



## Management of unused healthcare materials and medicines discarded in a Brazilian hospital from 2015 to 2019

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### ABSTRACT

Unused materials and medicines in the hospital environment can evolve to disposal, without having been used, and these represent a problem that needs to be more closely analyzed. This study evaluated the unused materials and medicines management, focusing on those discarded as waste without use. A cross-sectional study was done with data including all unused material and medicines generated by the hospital, considering the records of the years 2015–2019. The main analyzed variables were: disposal records (number); healthcare waste type (material or medication), based on classification; indication of use; year of disposal; quantity discarded (in kilograms); reason for disposal (inability to use or expiration date); cost of acquisition and final destination per year. Total cost of discarded items was USD 108,722.41, with the higher value in 2016 (USD 47,686.71) and the lower in 2017 (USD 1028.40). Over the years, data suggested an increased tendency of unused materials discharged and a decreased tendency to medicines. There was also a trend toward an increase in discards due to the impossibility of using materials and medicines, and a reduction in discards due to expiration date. Finally, there is a need to improve information systems and strengthen educational practices aiming at making more robust the organizational management process.

### 1. Introduction

Hospital management has been experiencing constant challenges for decision making, resource allocation and cost reduction. There is a growing demand for hard technologies, training of human resources, internal need to interconnect all processes, in order to establish a strategic, systematized and innovative planning, paying attention to constant accounting monitoring (Tucker, 2004).

Thus, given the complexity of hospital organizations, with differentiated procedures, new technologies and the use of a huge variety of materials, controlling these inputs and their costs is essential. It is known that one of the greatest challenges in materials management is the correct dimensioning of stocks, to meet the real needs, with regular supply. Efficient control and the use of instruments to record information that facilitate monitoring is necessary (Paschoal and Castilho, 2010; Brasil, 2013; Yang et al. 2021).

One of the objectives of this well-executed control is to minimize the waste generation, which has been the focus of scientific investigations, especially due to the large amount of waste generated in healthcare

facilities, and the potential to cause negative impacts in the environment and in the health community (Barbosa et al., 2020; Pimenta et al., 2021). The waste generation in this establishments is growing exponentially along the years and its destination is still incorrectly presented in many countries, in particular those in development (Costa and Fonseca, 2009; Castro et al., 2014; Pimenta et al., 2021).

In Brazil, the National Health Surveillance Agency (ANVISA) defines waste management as a set of management procedures, planned and implemented based on scientific and technical, normative and legal bases. It aims to minimize the amount of waste and rejects, in addition to providing their safe forwarding and, consequently, contributing to the protection of workers, the preservation of public health, natural resources and the environment (Brasil, 2018; WHO, 2014). In addition, the National Solid Waste Policy reaffirms the principles, objectives and instruments of waste management, as well proposed the guidelines relating to the integrated management of solid waste in relation to the dangers, the responsibilities of generators and public authorities and the applicable economic instruments (Castro et al., 2014; Brasil, 2018; Brasil, 2010).

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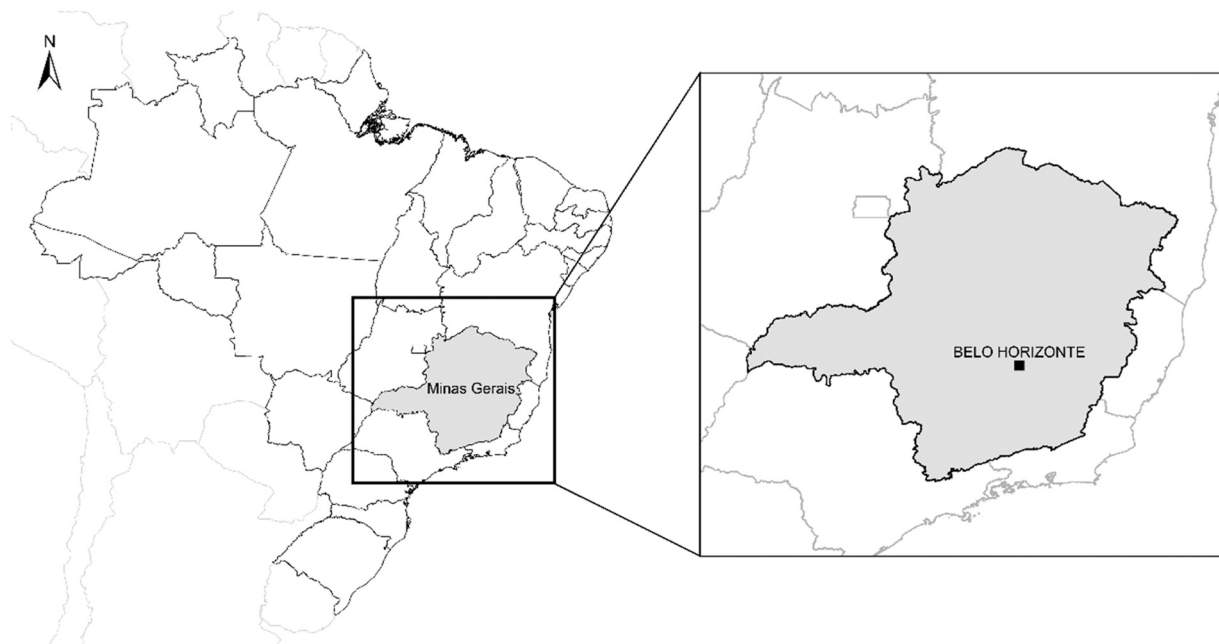


Fig. 1. Brazilian map pointing out the city of Belo Horizonte.

The activities related to health assistance, teaching and research area generate healthcare waste (HCW) that can present a particular risk during the management, due to the hazardous characteristics, as chemicals, biological, radioactive or puncture risks (Brasil, 2018; WHO, 2014; Pimenta et al., 2021). Despite representing a small portion of the total amount of waste generated in urban areas, healthcare wastes (HCW) pose a worrying health and environmental risk when inadequately managed, as they are possible sources of disease propagation (WHO, 2014). They can also contribute to the increased incidence of nosocomial infection, if poorly managed at the place of generation, in addition to presenting an occupational risk within and outside health establishments (Sales et al., 2009).

The HCW management includes the stages of segregation, generation minimization, prior treatment when indicated, safe packaging, internal or temporary and external storage, internal and external collection and transport, and final disposal (Brasil, 2018; WHO, 2014). The minimization can be optimized by a well-detailed segregation, as well as selective collection when possible, representing a decisive alternative in the amount of waste generated reducing, allied to saving natural and energy resources (Ribeiro et al., 2020).

Healthcare establishments need to management correctly the HCW, as an environmental and health community protection, and also aim to reduce waste generation. When materials and medicines (MAT/MED) are discarded as wastes, it represent a product lose and a waste generation increasing, reported by scientific studies as worst scenario (Odonkor and Mahami, 2020, Lakbala and Lakbala, 2013). HCW can be also generated in the home healthcare assistance, as discussed by Silva and colleagues (2022).

The many services usually offered by hospitals make the waste management complex, costly, and extremely challenging to control (Pimenta et al., 2021; Singh et al., 2021). Monitoring these wastes requires updated scientific evidence and commitment from all employees. The process that precedes generation and disposal of waste often presents weaknesses that are not noticed and require intervention. Specifically, the generation of HCW from MAT/MED stored in the hospital environment and evolved to disposal, without having been used, represent a problem that needs to be analyzed. Products when managed in a non-conforming manner turn into wastes, burdening the institution not only with the demand for new purchases, but also with the cost of final disposal (Yang et al., 2021).

Therefore, this research guided the discussion about the need to investigate the MAT/MED that became waste without use, and the importance of minimizing their generation. Management practices can offer significant opportunities for improving processes and better use of resources in the context of health services provision (Burns, 2002; Pereira and Patrão, 2012).

A challenge for materials management is the correct dimensioning of stocks, to meet the real needs, with regular supply. Efficient control and the use of instruments to record information and facilitate follow-up are necessary (Yang et al., 2021). Inventories must be well dimensioned to avoid institutional damage, excess material in relation to actual demand or shortages. It is also necessary to review stock levels in order to continuously, update them avoiding problems caused by the greater demand or reduction (Brasil, 2013). It is essential that health organizations establish and monitor criteria to ensure that medicines are being received, stored, and controlled effectively and correctly (Pinto, 2016). Thus, the aim of this study is to discuss data about MAT/MED resulted in HCW without prior use for its original purpose, in the period from 2015–2019, in a Brazilian university hospital, and show the financial cost associated with all process, with an emphasis on acquisition and waste treatment. The focus was to discuss a topic rarely published in the scientific context.

## 2. Methods

A cross-sectional, descriptive study with a quantitative approach was carried out, in a Brazilian university hospital. The hospital is in Belo Horizonte city, Brazil, as showed in Fig. 1. The health assistance includes intensive care, hospitalization, urgency, and multi-professional care, with approximately 80% of occupancy rate for their 509 beds.

Two questions guided this investigation: (1) what are the materials and medicines that have evolved to be discarded without being used, in a university hospital; and (2) what is the cost of this disposal?

Data collected considered MAT/MED generated in the period of 2015–2019, by consulting a restricted database of the institution in digital media. The choice of this period is due to institutional records that were digitalized only after 2015, and due to the internal improvement of information technology processes.

The investigated variables were: number of disposal records; type of HCW (material or medicine); HCW categorization based on the use

classification; year of disposal; amount discarded (in kilograms); reason for discarded (impossibility of use or expiry date); and the acquisition and treatment/final disposal cost per year.

The material category (MAT) included: cleaning materials (sodium hypochlorite, alcohol), hospital supplies (several needles, surgical threads, diagnostic catheter, guide catheter, equipment), chemical material (various acids, methylene blue), and monitoring material (several cables, electrocardiogram pen).

Medicines (MED) category were: symptomatic, cardiovascular, anti-infective, electrolyte solution, antineoplastic, anesthetic, hormone, dermatological, diagnostic agent, antiseptic, laxative, supplement, corticosteroid, antithrombotic, diluent, ophthalmological, oxidant, antifungal, antidepressant, anti-inflammatory, anticonvulsant, solvent, herbal, anti-inflammatory, thrombolytic, coagulant, antiparkinsonian, antipsychotic, muscle relaxant, anxiolytic, and antiparasitic.

The specification "discarded due to impossibility of use" was adopted for the MAT/MED that were opened and not used due to a change in the medical prescription or non-conformity in storage or during the use. The specification "expired date" was used for MAT/MED which, as a result of their replacement by more modern and/or more suitable ones for the procedure, were not used and thus discarded; or because they were not opened before their expiry date, making their use impossible.

The cost of acquiring these MAT/MED was transcribed from database, or researched on the internet when not available. The costs of waste treatment and final disposal were calculated based on invoices for collection, transport, treatment, and final disposal services issued by the service providers. It was not possible to weigh the HCW separated by category due to the still deficient infrastructure to perform the service in the investigated institution.

Descriptive data analysis was performed using the Statistical Package for Social Sciences (SPSS) software, version 19.0, with calculation of absolute and relative frequencies, measures of central tendency and variability, and graph construction.

Also, considering that the balanced scorecard is the theoretical methodological framework that guides the strategic planning, the HCW management were analyzed in the MAT/MED cycle context, looking for the entire supply chain (Macroplan, 2001). Departments working in any step of MAT/MED management were visited and analyzed to guarantee performance indicators that included: customer perspectives, financial aspects of the health institution, internal processes, and finally, the perspectives of learning and growth for the various employees who participated. Effectively of this intervention through registration, risk identification and timely allocation.

This study followed all the guidelines and determinations of Ethics in Research, being approved with number 4.003.139, CAAE 27528919.1.0000.5149.

### 3. Results

A total of 1485 unused MAT/MED disposal records were carried out, between the years 2015 and 2019. Considering the value of discarded items, USD 108,722.41 were added up over these five years, with the highest value in the year 2016 (USD 47,686.71) and the lower in the year 2017 (USD 1028.40), as described in Table 1.

In addition, the amount discarded per year ranged from 528.12 kg in 2015 to 949.50 kg in 2019, totaling more than two tons of these MAT/MED discarded over 5 years. The final disposal cost of these products was USD 851.41 (Table 1).

It is also worth mentioning that in 2017, only 42 records were made, while in other years there was always a greater value than 200 records, indicating a probable underreporting in that period. It may be explained by accumulation of materials from other years, and only discarded in 2019.

According to the results presented in Tables 2, 39.1% of the records were related to material disposal, and 60.9 % to medication. Also,

**Table 1**

Discarded MAT/MED value, quantity (in kg), and final destination value per year, in the period from 2015 to 2019.

Year	Number of MAT/MED records discarded	Total value (USD) of discarded MAT/MED	Discarded quantity (kg)	Value of final destination amount (USD)
2015	456	30,719.65	528.12	252.25
2016	481	47,686.71	431.20	173.62
2017	42	1028.40	335.56	128.40
2018	293	15,895.33	194.66	52.20
2019	213	13,392.31	949.50	244.94
Total	1485	108,722.41	2439.04	851.41

Source: Prepared for the purpose of this study, 2021.

Note: MAT/MED wastes were classified as chemical or no dangerous waste, and the cost varied due to market services.

comparing MAT and MED discarded, the greater number of discarded drugs influenced the higher value of MED observed in Table 2.

Most records were for medicines when considering the relation between MAT and MED per year, in 2015 and 2016 (98.9% and 89.8%, respectively for 2015 and 2016), and most records were related to materials (64.3% in 2017, 100% in 2018 and 97.2 % in 2019) in 2017 and 2018.

As shown in Tables 3, 38.2 % of the total records analyzed refer to discards made due to the impossibility of using the MAT/MED, while 61.8 % were due to expired validity. These reasons have fluctuated over the years, as in 2015 all records (100 %) were for discards due to expired validity, while in 2019, 97.2% of discard records were due to impossibility of use.

Among the 904 records of medicines discarded between 2015 and 2019, the most frequent category was symptomatic (13.5%), followed by cardiovascular (11.4%), and anti-infectives (10.8%). On the other hand, with regard to the cost of discarded medication, the categories that added the highest amount were antineoplastics (USD 30,769.03), hormones (USD 9145.90), and cardiovascular (USD 8423.86).

To contribute and guide the processes in order to prevent MAT/MED without prior use from becoming HCW, a guiding flowchart was created based on the studies carried out by Macroplan (2001), to facilitate the application of this methodology in the investigated service (Fig. 2).

### 4. Discussion

The results of this study showed a high contingent of MAT/MED discarded over the five years analyzed, which added up to a high cost for the institution. Also it pointed to the need for effective planning, through strategic management, which includes the macro and micro processes of the entire chain of responsibility for its internal flow. This means identifying, in the midst of the various processes, weaknesses, potentialities and, based on that, intervening in this scenario.

It was found that, although the amount of MAT/MED discarded as waste represents only 0.05% of the total waste generated, the amount cost loss of its acquisition, added to the cost of final disposal as HCW, represented 11.2% of the total spent on disposal in the period. Another highlighted point by this study was the occurrence of probable underreporting wastes in some periods, especially in 2017.

Strategic management can contribute to minimizing underreport and the implement of information technologies such as digital databases is proposed. This can provide indicators that support the decision-making of the manager, in order to strengthen the mechanisms for maximizing resources, reducing waste and monitoring data in real time (Souza and Mello, 2011; Vargas et al., 2013; Yang et al., 2021; Singh et al., 2021).

In addition, there was a trend towards an increase in the total value of discards due to the impossibility of use and a reduction in those due to expired validity. The information about expired material or without

**Table 2**  
Value of material and medicine discarded along the year.

Year	Material (MAT)			Medicines (MED)		
	n	%	Total value (USD)	n	%	Total value (USD)
2015	5	0.8	57.79	451	49.9	30,959.39
2016	49	8.4	1752.79	432	47.8	4639.58
2017	27	4.6	600.10	15	1.6	438.26
2018	293	50.4	16,049.28	0	0.0	–
2019	207	35.6	13,353.23	6	0.6	168.81
Total	581	100.0	31,813.18	904	100.0	77,962.24

Source: Prepared for the purpose of this study, 2021.

the possibility of use depends on who makes the MAT/MED conference to release for disposal, so the use of this expression was conditioned to the releaser. This is also a weakness in the registration process, which may be revised with specific standardization.

The data showed that there is a weakness in the stages of the management process and use of MAT/MED. In practice, the results revealed that the HCW management service is able to perceive these non-conformities between the sectors that plan the purchase and distribution of MAT/MED for use, where intervention actions are necessary. Increasing the products that turn into waste, it will demand to reorganize the entire infrastructure for storage, collection, segregation, transport, and treatment of all HCW.

The situation is very delicate, as financial resources for healthcare are, every day, more restricted. It's necessary to investigate the purchasing/distribution/use processes in more detail and intervene. The intervention proposal may be addressed in future studies, through the proposition and implementation of indicators, such as: inventory coverage, urgent purchases indicator, non-standard purchases indicator and finally loss indicator as recommended by [Silva et al. \(2017\)](#). This means that healthcare service managers need to analyze, evaluate and monitor, through indicators, the strategic positioning and the life cycle costs of the products purchased by the institution ([Silva et al., 2017](#)). Thus, it should interconnect the various processes of the entire internal value chain, contemplating management strategies ([Souza and Mello, 2011](#); [Vargas et al., 2013](#)).

Using indicators for calculating losses and optimizing use can be used for the technical sector to plan needs, while the purchasing sector must monitor what was purchased, and the warehouse sector must monitor the distribution, as proposed by [Barbosa and Mol \(2018\)](#) when monitoring HCW generation. Based on the losses, it may be possible to assess the real demand for use, showing what is actually bought and used, and from there, establish loss targets for purchased material.

In this perspective, it can be said that strategic management must pay attention to the effectiveness of all processes, of the most varied levels and complexity, thus aiming to avoid/eliminate waste and costs resulting from the generation of this type of HCW ([Barbosa and Mol, 2018](#)). It is then necessary a strategic planning capable of identifying weaknesses and potential in a given process within the value chain, as shown by the scientific evidence in this field ([Kuschnir et al., 2012](#);

[Souza et al., 2014](#); [Buogo et al. 2019](#); [Rodrigues and Blattmann, 2014](#); [WHO, 2014](#), [Nogueira and Castilho, 2016](#); [Zimmerman, 2015](#)).

For Kuschnir and collaborators (2012), without planning, we lose sight of the objective and start to consider the management of resources (material, human and mainly financial) as the final objective, that is, the means become the ends. This occurs as the management itself is analyzed, without identifying the primary causes that led to the generation of HCW from MAT/MED without previous use, which should have another destination.

Although it seems technically obvious to some health service managers, it is necessary to emphasize that the subject elucidated above demands improvement and interconnection of processes through information technology ([Souza et al., 2014](#)). Buogo and colleagues (2019) emphasize that this must occur in order to protect information, guiding organizational processes so that there is the least possible exposure of those involved.

Thus, the investigated institution itself advocates in its Strategic Master Plan (2018–2022) the promotion of standardization and full computerization of all organizational processes by improving supply management. It means mapping the processes of the value chain and interconnecting the administrative and assistance areas in order to consolidate the waste management policy.

The challenging practice of interconnecting the macroprocesses of the various value chains involved must have the preservation of autonomy according to specificity. Additionally, information security must always consider culture, as it is directly interfered with by the environment ([Rodrigues and Blattmann, 2014](#)).

About the proposed balanced scorecard, such processes often occur simultaneously and the idea that a process only begins at the end of a previous one is wrong. Planning is recurrent and is updated during the execution process ([Zimmerman, 2015](#)). In this perspective, in strategic management through planning, attention should be paid to: the standardization of MAT/MED within value chains; plan and carry out bids; resupply of consumption points considering a contingency plan for complications. It is important that the storekeeper, the pharmacy and therapy committee, the care and administrative staff act in advance in the management of the MAT/MED throughout their lifecycle.

It is important to mention that to strengthen this entire process and raise awareness about the non-generation of the type of waste analyzed

**Table 3**  
Percentage of records and costs of MAT/MED discarded by impossibility of use and expired validity, in the period from 2015 to 2019.

Year	Impossibility of use			Expired validity		
	n	%	Total value (USD)	n	%	Total value (USD)
2015	0	0.0	–	456	49.6	31,017.18
2016	36	6.3	1195.66	445	48.5	46,952.91
2017	31	5.5	702.77	11	1.2	335.59
2018	293	51.7	16,049.28	0	0.0	–
2019	207	36.5	13,357.51	6	0.7	164.51
Total	567	100.0	31,305.30	918	100.0	78,470.11

Source: Prepared for the purpose of this study, 2021.

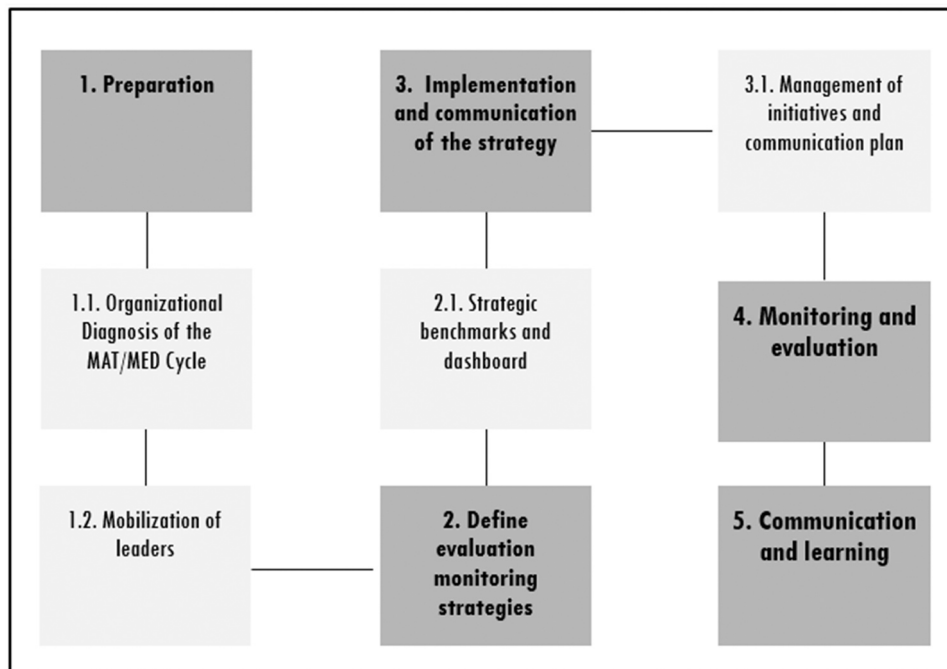


Fig. 2. Flowchart of methods steps about strategic planning for MAT/MED discarded materials. Source: adapted from Macroplan (2001).

in this study, permanent education in health is essential, as the sum of scientific, technological and practical knowledge gives subsidies to professionals in the health sector to the construction of a critical and broad view on work, management and care processes, playing a fundamental role in the organization of the service. Education is essential in this management increasing, as also concluded by scientific studies about training actions in healthcare waste management context (Odonkor and Mahami, 2020; Lakbala and Lakbala, 2013; Silva et al., 2022). Educational practices using participatory methodologies enable those involved in the learning process to link previous and new knowledge. This articulation facilitates the process of elaboration and differentiation of knowledge, that is, learning from what is known (Kalinowski et al., 2013).

## 5. Conclusion

The results of this study emphasized the need to improve the management of MAT/MED through an integrated and sustainable standard and emphasize waste minimization in the investigated institution. Inventories must be well dimensioned so as not to cause institutional damage, excess material in relation to actual demand or shortages. In this perspective, it is worth emphasizing the need to improve the MAT/MED management process through integrated strategies with sustainable standards and waste minimization in the institution.

The findings strengthen the importance of carrying out educational practices in the service, focusing on workers who deal directly with the MAT/MED objects of this study. They also point to the need to improve the health institution's information systems, aiming to make the work process and organizational management more robust. The scarcity of literature related to professional performance so that MAT/MED without prior use for its purpose do not become waste was proven in this investigation.

This research was limited to being carried out in a single health institution; however, it is proposed to carry out future investigations in order to compare the total HCW generated in the setting of this study with other publications; and analyze reverse logistics and the overall picture of what is generated nationally. Another proposal for further

studies would be to advance in data analysis by producing future estimates (forecasts) of planned purchases, with a view to subsidizing the minimization of products that turn into waste.

## Data Availability

The data that has been used is confidential.

## Declaration of Competing Interest

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

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