

Knowledge of management of health waste in COVID-19 for environmental impact

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Abstract— The pandemic due to COVID-19 has been shaping the healthcare landscape, mainly due to the amount of Health Service Waste (RSS) that is being produced. Understanding how these SSR are managed and how health professionals are involved in this process can provide a better understanding of how this knowledge directly impacts the better management of the SSR itself, as well as the reduction of environmental impacts from this flow. The objective of the study is to evaluate the knowledge of health professionals on waste management in time of COVID-19. An exploratory, descriptive, cross-sectional, observational study was conducted with 55 health professionals, working in a public hospital in Manaus – Amazonas - Brazil. Were included subjects over 18 years old, working in an institution that dealt with confirmed cases of COVID-19. The instruments used in the data collection were: Questionnaire defining the profile of the participants; Questionnaire evaluating basic knowledge about waste management of health services. The results indicated that the institution of interest has a protocol for the management of residues contaminated by COVID-19 as reported by 50 participants (90.9%), but most do not know what the Health Services Waste Management Plan (56.4%) is, not received training on SRHS (69.1%), not knowing how to classify without difficulty which are the Health Service Residues (54.5%), even performing invasive procedures (87.3%). Even with the increase in demand for health services during the COVID-19 pandemic, training and knowledge on how to manage the waste from these services did not follow the same growth.

I. INTRODUCTION

The pandemic by COVID-19 has been shaping the waste generation scenario, mainly by the amount produced of this waste in health services (SSR), which are composed mainly of personal protective equipment (PPE) produced

with single-use plastics (Capoor; Parida, 2021; Hantoko *et al*, 2021; Sharma *et al*, 2020).

Due to the content of the SSR and its potential impact on the environment and on the service where it is generated, the concern about how this waste is already managed is part of the routine of health services, and

increased even more during the pandemic by COVID-19, focusing now on ensuring safe and sustainable management (Chowdhury *et al.*, 2022). In Wuhan, China's first pandemic epicenter, one of the strategies to manage over 6,000 tons of SSR per day was to ensure proper management with instructions and training to optimize disposal (Singh *et al.*, 2020). On the other hand, the lack of adequate knowledge about SSR management can generate local damage, such as the occurrence of biological accidents and contamination of co-workers and even patients, in addition to long-term impacts on the environment in which this waste is disposed of, such as loss of local species and depletion of resources (Rizan; Reed; Bhutta, 2021; López-Feldman *et al.*, 2020).

The training on the SSR Management Plan is one of the processes implemented in health institutions that aim to reduce such impacts, however, what is the actual knowledge that has been absorbed by health professionals in relation to this process? And how is this knowledge being acquired/reinforced during the COVID-19 pandemic?

This study aimed to evaluate the knowledge of health professionals on waste management in times of COVID-19 pandemic aiming at the environmental impact.

II. LITERATURE REVIEW

2.1. Waste classification

In general, the classification of waste types depends on their origin and characteristics. As to the origin, they can be categorized as residues of hospital origin or health services (SSR), industrial or municipal solid waste (SNS). Regarding the characteristics, they can be inert, hazardous or not (Rosa Filho; Rosa; Sena, 2016).

Thus, it is noted that the presence of pathogens in the waste is what in fact differentiates whether the waste originates in health services or not. A different but complementary definition is the one informed in the resolution of the National Council for the Environment, through resolution 358/2005, which states that "health services residues apply to all services related to human or animal health care" (Brasil; CONAMA, 2005).

2.2. Residues and COVID-19 Pandemic

With the pandemic due to COVID-19, the increase in the number of residues, not only from healthcare services, but also from municipal/domestic solid waste, dramatically worsens the waste management landscape (Yousefi *et al.*, 2021).

One of the factors that contributed to this increase in waste production was the new habits acquired by society,

which began to have a constant concern for hygiene during this pandemic period. Recent data reveal that in Brazil, improper disposal of masks has been identified in several cities (Urban; Nakada, 2021).

Similarly, hospital overcrowding has directly impacted the exorbitant production of a greater amount of waste. Hospitals in Wuhan, the first epicenter of COVID-19, recorded a jump from 40 to 240 tons of SSR per day. The situation was so serious that to get around it was necessary to create a new plant to treat this waste (Sangkham, 2020). In Brazil, besides the increase in SSR production, it was observed that 35% of hospital residues was not properly treated, impacting negatively on the environment (Urban; Nakada, 2021).

2.3. Residues management and environmental impact

One cannot ignore the direct relationship between knowledge about SSR management and the environmental impact arising from the lack of this knowledge, such as pollution of water, soil, and even in the air (Manzoor; Sharma, 2019). Zand and Heir (2021) report that some hospitals in Tehran, Iran, for example, modified their SSR management policy to meet the high demand during the COVID-19 pandemic, but ignored the environmental impacts caused by the new strategies adopted, such as the disposal of SSR along with MSW, without any specific treatment before final disposal. Therefore, even if the healthcare professional who deals directly with the SSR disposes of them properly, the problem can happen when the healthcare service management does not use an adequate SSR management plan (Zand; Heir, 2021).

The SSR management guidelines reinforce the importance that the health professional has in this whole process. Understanding how professionals are being trained and what knowledge they have at this point can impact the professional and environmental environment in the short and long term (Jalal *et al.*, 2021).

III. MATERIALS AND METHODS

According to the definition of Merchán-Hamann and Taulil (2021), this research is observational (because there is no manipulation of direct interventions over the investigated ones), sectional (collected in a single moment in time), exploratory and descriptive (describes the characteristics of the study variables, establishing no causal relationship between them).

The population of interest of the study consisted of 55 health professionals, working in a public hospital in Manaus - Amazonas. For the study, individuals met the following inclusion criteria: being a health professional; being over 18 years old; accepting to participate in the

study and signing the informed consent form; work in a health institution that deals with confirmed cases of COVID-19.

specifically in the hospital of interest were excluded. Figure 1 exemplifies the flow chart for conducting the study.

Health professionals who were not working

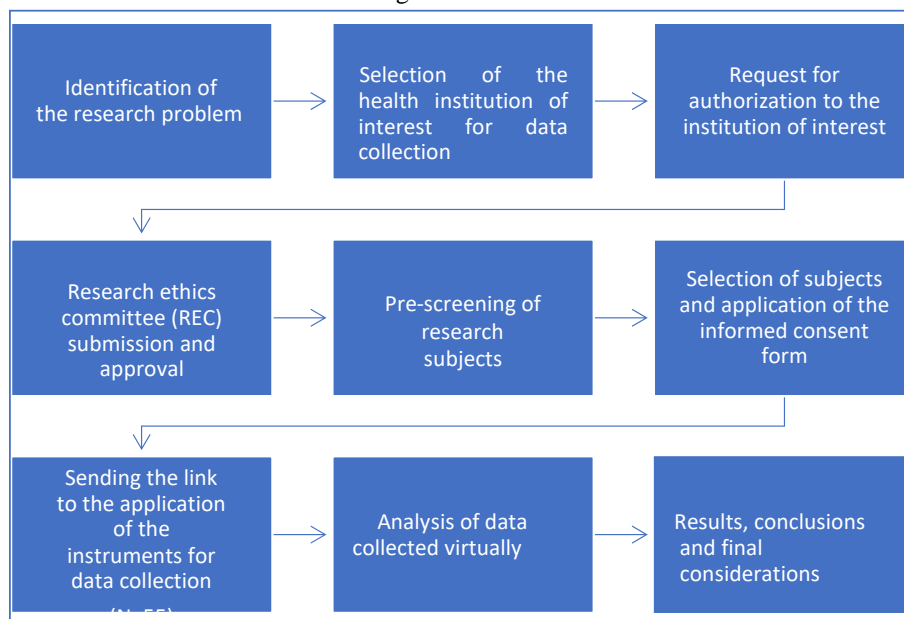


Fig. 1: Flow chart of the study

For data collection in this study, forms were used with virtual application, aiming at practicality and ensuring social distance. For this, all the recommendations of the "Circular Letter no. 1/2021-CONEP/SECNS/MS of March 3rd, 2021" were followed, from the collection of data, guarantee of confidentiality and security, as well as the content of the documents processed.

All biosafety protocols and standards were followed by the responsible researcher to avoid any risk of contamination on the part of the researcher and the research subjects, according to the Health Measures Plan.

No data collection step or approach to the subjects took place without the previous approval of the project by the Research Ethics Committee, under CAAE: 51785221.9.0000.5016.

Consent to participate in the research was acquired virtually, after pre-screening with the heads of unit, according to the standard protocol of the selected institution. The pre-screening consisted of selecting individuals who met the study criteria (health professionals, over 18 years old, and working in a sector that works directly with COVID-19).

All individuals who during the pre-screening met the research criteria were invited by the researcher (and not by the manager, in order not to influence their judgment) to voluntarily participate in the study. The electronic forms were then sent out via link.

The instruments used are described in Figure 2.

The data were analyzed using GraphPad Prism Software, version 22. Initially, analysis was performed to define the normality distribution of the data, then parametric comparisons and correlations were performed to achieve the study objectives.

The results were grouped into mean and standard deviation and represented in descriptive frequency tables. This study followed the ethical precepts of resolution 196/96 of the Ministry of Health, which aims at autonomy, non-maleficence, beneficence, and justice, among other rights of the research participant, by signing the ICF.

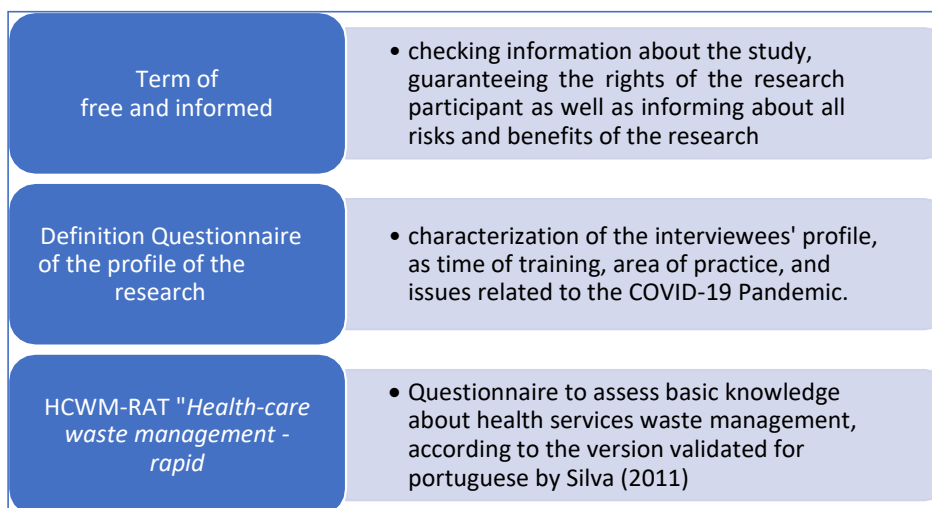


Fig. 2: Data collection instruments

IV. RESULTS AND DISCUSSIONS

4.1. Profile of the interviewees

A total of 55 health professionals were interviewed, with an average age of 37 years, and 75% were female.

Table 1 shows that most of the interviewees had graduated from a technical nursing course (38.2%); 21 (38.2%) had a specialization course as a minimum; 21 (38.2%) had between 6 and 10 years of experience in the health area and 18 (32.7%) had between 6 and 10 years of experience in a hospital environment; 29 (52.7%) worked in the medical clinic sector.

Tab. 1: Characteristics of the population of health professionals interviewed

Features	N (%)
Area of Concentration	
Other	1 (1,8)
Nurse	18 (32,7)
Pharmacist	2 (3,6)
Physiotherapist	9 (16,4)
Physician	3 (5,5)
Nutritionist	1 (1,8)
Nursing Technician	21 (38,2)
Education (last completed course)	
High school/technical education/professional education	15 (27,3)
Higher education complete	10 (18,2)
Specialization	21 (38,2)
Master's Degree	9 (16,4)

Time of professional activity in the health area	
Not applicable	1 (1,8)
Between 01 and 5 years	10 (18,2)
Between 11 and 15 years old	16 (29,1)
Between 6 and 10 years old	21 (38,2)
More than 15 years	7 (12,7)
Time working in a hospital environment	
Not applicable	1 (1,8)
Between 01 and 5 years	13 (23,6)
Between 11 and 15 years old	15 (27,3)
Between 6 and 10 years old	18 (32,7)
More than 15 years	8 (14,5)
In which sector(s) of the hospital do you work?	
Outpatient, Other	1 (1,8)
Surgical Center, Outpatient, Other	1 (1,8)
Surgical Clinics	2 (3,6)
General Medical Practice	29 (52,7)
Internal Medicine, Outpatient Clinic	1 (1,8)
Medical Clinic, Surgical Clinic, Intensive Care Unit	1 (1,8)
Medical Clinic, Surgical Clinic, Intensive Care Unit, Surgery Center	1 (1,8)
Other	3 (5,5)
Intensive Care Unit	16 (29,1)

4.2. Aspects about the COVID-19 pandemic

In Table 2 it can be seen that 98.2% of the interviewed population had been vaccinated against COVID-19, however 90.9% had confirmed infection with COVID-19. The severity of the acquired infection was not questioned. The institution where the professionals interviewed work has encouraged vaccination in the opinion of 52 (94.5%), even though 28 (50.9%) reported that they are not vaccinated regularly.

Table. 2: Aspects related to the COVID-19 pandemic questioned to the interviewed population of health professionals

Aspects about COVID-19	N (%)
You had Covid-19	
No	5 (9,1)
Yes	50 (90,9)
Have you been vaccinated against Covid-19?	
Not applicable	1 (1,8)
Yes	54 (98,2)
Were you encouraged by the institution you work for to get vaccinated against Covid-19?	
No	3 (5,5)
Yes	52 (94,5)
Are the professionals of the institution you work for regularly immunized/vaccinated?	
No	28 (50,9)
I don't know	17 (30,9)
Yes	10 (18,2)

Similar results were described in the study by Parikh et al, (2021) who found high rates of COVID-19 contamination among their professionals, even with classical preventive measures. The authors adopted different strategies to circumvent the situation, including the proper use and disposal of PPE.

Vaccination against COVID-19 in healthcare workers achieved high levels of acceptability both in the present study and reported by other authors (Papagiannis *et al*, 2021; Rosiello *et al*, 2021).

4.3. SSR management knowledge

The information about the Health Services Waste Management Basic Knowledge Assessment Questionnaire is described in Table 3.

It was verified in general that the institution has a protocol for management of waste contaminated by

COVID-19 as reported by 50 participants (90.9%), however most did not know what the Health Service Waste Management Plan is (56.4%), nor received training on HSWM (69.1%).s Waste Management Plan (56.4%), nor received training on SWM (69.1%), not knowing how to classify without difficulty which are the Health Service Waste (54.5%), even performing invasive procedures with risk of contamination (87.3%).

Table. 3: Questionnaire to assess basic knowledge about health services waste management

Items of the "Health Services Residues Management Basic Knowledge Assessment Questionnaire"	No N (%)	I don't know N (%)	Yes N (%)
Does your institution have a protocol for handling Covid-19-contaminated waste?	1 (1,8)	4 (7,3)	50 (90,9)
Is the sector you work in always full of patients?	5 (9,1)	0 (0,0)	50 (90,9)
Do you know what the Health Services Residues Management Plan is?	31 (56,4)	0 (0,0)	24 (43,6)
The institution you work makes available to employees for consultation and withdrawal of questions about handling contaminated materials the Health Services Waste Management Plan?	29 (52,7)	23 (41,8)	3 (5,5)
Have you ever taken any training made available by the institution you work for on Health Services Waste Management Plan?	38 (69,1)	0 (0,0)	17 (30,9)
Do you know how to classify without difficulty which are the Health Service Residues?	30 (54,5)	0 (0,0)	25 (45,5)
Do you have direct contact with the patients?	5 (9,1)	0 (0,0)	50 (90,9)
Do you perform invasive procedures on the patients you see?	7 (12,7)	0 (0,0)	48 (87,3)
Do the procedures you perform generate garbage or contaminated residues?	4 (7,3)	0 (0,0)	51 (92,7)
Have you ever had an accident with sharp objects?	38 (69,1)	0 (0,0)	17 (30,9)

Are needles and syringes disposed of together?	23 (41,8)	4 (7,3)	28 (50,9)
Do you receive equipment for handling the contaminated products?	2 (3,6)	0 (0,0)	53 (96,4)
Are there suitable containers for disposal of biological material?	1 (1,8)	1 (1,8)	53 (96,4)
Are there suitable containers for cutting material disposal?	0 (0,0)	0 (0,0)	55 (100)
In the sector you work, has there been a lack of suitable containers for the disposal of sharp drills?	28 (50,9)	2 (3,6)	24 (43,6)
Is there a specific colour-coding system for disposing of waste from healthcare services?	31 (56,4)	4 (7,3)	20 (36,4)
Do you think that the current practices for collecting and transporting health care waste provide sufficient safety?	6 (10,9)	15 (27,3)	34 (61,8)
Are there written instructions about regulations /waste management plans for health services?	47 (85,5)	3 (5,5)	4 (7,3)

It is evident that even in times of COVID-19 pandemic, the trainings necessary to have knowledge about Residues Management in Health Services in the investigated institution are still a challenge. Most of those interviewed said they did not have enough knowledge about the subject and did not receive recurrent training or have access to materials for consultation.

In contrast to this result, a study in Malaysia revealed that local policies integrate SSR management and environmental protection. The public hospitals evaluated in this study used not only the policies indicated, but also added their own strategies to ensure the correct management of waste, such as the application of a management policy, training of employees on this policy, separation of waste types still in the hospital using their own labels and use of specific PPE for the team handling the COVID-19 infected waste (Agamuthu; Barasarathi, 2021). Therefore, in addition to local training, ensuring that environmental laws are enforced is fundamental and feasible.

The availability of appropriate material for sharps disposal was confirmed by all the interviewees in this study, as well as the existence of appropriate containers for disposal of biological material (96.4%), as reported in table 3. This finding is positively relevant, because it reveals that even with the lack of adequate training, the institution is concerned with the execution of the Health Services Waste Management Plan.

A recent study has shown that such attitudes are key to alleviating the problem of landfills, as on-site SSR treatment and temporary storage reduce the burden of such waste, helps reduce virus transmission and facilitates recycling work, effects that have a positive impact on the environmental preservation and safety of health professionals (Das *et al*, 2021).

It should not be forgotten that the city of Manaus in Brazil, the place of interest of this study, was the scene of one of the most critical episodes of Brazilian public health during the COVID-19 pandemic period (Orellana *et al*, 2020) and it is essential to stress that during periods of health crisis, ensuring the safety of professionals and patients is essential.

In general, several approaches are recommended to circumvent the problem of SSR management, such as the need to know the status quo, characterization of the problem and the involvement of environmental departments in the supervision of health institutions, that acting together, can have a more holistic view of the situation and have greater chances of success in the implementation of effective PGRSS (Du *et al*, 2021; Das *et al*, 2021; Sarkodie; Owusu, 2021).

Therefore, the identification of the problem is one of the pillars for the construction of a more tangible solution, as carried out in this study, identifying which actions are being taken at the cutting edge linked to health services to then understand the possible consequences on the edge of the environment.

V. CONCLUSION

With the present research it was identified that the knowledge of healthcare professionals about residues management in times of COVID-19 pandemic still needs attention.

Most of the professionals reported that they do not have sufficient knowledge, and/or did not receive adequate training, even though the institution is providing the necessary tools to ensure the final disposal of waste health services. Even reporting that they have frequent contact with contaminated waste, more than half of the professionals reported that they do not know how to

identify without difficulty the types of waste, which consequently can impact on the inadequate disposal and, therefore, on environmental impact resulting from the dumping of contaminated material in inappropriate places. As a contribution, this study returned the results to the management of the research site and suggested strategies for improving knowledge about SSR management, such as frequent trainings focused on the main difficulties reported during the interviews. In addition, at the end of data collection, the professionals received access to additional material on the subject, aiming at self-training, as well as materials that highlighted the impact of their actions on the environment.

We conclude that even with the increase in demand for health services and SSRs during the COVID-19 pandemic, the training and knowledge about how to manage such waste did not follow the same growth, thus, the increase in the production of SSRs can negatively impact the environment if the necessary measures are not known by all actors involved in this process.

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