Knowledge About Medical Waste Management: How do Healthcare Professionals Learn and Practice?

Amanda Werlang and Ane Isabel Linden
Universidade do Vale dos Sinos – UNISINOS, Porto Alegre, Brazil

amanda.werlang@hotmail.com
linden@unisinos.br

Abstract: The management and disposal of medical waste follow scientific protocols to ensure safety. However, the effective implementation of the medical waste management system depended on correct handling and segregation by the healthcare workers, during their daily activities. These professionals need to know about health waste management, since incorrect handling and disposal pose a potential risk to the environment and human health. This study aimed to analyze the knowledge regarding the management of medical waste of the healthcare teams working in the Family Health Strategy (FHS). Designed to provide preventive and basic healthcare using multidisciplinary professional teams, the FHS reflects many best practices. The research was carried out in a city that is the 3rd economy in southern Brazil. This was a cross-sectional descriptive study with a quantitative approach, and data were assessed by using self-administered and pretested questionnaire. The study sample consisted of 74 participants, including doctors, nurses, and nursing technicians. Descriptive statistics were carried out to express participants' demographic information, mean knowledge score, and the teaching strategies used with the team. The main research results show that the healthcare teams working in the Family Health Strategy have, in part, knowledge about the correct management of waste. Besides, they are sensitive, in general, to its impact on the environment. Nevertheless, the results highlighted that more practical training would be needed, to help healthcare workers with everyday doubts. Furthermore, the results show that it requires attention to rethinking the strategies used to train and develop knowledge and skills in health services.

Keywords: Healthcare workers,Knowledge, Social learning, Medical waste, Environmental impact

1. Introduction

We are currently experiencing an environmental crisis related to the improper disposal of solid waste. Around the world, many cities still don't have comprehensive solid waste management programs, depositing them on unregulated dumps, compromising natural resources and the quality of life of future and current generations. In Brazil, most places for waste deposits are inefficient since both home and health collection are irregular, being deposited in open-air dumps, usually located close to low-income populations, further aggravating the problem. To change the current scenario and to preserve public health, natural resources, and workers' health, many public policies and technical standards were created in Brazil since the 1970s, which include the management of solid waste. Solid waste can be defined as the materials resulting from human activities in society, in a solid or semi-solid state (Word Health Organization, 2018). These include waste from healthcare services, such as hospitals and health clinics.

Of the total amount of waste generated by healthcare activities, about 15% is considered hazardous material that may be infectious, chemical or radioactive (Word Health Organization, 2018). According to Santos and Souza (2012), healthcare professionals are directly involved in the production of waste, not only in hospitals, but also in those produced in primary care, where multidisciplinary teams work by developing actions to promote the health of the population, and to improve both disease prevention and health rehabilitation According to Matos et al (2018), it is extremely important to understand the issue of waste generated in environments that provide health services, such as in primary care, thus preventing harm to human health.

Regarding primary care, the Brazilian Family Health Strategy (FHS) model changed the individual model of care, which used to be centred only on curing illnesses, to expand the focus to a comprehensive healthcare. This model has health promotion as its central axis, adding environmental factors to health determinants. In this way, it enables professionals working in health services, responsible for making the work environment safe, to guarantee the quality of care offered, avoiding exposure to physical, chemical, and biological agents, as well as favouring their dissemination in the environment and causing disease in the population (Peres et al, 2014).

Seeking to contribute, due to the relevance of the theme, the research questions of this study were: Do the FHS healthcare team know the correct management of waste and its impact on the environment? How did they learn about this matter? What were the teaching strategies they experienced?

The objective is to analyse the knowledge of the healthcare teams working in the FHS in a city in southern Brazil about the correct management of waste and its impact on the environment. The research theme is

justified by its relevance in the purpose of identifying weaknesses in the knowledge of professionals about the waste management process. The results may contribute to reflections on this problem in order to change attitudes towards environmental preservation, and to promote human health.

2. Research Method

This is a cross-sectional descriptive study with a quantitative approach, which used structured questionnaires applied in forms as a research instrument. The study was carried out in the municipality of Canoas, in Family Health Strategy teams. The municipality of Canoas, according to data from the Brazilian Institute of Geography and Statistics (IBGE) in 2021, has 349,728 inhabitants. In the 2022 edition of the Entrepreneurial Cities Index, the city ranked 45th largest in the rankings out of the 101 Brazilian municipalities in the survey. The study is an important indicator of the competitiveness, opportunities, and development of municipalities. In addition, the city owns the 3rd largest technological park in total area in the country.

Regarding the healthcare network, there are approximately 200 professionals allocated to Primary Care, in the Family Health Strategies. The territory of the municipality is divided into four quadrants, named Southeast, Southwest, Northeast, and Northwest. From this universe, the selection of the sample was made considering the suggestion of the Health Secretary to approach the four quadrants of the municipality in the research, as an idea of collecting data in different healthcare scenarios. Also, a sample calculation was performed using proportionality, in which 138 respondents would participate. To calculate the sample, the proportional stratified sample formula was used, using a confidence rate of 95%.

To reach this sample, questionnaires were delivered in the units with the largest number of FHS, to contemplate the four quadrants of the municipality of Canoas and reach the maximum number of participants.

The research subjects were members of the multidisciplinary teams working in the FHS who agreed to participate in the study and also signed the Informed Consent Form.

The inclusion criteria listed for this research were professionals working in the FHS such as doctors, nurses, nursing technicians, and nursing assistants. Professionals who were on leave, on vacation, away from work for some reason, community agents, and Oral Health Teams such as dental surgeons, assistants, and oral health technicians were excluded from the study. Community agents were excluded because they are not exposed to the risk of accidents with biological materials, or with sharp punctures, since in their role they do not perform invasive procedures. As for the Oral Health Teams, it complements the work of the FHS teams, but since they are not allocated in all units, in this study only the minimum multidisciplinary team of the FHS will be addressed.

The project was initially submitted to the Municipal Committee of Education and Collective Health and to the Research Ethics Committee of the University of Vale do Rio dos Sinos. After approval of the research project (registration number 3,773,514) data collection was started, which was carried out through printed forms, thus allowing the research participant to fill in the alternatives of his choice, facilitating the collection process data, providing greater flexibility to respondents.

The data collection instrument with simple and multiple-choice questions were delivered to the healthcare units, along with an identified collection box, which was removed two weeks after the date of delivery. The questionnaire was previously tested with 8 health professionals in another unit of the municipality, and the results were not used in this research. Some modifications were made after this test.

To carry out the data analysis, descriptive statistical analysis was applied, through the observation of relative and absolute frequencies, in addition to the t-Student test and Analysis of Variance (ANOVA).

3. Results and Discussion

Due to the pandemic related to the New Coronavirus (World Health organization, 2020), the research was, in a way, hampered during data collection, since social isolation was recommended by the National Department of Health, and healthcare units were focused on combating Covid-19. The collection period lasted for 3 months, from May to July of 2020. To try to obtain the maximum number of responses, several visits were made by the researcher to the units. The researcher personally delivered the forms to the healthcare workers, to encourage participation. However, the modified dynamics of the healthcare teams made it difficult to reach the expected goal of cases.

3.1 Sample Characterization

The participants were 74 members of the Family Health Strategy teams, 36 nursing technicians, 12 physicians, 25 nurses, and 1 nursing assistant, distributed in the four quadrants of the municipality. Participants were mostly female (86.5%).

3.2 Knowledge of FHS Teams about Solid Medical Waste Management

The following questions investigated previous training, as well as specific knowledge about medical waste management in Primary Care (Table 1).

Table 1: Previous Training about Waste Management

		N	%
Have you received any training at your service on the topic: "Waste management?"	Yes	24	32.43
	No	50	67.57
	Total	74	100,0
If you answered yes to the previous question, how long ago was the last training on the subject?	Less than 1 year ago	1	1.4
	Between 1 to 5 years	19	25.7
	More than 5 years ago	4	5.4
	not applicable	50	67.6
	Total	74	100.0

From the results presented on professionals who received training related to the correct waste management only 32.4% marked yes. Among these, 19 reported having occurred between 1 and 5 years (25.7%), four answered for more than 5 years (5.4%) and one answered less than 1 year ago (1.4%). These findings suggest a lack of adequate and ongoing training in waste management for healthcare professionals. It is consistent with previous research by Almeida et al (2009), Santos and Souza (2012) and Rizzon, Nodari, and Reis (2015), which also reported unsatisfactory results related to the professional qualification of the healthcare team involved in waste management.

It is emphasised here that it is the responsibility of healthcare services to provide such training as a routine practice, following the regulations set by the Brazilian Health Surveillance Agency (Agencia Nacional de Vigilancia Sanitária, 2004).

In this study, it was also verified the existence of significant differences between the averages of the variables: category and previous training, through the Analysis of Variance, or ANOVA. This analysis confronts variations from specific sources, with variation between groups, which should be similar (Hair et al, 2009). Thus, the one-way ANOVA investigates the effect of a factor on the endogenous variable, examining whether or not the means of the endogenous variable in each category of the factor are equal to each other. The rule was to verify whether or not there was a significant difference ($p<0.05$) between the groups; subsequently, differences in means were examined. The result shows that there was a significant difference between categories regarding whether or not they received the training [$F(2.71) = 4.144$; $p<0.05$), as observed in Table 2.

Table 2: Difference Between Categories with Regard to Receiving Training or not

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.695	2	0.848	4.144	0.020
Within Groups	14.521	71	0.205		
Total	16.216	73			

To identify which categories present significant differences, Tukey's post-hoc study showed that, on average, training is significantly higher for nursing technician respondents than for other professionals, being lower for physicians (Table 3).

Table 3: Professional Category Related to Training Through Tukey's Post-Hoc Analysis

Category		Sig.	average
Nurse technician	Nurse	0.604	1.57
	Physician	0.014	
Nurse	Nurse technician	0.604	1.68
	Physician	0.116	
Physician	Nurse technician	0.014	2.00
	Nurse	0.116	

It is essential to systematically build healthcare professional understanding of their role in an interprofessional team. There is an increasing acknowledgement of the value of multidisciplinary training since errors are the result of a chain that originates from a systemic or organizational failure. That facilitates the fact that a frontline care professional makes an error that can cause harm to others and to the patients (Mira, 2019). Biosafety assumes an extremely important role for all healthcare professionals responsible for identifying and managing medical waste.

There are several steps in healthcare waste management. It starts with waste classification; when properly segregated, about 85% of healthcare wastes are general waste with the same risk as domestic solid waste. It can make possible the recycling of non-hazardous general waste as well as lower the cost of treatment and disposal of healthcare waste. However, incorrect classification and segregation can raise the risks of exposure to hazardous healthcare waste for workers. So, healthcare teams must recognize the waste classifications that pose the highest risk, such as waste contaminated with blood or body fluids, sharp objects or even chemical waste (Zhou et al, 2022).

The classification of healthcare waste varies from country to country. Medical waste in Brazil is classified into five groups in accordance with national regulations: *A* (Biological or infectious risks, such as gauzes and bandages; infusion bags, syringe, blood bags, gloves, labware), *B* (Chemical risks, such as drugs and chemotherapy), *C* (Radioactive products, such as radionuclides from x-ray sectors), *D* (Non-recyclable and compostable waste, like food waste, and recyclable waste, like paper, cardboard or plastics), and *E* (Sharps waste, such as needles, knives and blades).

One of the research questions was related to the types of waste from health services. We provide the participants with examples of materials representing groups A, B, D and E. As the units do not have type C waste, they were not included in the question.

The results showed that, concerning the identification of residues during their segregation by risk groups, 62% of the participants correctly answered the alternative that represented group A. It is important to highlight that it is the kind of medical waste that implies a great occupational risk. 79% of the participants correctly answered the alternative that represented group B, which also implies a risk, especially to the environment, if it is discarded incorrectly. 78.3% of the participants correctly identified group D, referring to common waste, and 98.6% correctly answered the alternative that represented the group E, represented by sharp objects, one of the wastes with the greatest risk to the workers' safety.

Vieira's research (2013) also demonstrates that professionals mostly identify the correct place for disposal, but they have some uncertainties during this process, highlighted in the study, due to the lack of training addressing the issue.

There is greater knowledge of the research participants about the container for the disposal of sharps, evidenced in the results. Compared to the research by Gessner et al (2013), greater attention was also observed with group E waste, relating the concern of professionals with occupational accidents due to contaminating material. In the study by Bento et al (2017), on the other hand, professionals showed less ease in identifying and disposing of waste from group E. It is important to highlight that the segregation of waste at the generating source defines the efficiency of the other management stages (Agencia Nacional de Vigilancia Sanitaria, 2004).

We cannot fail to highlight the period in which the survey was being carried out: all healthcare units were dealing with cases of Covid 19, and therefore attention should be redoubled, due to the risks that the improper handling of masks or gloves could bring. Notwithstanding, a crisis like a pandemic could be an

effective source of knowledge (Thumiki and Jurcic, 2021). By identifying deficiencies in the knowledge and attitudes of workers, leadership will be able to take measures related to knowledge management.

In the questionnaire, three questions were related to the work environment and the conduct of professionals: one question was formulated to diagnose satisfaction with the infrastructure of the professionals' work environment, like number and type of bins, and the supply of plastic bags, for example. Another question was related to evaluating their conduct as a professional in the correct management of healthcare waste, and the last one was related to the concern with their actions and impact on the environment. To demonstrate the degree of agreement, the Likert scale was used, where the participant could choose between 5 applicable alternatives: I totally disagree; I disagree in part; neither agree nor disagree; partially agree and fully agree (table 4).

Table 4: Assessing the Structure of the Workplace and Professionals'conducts

Questions	I totally disagree	I Disagree in part	Neither agree nor disagree	Partially Agree	Fully agree	mean	Standart deviation
"The structure of the health unit (number and type of bins, supply of plastic bags) favors the management of health waste in my work". **Do you agree with this statement?**	1	10	1	24	38	4.19	1.08
"In my daily work routine, I try to segregate health waste, which consists of separating and disposing of it in appropriate containers. I believe that I performed this step correctly". **Do you agree with this statement?**	1	2	2	17	51	4.51	0.95
"The lack of care during the segregation of health waste produced daily in the Family Health Strategy has an impact on the environment." **Do you agree with this statement?**	2	1	1	7	62	4.66	0.97

Regarding the health service facilities and the conditions offered to segregate waste, 38 participants responded with Fully Agree and 24 marked Partially Agree, thus demonstrating that more than half of professionals positively evaluate their workplace structure. In this research, the participants considered, in general, the structure as adequate. In different studies, Camargo and Melo (2017) and Rizzon, Nodari and Reis (2015) pointed out that the work environment was not adequate, with insufficient containers, a lack of standardisation in packaging devices and plastic bags, causing difficulties in segregating and discarding medical waste. In addition to this, there is a fact that healthcare units in other municipalities suffer from a lack of safety equipment, human resources and medical supplies to meet the demands.

In the research question regarding the findings of the self-assessment of professional conduct during the segregation and disposal stages, 51 professionals marked Fully agree, and 17 chose Agree in part, indicating that most consider their conduct as appropriate. These results are intriguing and can be more than a "Dunning-Kruger effect" (cognitive bias that leads people to overestimate their knowledge or expertise). Specifically, the study by Rizzon, Nodari and Reis (2015) showed a lack of understanding of the legislation and, consequently, the practical application of its guidelines. Maybe the translation of healthcare policies and guidelines to the daily routines is missing. Distinct professional features in terms of competencies and experiences, "could create barriers in the transfer and sharing of knowledge" (Dal Mas et al, 2020, p.199). So, developing effective knowledge translation interventions "that maximize professionals' knowledge about best practices is an important step towards closing this knowledge-to-practice gap" (Thomas et al, 2014, p.2).

In the research question related to the environmental impact of waste management, 62 of the professionals answered with the alternative I totally agree, and 7 chose I agree in part, which is interesting: even having doubts about the medical waste managing process, they recognize its importance and the relationship with the environmental preservation. Studies by Camargo and Melo (2017) and Peres et al (2014) also observed

that respondents recognize that their actions at work have an environmental impact and believe that improper disposal of waste produced in healthcare units causes environment contamination.

In addition to the objective questions on the form, we offer research participants the possibility to write their suggestions and concerns regarding this topic, specifically asking about the actions of the FHS team that could cause any environmental impact during the managing of healthcare waste. Some participants reported inadequate equipment and structure, such as insufficient amount of trash cans and lack of correct identification. It demonstrates that at some locations, despite the satisfaction with the workplace infrastructure, there are opportunities for improvement. Some participants expressed the need for further discussions on the subject, as they observed numerous mistakes in waste segregation and disposal, among healthcare professionals and patients alike. Finally, many participants highlighted the need to recycle correctly, and to promote practices that reduce the volume of waste generated in day-to-day activities. On this subject, Lattanzio et al (2022) emphasize the need for a better awareness about recycling possibilities among healthcare workers and the commitment to collect and recycle.

3.3 Training and Knowledge Sharing Opportunities

Regarding their interest in receiving training on waste handling and disposal in the workplace, 64 professionals answered yes (86.4%), only 5 answered no (6.7%), and 5 did not answer the question (6.7%). In the same question, an optional space was left so that topics related to waste management could be proposed, in which 44 professionals participated.

The topics listed by the participants were: risks to patients and professionals by handling solid medical waste; waste classification, collection and final destination; correct use of personal protective equipment; work accident prevention; environmental effects of incorrect waste disposal; and correct disposal of expired drugs and vaccines.

Other studies, such as Almeida et al (2009), Camargo and Melo (2017), Matos et al (2018) and Rizzon, Nodari, and Reis (2015), also showed the interest of professionals in receiving training on the subject, thus pointing to the need to invest in permanent education, not only in the stages in which they are directly involved, but throughout the entire process.

An interesting point of the results was that the fact that the professionals received training did not directly influence their responses. In order to verify the comparison between receiving some training in their service on the subject and the other questions, Student's t-statistic analysis was performed (Hair et al, 2009). Thus, it was evidenced that the fact that people received training or not did not provide different averages for the questionnaire responses ($p>0.05$), since whether or not they received training, the participants were correct in the same proportion.

These results may stress the need to identify successful learning strategies to reframe the topics for application in practice. Bordoloi and Islam (2012, p.116) claim that "healthcare professionals noted that continued education to keep in touch with the most updated information and evidence played a very important role in their professional life". Undoubtedly, investing in the education and training of healthcare professionals appear to be a winning strategy for managing medical waste. However, some studies show that inadequate knowledge was identified as one of the main barriers to implement correct and environmentally sustainable practices, regarding medical waste. (Wu, Cerceo, 2021; Lattanzio et al, 2022). One of the suggestions is the creation of "an 'environmental greening team' to increase knowledge, improve attitudes and facilitate the success of green initiatives." (Lattanzio et al, 2022, p.7).

Furthermore, it is essential to evaluate the effectiveness of knowledge management enabling initiatives. But what about the teaching techniques currently used with FHS teams? In this research, the participants who confirmed having received training, did so in the form of short theoretical courses. It is a common strategy to have short-term training in healthcare practice, tending to focus on techniques such as short presentations and simulations. These techniques can be effective in some matters. Nonetheless, healthcare services are very complex and are constantly facing significant challenges. We must recognize that there are a multiplicity of practices and learning processes by individuals and their peers in the healthcare context. It is relevant to consider learning as a social construct, something that people are doing, sharing and building together in their daily activities (Linden, Bitencourt and Muller, 2019). Therefore, dynamic teaching strategies, which start from practices, building knowledge in a bottom-up, and networked fashion (Coffie et al, 2023) could improve trust and safety.

4. Conclusions

The study allowed us to identify the knowledge of healthcare professionals about medical waste management. It was found, when evaluating the results, that doubts persist about segregation and disposal of waste produced in the Family Health Strategy Units. In general, the results point to the teams' mastery over some aspects, observing the number of correct answers. Doubts, however, cannot be minimized, since the topic is critical, both for human health and for the environment. Healthcare workers must be aware that caring for the environment is also part of their work routine.

Even if the conditions of workplace facilities were well evaluated, it does not mean that improvements cannot be developed. The research opens space to discuss other questions about workers' knowledge in the municipality's FHS. For example, how much do sanitation service employees know about waste management? Do they use personal protective equipment during segregation and disposal processes? Do the waste storage locations comply with the legislation and technical standards?

Another important finding was related to the continuing and up-to-date education of professionals. In the survey, even those who received the training showed uncertainties about the process, demonstrating that they need more opportunities for discussion on the subject to clarify doubts, as lack of training can increase occupational risks and impact on environmental care.

As a suggestion, it is important that the subject can be addressed at all levels of training in the field of healthcare. Beyond that, it is crucial to rethink the strategies being used for on-the-job training, to improve the process of continuing health education.

References

Almeida, V.C.S, et al (2009) "Gerenciamento dos resíduos sólidos em unidades de saúde da família", Revista Rene, Fortaleza, Vol 10, No. 2, pp 103-112.

Agência Nacional de Vigilância Sanitária ANVISA (2004) "Resolução RDC nº 306, de 7 de dezembro 2004. Dispõe sobre o Regulamento Técnico para o gerenciamento de resíduos de serviços de saúde", Brasília, DF.

Agência Nacional de Vigilância Sanitária ANVISA (2018) "Resolução da Diretoria Colegiada: RDC nº 222, de 28 de março de 2018 - Regulamenta as Boas Práticas de Gerenciamento dos Resíduos de Serviços de Saúde e dá outras providências", Brasília, DF.

Bento, D.G. et al (2017) "O gerenciamento de resíduos de serviço de saúde sob a ótica dos profissionais de enfermagem", *Texto & Contexto - Enfermagem*, Vol 26, No. 1, pp 1-7.

Bordoloi, P. and Islam, N. (2012) "Knowledge Management Practices and Healthcare Delivery: A Contingency Framework", *The Electronic Journal of Knowledge Management*, Vol 10, Issue 2, pp 110-120.

Camargo, A. R. and Melo, I. B. N. (2017) "A percepção profissional sobre o gerenciamento dos resíduos de serviços de saúde em unidades básicas e ambulatórios de saúde" *O Mundo da Saúde*, Vol 41, No. 4, pp 633-643.

Coffie, R.B.,Boateng, K.A., and Alhassan, A.U. (2023) "Knowledge Management Practices for Enhanced Organisational Performance: Can Leadership Style be a Moderator?" *The Electronic Journal of Knowledge Management*, Vol 21, No. 1, pp 13-28.

Dal Mas, F., et al. (2020) "Knowledge Translation in the Healthcare Sector. A Structured Literature Review", *The Electronic Journal of Knowledge Management,* Vol 18, No. 3,pp 198-211.

Hair, J.F. et al. (2009) *Análise multivariada de dados*, Bookman, Porto Alegre.

Lattanzio, Set al (2022) "Waste Management and the Perspective of a Green Hospital—A Systematic Narrative Review", *International Journal of Environment*, Vol 19, 15812.

Linden, A. I., Bitencourt, C. C. and Muller, H.F. (2019) "Contribution of knowing in practice to dynamic capabilities", *The Learning Organization*, Vol 26, No. 1, pp 60-77.

Matos, M. C. B et al. (2018) "Conhecimento de profissionais da Enfermagem sobre o gerenciamento de resíduos produzidos na atenção básica", *Revista Brasileira de Enfermagem*, Vol 71, No.6, pp 2891- 2898.

Mira, J. J. (2019) "Sem profissionais de saúde engajados não há futuro para segurança do paciente", *Acta Paulista de Enfermagem*, Vol 32, No.5, pp 3–5.

Peres, R.R. et al. (2014) "A responsabilidade ambiental sob a ótica de trabalhadores da atenção básica à saúde", *Revista de Pesquisa e Cuidado é Fundamental Online*, Vol 6, n. 3, pp 1090 – 1104.

Rizzon, F., Nodari, C.H. and Reis, Z.C. (2015) "Desafio no gerenciamento de resíduos em serviços públicos de saúde " *Revista em gestão em sistemas de saúde*, Vol 4, No. 1, pp 40-54.

Santos, M.A. and Souza, A.O. (2012) "Conhecimento de enfermeiros da Estratégia Saúde da Família sobre resíduos dos serviços de saúde", *Revista Brasileira de Enfermagem*, Vol 65, No. 4, pp 645 – 652.

Thomas, A., Menon, A., Boruff, J. et al (2014) "Applications of social constructivist learning theories in knowledge translation for healthcare professionals: a scoping review", *Implementation Science*, Vol 9, No.54, pp . 2-20.

Thumiki, V. R. R.,and Jurcic, A. (2021) "Impact of COVID-19 Crisis on Knowledge Management Practices in Sultanate of Oman", *The Electronic Journal of Knowledge Management*, Vol 19, No.3,pp. 213-225.

Vieira, C.S.M. (2013) "Análise do manejo dos resíduos de serviços de saúde em unidade básica de saúde vinculada a Instituição de Ensino Superior", *Trabalho de Conclusão de Curso (Bacharel em Engenharia Ambiental e Sanitária) – Curso de Engenharia Ambiental e Sanitária*, Universidade Federal de Pelotas, RS, pp 78.

World Health Organization - WHO (2018) "Healthcare Waste" Available on: https://www.who.int/news-room/fact-sheets/detail/health-care-waste (Accessed 12 february 2023).

World Health Organization - WHO (2020) "Coronavirus disease (COVID 19) pandemic, health topics", Available on: https://covid19.who.int (Accessed 12 february 2023).

Wu, S. and Cerceo, E. (2021) "Sustainability Initiatives in the Operating Room", *The Joint Commission Journal on Quality and Patient Safety*,Vol 47, No. 10,pp 663-672.

Zhou, H., Yu, X., Alhaskawi, A. et al. (2022) "A deep learning approach for medical waste classification", *Scientific Report*, Vol 12, pp 21-59.