribeiro [50]. However, its final results have been condensed and organized in the next section. All matrices were subjected to the consistency test and obtained results within the parameters recommended by Saaty [49]. Therefore, the participants were informed about the consistency criteria and received instructions and examples to focus on when judging their parental matrices. Moreover, the consistency test was performed as the pharmacists made the judgments, ensuring an immediate review of the judgments, thus achieving the minimum consistency required by the AHP method in all matrices.
4. Results

4.1. MRL Practices Used

By interviewing those responsible for the MRL process in each hospital, it was possible to discover the practices used in the organizations surveyed. Table 3 shows this information, in which the “×” refers to a specific practice used by a specific hospital. The absence of the “×” refers to the contrary. The “%” column shows the percentage of hospitals that use a specific practice.

Table 3. MRL practices used for end of use (EoU) and end of life (EoL).

| Practices for End-of-Life Products (EoL) | # HSJB | SCR | SCBM | CSSM | SMR | HCL | HRG | HUVR | HUR | HEM | APM | HML | HMR | %  |
|----------------------------------------|-------|-----|------|------|-----|-----|-----|------|-----|-----|-----|-----|-----|----|
| Management Plan of Waste (external)    |       |     |      |      |     |     |     |      |     |     |     |     |     | 7.6 |
| Government Incentives and Policies     | ×     | ×   |      |      |     |     |     |      |     |     |     |     |     | 30.8|
| Waste Management Plan (internal)       | ×     | ×   | ×    | ×    | ×   | ×   | ×   | ×    | ×   | ×   | ×   | ×   |     | 92.3|
| Sending to Incineration/Landfill        | ×     | ×   | ×    | ×    | ×   | ×   | ×   | ×    | ×   | ×   | ×   | ×   | ×   | 100 |
| Professional Education (internal)      | ×     | ×   | ×    | ×    | ×   | ×   | ×   | ×    | ×   | ×   | ×   | ×   | ×   | 100 |

| Practices for End-of-Use Products (EoU) | # HSJB | SCR | SCBM | CSSM | SMR | HCL | HRG | HUVR | HUR | HEM | APM | HML | HMR | %  |
|----------------------------------------|-------|-----|------|------|-----|-----|-----|------|-----|-----|-----|-----|-----|----|
| Government Incentives and Policies     |       |     |      |      |     |     |     |      |     |     |     |     |     | 23.1|
| Medicine Reuse (external)              | ×     |     | ×    |      |     |     |     |      |     |     |     |     |     | 30.8|
| Financial Incentive                    | ×     | ×   |      |      |     |     |     |      |     |     |     |     |     | 30.8|
| Medicine Donation (internal)           | ×     | ×   | ×    | ×    | ×   | ×   | ×   | ×    | ×   | ×   | ×   | ×   | ×   | 76.9|
| Medicine Reuse (internal)              | ×     | ×   | ×    | ×    | ×   | ×   | ×   | ×    | ×   | ×   | ×   | ×   | ×   | 100 |
| Professional Education (internal)      | ×     | ×   | ×    | ×    | ×   | ×   | ×   | ×    | ×   | ×   | ×   | ×   | ×   | 100 |
| Information Sharing                    | ×     | ×   | ×    | ×    | ×   | ×   | ×   | ×    | ×   | ×   | ×   | ×   | ×   | 100 |

# Acronyms for the names of the hospitals surveyed. For more information on these hospitals, see Table 2. Source: Author’s own elaboration.

Table 3 shows that five practices are used in hospitals, namely: “Sending to incineration/landfill”, “Medicine reuse (internal)”, “Professional education (internal)”, and “Information sharing”.

Other results found during the interview were:

1. Most respondents reported that MRL practices for EoL and EoU medicines are inexistent on the part of suppliers, with no cooperation between them and hospital pharmacies. In the interview, only pharmacies alleged being responsible for the waste. In the interviewees’ perception, this fact is due to the lack of specific legislation that makes manufacturers and suppliers responsible for waste;
2. All respondents highlighted the lack of communication on the part of hospital professionals to patients regarding the importance of the correct disposal of medication. That is, no patient receives guidance on what to do with the medication if it is not used or if it perishes;
3. The interviewees also frequently mentioned the inexistence of government incentives and policies that help the disposal or distribution of medicines in EoU. Resende was the only municipality in which there was help from the municipal government, which will be further discussed in the results.

4.2. Practices with the Potential to Improve MRL

This research seeks to identify what practices can improve the MRL. The practices used by all hospitals were excluded from the comparisons, resulting in the hierarchical structure of the AHP (Figure 3).

The hierarchical structure was organized according to Saaty [49], that is, with the objective of the decision at the top, then the broad objectives, followed by the intermediate levels (criteria on which the subsequent elements depend) and the lowest level (which is usually a set of alternatives).
In the hierarchical structure, all criteria have weights. In Figure 3, the first level criterion of the structure is “Practices for products in EoL” and “Practice for products in EoU”. Since each group of practices has the same priority, each one has a weight of 0.5. The second level (criterion) is related to “External” and “Internal” practices that will be judged by the experts. Considering all pharmacists with equal weight within the judgments, the arithmetic average of the priorities for each type of product was performed. Table 4 presents a summary of the 13 judgment matrices between “External” or “Internal” practices.

Table 4. Priority in the internal and external practices.

| Hospital | Internal Practices | External Practices |
|----------|--------------------|--------------------|
| HSJB     | 0.25               | 0.75               |
| SCR      | 0.1                | 0.9                |
| SCBM     | 0.25               | 0.75               |
| CSSM     | 0.25               | 0.75               |
| SMR      | 0.13               | 0.88               |
| HCL      | 0.25               | 0.75               |
| HRG      | 0.17               | 0.83               |
| HUVR     | 0.5                | 0.5                |
| HUR      | 0.25               | 0.75               |
| HEM      | 0.1                | 0.9                |
| APM      | 0.17               | 0.83               |
| HML      | 0.25               | 0.75               |
| HMR      | 0.13               | 0.88               |
| Average  | 0.21               | 0.79               |

Source: Author’s own elaboration.

Based on the hierarchical structure presented in Figure 3, Figure 4 presents the hierarchical matrix resulting from AHP analysis with a summary of the judgment matrices between “External” or “Internal” practices of the medicines in EoL and EoU.
5. Discussion

Many of the external practices, which do not depend on hospitals, exist in a reduced proportion or simply do not exist. This fact is partially due to the Brazilian legislation that holds pharmacies responsible for their residues, thus, freeing drug suppliers and manufacturers from concerns about residues from their products.

Public hospitals, which depend on bids to buy, would not be able to obtain financial benefits if they returned products to the manufacturer or supplier, since the value of their purchase is tied to a bidding contract. “Medicine Donation” also proved to be non-applicable to some hospitals due to their policy. According to pharmacists, the hospital becomes responsible for the use of that medicine in the future: if the new holder of that medication consumes or stores it incorrectly, the donor hospital would be responsible for providing that medication.

Medicines in EoL are, in general, discarded in orange bags that symbolize chemical residues. These bags are placed inside covered bins in hospital pharmacies, either in satellite pharmacies or in the central pharmacy. When full, they are collected by the cleaning team and disposed of in an area suitable for chemical waste, thus being separated from ordinary and biological waste. Transportation companies are then responsible for sending it to the landfill or to incineration.

Some pharmacists claimed to face difficulties in the disposal process related to the following:

- Separation of tablets from packaging (one report);
- Difficulty with suppliers (three reports);
- Implementation of a standard process for disposal (three reports);
- Medications held by nurses or in satellite pharmacies that are beyond the pharmacist’s control (three reports);
- Free sample medicines that cannot be used (one report).

Figure 4 shows the relative priority of each practice judged by hospital professionals. The first observation is about the professionals’ preference for external practices. Most professionals believe that external practices are more important, since there is no external support to deal with such an issue. The absence of such external practices is due to the
legislation in force, in which only pharmacies are responsible for the waste. Moreover, most of the internal practices are already used.

Regarding the practices for products in EoL, the “Waste Management Plan (external)” was the best judged. Some interviewees declared that it would be more appealing for the suppliers to provide a plan to manage the waste generated by themselves, given their particular knowledge about their own chain. On the other hand, the “Waste Management Plan (internal)”, was considered less relevant, and one pharmacist ignored its existence in the hospital, believing that it would be better managed by suppliers and manufacturers.

Regarding practices for products in EoU, the “Financial Incentive” was considered the best practice for helping hospitals to reduce their cost with the purchase of medicines—one of the main costs of hospitals. Two other EoU practices with high priorities were “Government Incentives and Policies” (makes hospitals responsible and exempts suppliers and manufacturers from disposing of medicines) and “Medicine Donation” (external)” (which would be a good social action, according to the interviewees). “Medicine Donation (internal)”, in turn, obtained a low score for being a responsibility of the hospital that would require a collaborator exclusively to manage a new process for the hospital.

Finally, “Government Incentives and Policies”, despite not being the highest priority either for EoU or EoL, had a high priority in both judgments. Some respondents believe that suppliers and manufacturers would assist in the pharmacies’ MRL process only with legislative support, since they would be required by law to support such an issue.

5.1. Internal Practices

“Sending to Incineration or Landfill” is a common practice for all respondents, since it is provided for in legislation. Hospitals are responsible for separating their waste and hiring a certified company responsible for transporting it to its final destination. According to ABDI [29], incineration is the final destination of medicines in EoL. It is found in the waste management plan for being a widely implemented operational practice [2].

Pharmacists know the practice “Professional Education (internal)” as “Drug Safety Policy”. This action addresses awareness and education programs and informs people about the environmental impact generated by drug residues and the correct way to dispose of medicines [2,17,33]. It is a usual action for hospitals, since everyone is responsible for disposing of their medications. All respondents affirmed that suppliers do not offer such a practice and that there is no such dialog with patients, only with employees. They also reported that communication between suppliers and the pharmacist is minimal, more frequently occurring with the hospital purchasing sector.

Except for one, all pharmacists declared an awareness of a “Waste Management Plan” (Table 3). This plan is an internal document describing step-by-step the disposal procedures for all types of waste generated by the hospital. It focuses on the collection and treatment of waste that has no other use [2], involves planning to reduce, reuse, and properly dispose of [33]; it may include a target plan for the reduction, generation, and disposal of waste; separation of allocated costs; monitoring of waste levels and practices [17]. Some hospitals include numerical information on the history of waste generated and contracts with third parties that assist in waste disposal.

“Medicine Reuse”, originating from patients that recover before taking all the supplied medicine, interrupted or changed therapies, or from the patient’s death [32], is used in all hospitals surveyed. However, it is known as “Reinsertion of Medicines to Stock” due to the returning of medication to the physical stock and in the hospital system.

“Information Sharing” is also performed by all hospitals. However, there is no standard for sharing this information. All hospitals have control over the expiration dates of the medications and seek to share their information in a way they consider most effective. Among the forms of sharing, the use of instant messaging applications with spreadsheets to partner hospitals stands out. Despite being a common practice, this information is not passed on to manufacturers and suppliers. Accurate inventory information reduces
costs by facilitating the internal and external activities of members involved in the RL process [16,19,39,40].

The “Medicine Donation” proved to be little used due to hospital regulations. The donor is responsible for the medicine donated, and the irregular use, handling, or storage may harm the future user of that medication, which may become the donor’s responsibility.

5.2. External Practices

In the context of “Financial Incentive”, the practice with the highest priority, Hua et al. [38] designed an approach offering incentives to pharmacies to encourage the return of medicines with high levels of stock and less demand before expiration. Only one hospital reported being able to negotiate the return of leftover medicines with suppliers; this negotiation is pre-agreed before the purchase, which guarantees security to the buyer. The practice of “Financial Incentive” is not applied to municipal hospitals due to their purchases being made by bidding.

“Waste Management” was the external practice with the second-highest score. This practice is a plan to reduce, reuse, and proper disposal by incineration and/or landfill [33], and may include goals for reduction, generation, and disposal of waste, separation of allocated costs, and monitoring of waste levels [17]. Such plans already exist in hospitals but are not supported by suppliers and manufacturers.

Regarding “Medicine Reuse”, pharmacists affirmed that few suppliers and manufacturers are willing to collect medication in EoU. In some situations, the exchange of the medicine if it approaches the expiration date is negotiated in the purchase. There is also the case of purchases of low-turnover medicines for rare treatments, while the return if it is not 100% used is negotiated also at the time of purchase. “Consignment Merchandise” is a practice used by some hospitals with some suppliers, consisting of an agreement, in which the hospital receives a certain quantity of products from the suppliers without any sales obligation. The hospital uses supplier’s merchandise and only pays for its consumption, returning the leftover products. In consignment, it is common to have a contract that determines the term that the merchandise will remain with the consignor, with information regarding price, quantity, among others.

Regarding “Government Incentives and Policies”, there is no support from the federal government or state, either with drugs in EoL or in EoU. Hua et al. [36] suggest that the government oversee the activities of the PSC and make relative policies (subsidy, penalty and advertising investment and support for recycling activities).

In the municipality of Resende, there is a certain concern on the part of the municipality with general waste management. The city hired a company responsible for transporting and disposing of medicines in EoU. In addition, the municipality also helps with medicines in EoU. The city has a Pharmaceutical Administration Center (PAC) that communicates with municipal and mixed hospitals and with the city’s health centers, checking the stock and the validity of medicines, relocating them according to the necessity.

Moreover, suppliers and manufacturers do not practice “Professional Education”—concerning medicines in EoL and EoU—or “Medicine Donation”. Such practices could also be managed by public agencies; however, they do not help in these two practices.

6. Conclusions

Regarding MRL practices, it is observed that medicines are treated differently when they expire and become waste (EoL) than when they have not yet expired (EoU). In the RL of medicines in hospital pharmacies, the following difficulties stand out: (i) Separation of tablets from packaging; (ii) Difficulty with suppliers; (iii) Implementation of a standard process for disposal; (iv) Medications held by nurses or in satellite pharmacies that are out of control; (v) Free sample medicines that cannot be used.

The practices of RL presented in the literature were shown to the professionals responsible for disposing of medicines in hospitals according to the description by each author in each article. The respondents identified immediately the practices that were part of
their hospital’s procedures. Thus, the practices used by each hospital could be identified, achieving the second specific objective of the research.

Regarding the research problem “RL practices for medicines that are used”, four of the six internal practices are used by all hospitals, namely: “Professional education for EoL”, “Professional education for EoU”, “Medicine reuse”, and “Information sharing”.

External practices, however, obtained less positive results. “Government Incentives and Policies” exist only in the municipality of Resende and “Professional Education”, “Donation of Medicines”, and “Waste Management Plan” are practices ignored by suppliers. Another relevant point observed was the lack of assistance from suppliers or manufacturers for EoU medicines.

The practice of “Information Sharing” about medicines in EoU is common to all hospitals; however, each pharmacist performs it differently—either by instant messaging in smartphone applications or through an information group, also via smartphone, among network hospitals private or public.

Finally, the AHP method allowed pharmacists to compare the practices of MRL not used in their hospitals and express their assessment of which of these practices would be better used in their organizations. Thus, this study reached its general objective.

Future studies on the topic should analyze the impact that a digital platform would have on the organization of information on medicines in EoU for any hospital to improve the sharing of medicines among hospitals and the reduction of products in EoL that are treated as waste and require differentiated disposal.

Another relevant issue to be researched is related to logistical and storage strategies used by suppliers, since the development of this knowledge has the potential to help PSC in the reduction of drugs in EoL, optimizing the use of drugs in EoU. Taking the suppliers of medicines as a basis, another research capable of improving the understanding of RL in PSC would be the analysis and understanding of actions taken by them in the discarding of their residues and the treatment of their products in EoU.

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