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Ensuring safe disposal: hospital preparedness for managing medical waste during the COVID-19 pandemic

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Abstract

Purpose: The increasing volume of medical waste generated during the COVID-19 pandemic poses a significant challenge to hospitals, highlighting the urgent need for effective hospital waste management. However, the current medical waste management practices in many hospitals may not be sufficient to handle the surge in waste, highlighting a critical gap in the system. This study. The present study aims to review articles discussing problems and solutions in low- and middle-income countries (LMICs) related to hospital waste management during the COVID-19 pandemic. **Methods:** This review study was performed by searching four databases - Scopus, Science Direct, PubMed, and ProQuest from 2020-2022. **Results:** Based on the findings of the article review, the 3R process - Reduce, Reuse, and Recycle - proves crucial in managing medical waste, particularly during the COVID-19 pandemic. This process serves as the primary stage in medical waste management, effectively minimizing the burden on the subsequent stages, such as storage, transportation, and final processing. By implementing the 3R process, healthcare facilities can effectively reduce the volume of medical waste, consequently mitigating the negative impact of the pandemic on the environment. Therefore, it is essential to prioritize the 3R process in managing medical waste to address the increasing generation of medical waste brought about by the COVID-19 pandemic. **Conclusion:** The COVID-19 pandemic has highlighted the need for stronger management and law enforcement commitment in LMIC hospitals. These events require hospitals to be better prepared for emergencies like pandemics. Therefore, governments and healthcare institutions must prioritize emergency preparedness measures to effectively handle such crises. By taking proactive measures to improve hospital management and law enforcement, LMICs can be better equipped to manage future pandemics and protect the health of their citizens.

Keywords: medical waste; strategy; management; hospitals; COVID-19

INTRODUCTION

The 2019 coronavirus disease (COVID-19) pandemic has caused a sudden collapse in waste management arrangements. Handling medical and household waste is critical to successfully controlling the disease. Poor management increases pollution. All countries with excess waste should assess their management systems, including preparedness and resilience. Any medical waste produced while caring for COVID-19 patients must be carefully collected in appropriate containers and bags, processed, and then disposed of safely or both safely and, preferably, on-site. They should also wash their hands after handling the waste [1,2].

The rise of COVID-19 has added to the burden on patients, COVID-19 works, and limits social interaction, the COVID-19 pandemic creates a double burden, namely an increase in medical waste and a decrease in processing capacity. medical personnel for waste disposal. As a result, the safe handling of medical waste suffers. Some 296,496,8093 confirmed cases of COVID-19 were recorded between March 2020 and January 2022. Many of these required personal protective equipment for employees. Each of these cases and hundreds of millions of people will be tested for COVID-19 through exposure to the virus, travel, work or other responsibilities. After all, more than 9 billion doses of the COVID-19 vaccine have been administered, protecting 35 percent of the world's population. Billions more estimated. Each of these activities generates a sizable amount of waste related to COVID-19 [1].

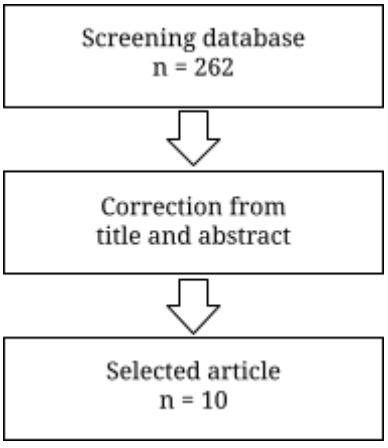
The amount of medical waste generated globally each year is rising, particularly due to healthcare services being provided in facilities, which has been further exacerbated during the pandemic. In Ghana, for instance, before the COVID-19 outbreak, homesick tamales led to the generation of as much as 29.56 kg of medical waste daily [3]. In India, medical waste production surged to approximately 101 tons during the pandemic year. Similarly, in Colombia, there was a 30% increase in hazardous medical waste between 2019 and 2020, with an average of 5,818 kg generated monthly, compared to the 7,575 tons produced in 2020. The growing amount of worldwide medical waste presents a significant environmental and health challenge that must be addressed urgently [4].

Arise medical waste in Bangladesh in normal conditions is much as 0.5 kg/patient/day, whereas, in the COVID-19 situation, it experienced a spike arising 3.4 patients/day along with an increase in total patients who contributed to the increase arising from medical waste [5]. Enhancement of medical waste in Jakarta from 0.96 kg/bed/ day to 1.62 kg/bed/day. Hospitals in Surabaya experienced increased use of tool protector self in the care of COVID-19 patients, with a rate generation of 0.74 kg/ place sleep/day to 0.79 kg/ place sleep/day [6]. According to the Ministry of Environment Life and Forestry, there exists a 30 percent increase in medical waste daily in Indonesia of 382 tons, post-pandemic, compared to pre-pandemic data of about 293 tons. Data was collected from 2,820 hospitals and 9,884 health centers nationwide [7].

Following the above studies, increased medical waste generated by healthcare facilities poses a potential health hazard due to its toxic and infectious nature, and also poses a risk of environmental pollution. Effective management of medical waste is essential for protecting public health and the environment, and this responsibility lies with both healthcare facilities and the country at large. However, information regarding managing hazardous and toxic waste in healthcare facilities during the COVID-19 pandemic is limited. To address this gap, this research aims to explore medical waste management practices in healthcare facilities during the COVID-19 pandemic.

METHODS

This study reviews the literature on hospital medical waste management during the COVID-19 pandemic. The literature search used keywords such as medical waste, management, hospital, and COVID-19 on several scholarly databases, including Scopus platforms, Science Direct, PubMed, and ProQuest. The inclusion criteria for the articles were that they must be free full-text publications, published in Indonesian or the United Kingdom, published in 2020–2022, have an ISSN, and be relevant to the keywords. The researcher excluded incomplete articles, purchased without a literature review, plagiarized, or irrelevant to the keywords.



Medical waste management has become an important strategy for hospitals during the COVID-19 pandemic, and using the keywords “medical waste” AND “medical waste management” AND “hospitals” and “COVID-19” OR “pandemic” can play a crucial role in conveying the message to the relevant stakeholders.

After a thorough search, the researcher finally found ten journals that met the inclusion criteria. The chosen articles were reviewed, summarized, and analyzed to write a report summarizing the findings on medical waste management in hospitals during the COVID-19 pandemic.

We analyzed the hospital medical waste paper produced by the WHO [8,9,10], which included six components: 3R, sorting, containers, collection, storage, and transportation to processing. Our assessment involved assigning a score of 1 if a particular component of medical waste management was carried out and a 0 if not, based on the article information.

RESULTS

Table 1 summarizes reviewed papers on medical waste management components during COVID-19. The weakest items are found in Belo Hospitals Brazil and Public Hospitals of West Guji Southern Ethiopia [11], where the Reduce, Reuse, and Recycle process has not been implemented as an initial stage in hospital medical waste management.

An interesting study was conducted on two hospitals that effectively implemented medical waste management, one in Mojokerto and the other in Tamil Nadu [12,17]. Medical waste management was carried out from stage 3 (Reduce, Reuse, and Recycle) to the final processing stage during the COVID-19 pandemic.

Only one hospital has met the stringent requirements for medical waste management during the COVID-19 pandemic, scoring 14 [12]. The hospital used WHO standards that were applied from the onset of the pandemic, and it is a commendable feat for this hospital to have successfully met all criteria for proper disposal of medical waste. In this hospital, Reduce, Reuse, and Recycle (3R) principles were applied. The amount of medical waste generation is high compared to other hospitals. Sorting according to the type of medical waste as many as nine types. Containers are adjusted to standard colors and labeled (a special label for COVID-19 medical waste). Collection of medical waste according to procedures, times, and routes determined and carried out by specially trained officers. Storage according to the time and place that has been prepared and meets the requirements. Lastly, medical waste is transported to final disposal by the hospital, trained personnel, or an appointed third party.

Whereas for other hospitals, the score is less than 14 and even below 10 because, based on a review of the article, several stages of medical waste management were not carried out, especially the 3R process that has not been carried out in hospitals during the COVID-19 pandemic.

In Mojokerto's study [12], activity subtraction as restrictions purchase could be conducted to reduce waste dangerous activity cycle repeat for material that can be recycled. 3R activities (reduce, reuse, recycle) result from findings that there is action in handling medical waste as reducing the use of medical waste from plastic, cotton masks disinfected until use return protector face. Reducing medical waste is one possible effort management at hospitals that ensure date expired medicine, disinfecting tool medical, and use of return tool medical the naturally after conducted disinfection. 3R activities result in finding parts not yet corresponding to describe standards set by the WHO for hospitals.

The study in Belo Horizonte Hospital in Brazil [11] and five other hospitals had not implemented adequate measures to manage medical waste efficiently. The study highlighted the lack of preparedness in managing medical waste, particularly in the early stages of the 3R process, which aims to reduce the volume of waste that eventually ends up in storage and processing facilities. The findings underline the importance of hospitals adopting sustainable waste management practices to minimize environmental and health risks. It is crucial for hospitals to prioritize the implementation of effective waste management protocols to promote a safe and healthy environment for patients, staff, and the surrounding community.

Several possible strategies can be carried out by hospitals in pandemic conditions, namely collaborating with the Ministry of Health, which deals with the field of medical waste management and the environment, so that they can provide medical waste disposal sites, increase medical waste treatment locations and help directly or through social media to educate the community and increase the provision of waste treatment technology to speed management process.

During a pandemic, hospitals can implement three short-term strategies for managing medical waste to cope with the sudden surge in waste generation from patients and medical staff. A proper medical waste management strategy is crucial to prevent environmental pollution caused by the mishandling of medical waste. Therefore, it is necessary to adopt suitable measures to manage medical waste effectively.

It is the legal and financial responsibility of all waste generators to utilize safe and environmentally friendly waste management methods. High vigilance should be

Table 1. Summary of hospital medical waste management components during the COVID-19 pandemic

Author and Year	3R			Arise medical waste (kg/bed/day)	Sor-ting	Container			Collection			Storage		Transportation		Total
	Reduce	Reuse	Recycle			Type	Colour	Label	Procedure	Time	Route	Time	Place	Processing	Transportation	
Peng,2020	1	1	1	6,25	0	1	0	1	0	1	1	1	1	1	1	11
Lemma,2022	0	0	0	2,1	0	0	0	0	1	0	0	0	0	1	0	3
Silva,2021	1	1	1	2,6	0	1	1	1	1	1	0	1	1	1	0	11
Samarjeet,2021	1	0	1	6,5	0	1	0	0	1	0	0	1	1	1	0	7
Krithiga,2021	1	1	1	2	0	1	1	1	1	0	0	1	1	1	0	10
Rahmani,2022	0	0	0	4,7	0	1	1	1	1	1	0	0	1	0	1	7
Putri,2022	1	1	1	11,1	1	1	1	1	1	1	1	1	1	1	1	14
A Susi,2020	0	1	1	5,46	0	1	1	0	1	0	0	0	0	1	1	7
Sangkham,2020	1	0	0	3,36	0	1	1	1	1	1	0	1	0	1	1	9
Neves,2022	0	0	0	7,18	0	0	0	0	1	0	0	1	0	1	0	3
Total	6	5	6	-	1	8	6	6	9	5	2	7	6	9	5	-

Notes: 1 =Meet the requirements for the stages of medical waste management in hospitals; 0 = Does not meet the requirements for the stages of medical waste management in hospitals

prioritized, especially when dealing with COVID-19 waste, by regulating health and safety principles and proximity when handling hazardous waste to minimize potential transportation risks.

The findings presented in Table 2 are quite informative, highlighting the hospital's various medical waste management techniques in response to the Covid-19 pandemic. Hospital X in Mojokerto [12] has taken a comprehensive approach to medical waste management, which involves the 3R process (Reduce, Reuse, and Recycle) and proper processing techniques. Overall, these results indicate that the hospital has taken proactive measures to mitigate the impact of Covid-19 on medical waste management, which is crucial for maintaining public health and safety.

Table 2. Strategy for medical waste management in hospitals during the COVID-19 pandemic

Issues	Strategy that has been done	Author and Year
An example of a strategy to meet WHO hospital medical waste management standards	3R principle, time and route of collection, as well as the final transportation process is carried out by trained officers to final processing using an incinerator for infectious medical waste.	Peng,2020 [13]
	Final processing is carried out using an incinerator	Lemma,2022 [14]
	3R, time and route of collection, as well as the final transportation process, is carried out by trained officers to final processing using an incinerator for infectious medical waste.	Silva,2021 [15]
	Final processing is carried out using an incinerator	Samarjeet,2021 [16] Krithiga,2021 [17]
	The final disposal process is left to and carried out by a third party or the private sector	Rahmani,2022 [18]
	3R, sorting medical waste according to its type, according to the type, color, and label on the container, the exact time of collection, place of disposal and final processing is submitted and carried out by a third party or the private sector and medical equipment that can still be used again will be heat sterilized and wet using autoclave in hospital.	Putri,2022 [12]
	Final processing is carried out using an incinerator	A Susi,2020 [19] Sangkham,2020 [20]
	Final processing is carried out using an autoclave and an incinerator	Neves,2022 [11]
Reasons for not being able to respond to the COVID-19 pandemic situation	Limited specially trained personnel, financing in managing medical waste.	Peng,2020; Lemma,2022; Silva,2021 [13, 14.15]
	Limited specially trained personnel, incomplete availability of PPE, and financing for managing medical waste.	Samarjeet,2021 [16]
	Limited specially trained personnel, financing in managing medical waste.	Krithiga,2021; Rahmani,2022; Neves,2022 [11, 17, 18]
	Limited specially trained personnel, financing, and special storage space in managing medical waste.	Putri,2022 [12]
	Limited specially trained personnel, financing in managing medical waste.	A Susi,2020 [19]
	Limited specially trained personnel, funding, and no special storage room for medical waste related to COVID-19 in managing medical waste.	Sangkham,2020 [20]

According to the World Health Organization, Table 3 outlines the strategies for managing medical waste in hospitals during the Covid-19 pandemic, categorized by short-term, medium-term, and long-term approaches.

DISCUSSION

The COVID-19 pandemic has significantly threatened public health and environmental sustainability. However, changes in routine activities, such as proper medical waste management, can mitigate these potential threats. The increase in medical waste, which has doubled since the start of the pandemic, requires appropriate disposal methods. Therefore, it is crucial to evaluate the procurement of incinerators in healthcare facilities by comparing the cost of medical waste before and during the pandemic. For instance, at Hospital X in Mojokerto, it is necessary to assess the cost-effectiveness of buying an incinerator to manage medical waste generated during the pandemic. By

managing medical waste properly, the potential threats posed by the pandemic on environmental sustainability and health outcomes can be effectively mitigated [2,12,21,22].

As a result, in England Hospital [21], the review identified three key themes that would inform the priorities and actions of the strategy. The first theme identified was resilience. This theme focused on how infrastructure, capacity, and cost could be managed to improve the resilience of hospital medical waste management processes. By improving the resilience of medical waste management processes, the hospital could better respond to challenges and maintain the continuity of service delivery. This was especially important during the COVID-19 pandemic when medical waste management processes were under significant pressure.

Table 3. Several implementation strategies in managing hospital medical waste during a pandemic [2,4]

Short-term strategy
1. All syringe components are made of the same plastic to facilitate recycling; selection of PVC-free medical products; 2. Identification and development with recycling selection whenever possible (such as plastic, glass and others); and 3. Research and promotion of new technologies or low-burning alternatives; 4. Until developing countries can adopt an environmentally friendly and healthier disposal option for hospital medical waste, incineration, if used properly, could be an acceptable solution. 5. Key factors for proper incinerator operation are waste reduction and efficient waste disposal, incinerator location away from densely populated areas, satisfactory engineering design, construction with suitable dimensional plans, proper operation, regular maintenance, and staff training and management.
Medium-term strategy
1. Reduce the number of unnecessary injections to reduce the amount of hazardous medical waste that needs to be treated 2. Conduct research on the health effects of chronic exposure to dioxins and low levels of furans 3. Conduct a risk assessment to compare the health risks associated with incineration and exposure to medical waste.
Long Term strategy
1. Promotion of effective enhanced non-incineration technology for final disposal of medical waste to prevent disease burden from unsafe management of hospital medical waste and exposure to dioxins and furans. 2. Promotion of effective enhanced non-incineration technology for final disposal of medical waste to prevent disease burden from unsafe management of hospital medical waste and exposure to dioxins and furans. 3. Support countries in developing and implementing national plans, policies, and laws on hospital medical waste. 4. Promotion of environmentally sound management of hospital medical waste as stipulated in the Basel Convention. 5. Support for allocating human and financial resources to manage hospital medical waste safely in countries.

The second theme was productivity. This theme focused on how reduced volumes of waste and improved compliance, culture, and data management could improve productivity in medical waste management. The aim was to reduce the amount of waste generated and improve waste management to increase efficiency and reduce costs. By doing so, the hospital could redirect resources to other areas that require more attention.

The third and final theme was sustainability. This theme focused on how improved medical waste management processes could contribute to meeting hospital net-zero carbon targets and minimizing negative environmental impacts. The aim was to reduce the environmental impact of medical waste management processes and to ensure that they aligned with the hospital's sustainability goals. This was important as the hospital had committed to becoming a net-zero carbon emitter by 2040.

In conclusion, the comprehensive review conducted by the hospital team highlighted three key themes that would inform the priorities and actions of the medical waste management strategy. These were resilience, productivity, and sustainability. The hospital could improve its medical waste management processes by addressing these themes and contributing to its broader sustainability goals.

CONCLUSION

Proper medical waste management is crucial during the COVID-19 pandemic to prevent potential threats to public health and environmental sustainability. The Hospital Team has identified three key themes for medical waste management: resilience, productivity, and sustainability, which can improve the management processes and contribute to broader sustainability goals. By addressing these themes, hospitals can respond better to challenges, reduce waste volumes and costs, and reduce their environmental impact while aligning with their commitment to becoming net-zero carbon emitters and good law enforcement.

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