International Journal of Public Health Science (IJPHS)
Vol. 11, No. 3, September 2022, pp. 949~956
ISSN: 2252-8806, DOI: 10.11591/ijphs.v11i3.21517

Repercussions of the COVID-19 pandemic on medical waste management

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Article Info

Article history:

Received Nov 6, 2021
Revised May 15, 2022
Accepted Jun 21, 2022

Keywords:

COVID-19
Incinerator
Medical waste
SARS-Cov-2

ABSTRACT

The COVID-19 pandemic is a global outbreak that also changes the generation of medical waste in hospital. The increasing number of people infected with the severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2) virus indirectly requires the management of infectious waste from patients to be safe and not have the potential to spread. The purpose of this study was to analyze the medical waste management in a hospital located in Jakarta City, Indonesia. This study employed direct observation and used secondary data in the analysis. Meanwhile, to determine the effect of the population infected with SARS-Cov-2 on medical generation, One Way ANOVA analysis was used. Data from May, 2020 showed that medical waste generation increased from 25.6 kg/month to 192.3 kg/month. The ANOVA significance test showed a value of 0.013; this indicates that the number of the infected population significantly affects the generation of medical waste. Medical waste that found during a pandemic becomes more complex, including hazmat clothes, masks, gloves, medical headgear, used bandages, injection and infusion equipment, eating and drinking utensils for patients exposed to COVID-19, and used swab and rapid test equipment.

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1. INTRODUCTION

The global pandemic caused by an outbreak of coronavirus disease (COVID-19) was announced by WHO on January 30, 2020. Every individual can potentially be infected with COVID-19 which results in death. The city of Wuhan, China, was the initial location for the spread of this virus which later spread to more than 190 countries in the world, including Indonesia [1]–[3]. In Indonesia, positive cases of COVID-19 until January 2021 have reached one million patients; until mid-2021, it is still increasing. To overcome this COVID-19 problem, the Government of Indonesia is taking serious action by appointing several hospitals as referral places to treat people infected with COVID-19 throughout Indonesia.

The increase in COVID-19 cases in Indonesia has also been accompanied by a significant increase in the amount of medical waste originating from masks, gloves, personal protective clothing, eating utensils, and so on [4]–[7]. It can be seen that there is an increase in the supply of p*ersonal protective equipment*

(PPE) to 40% per month and the compound annual growth Rate (CAGR) is projected at 6.5% [8]. Based on data from WHO, demand for PPE, including surgical masks and gloves, is expected to continue to increase during the post-pandemic period, which can reach a CAGR of 20% until 2025 [9]. The Ministry of Health recorded the amount of medical waste in August, 2018 of 294.66 tons/day for all provinces in Indonesia [10]. In addition, it is estimated that the volume of waste generated due to the pandemic will increase by up to 30% [11]. As with previous research in Vietnam, during a year under COVID-19, as much as 1,486 tons of COVID-19 waste was generated from the treatment of isolated COVID-19 patients, dominated by plastic waste and then paper waste [12]. In addition, the ratio of infectious waste in hospitals that have been studied previously increased by an average of 9% in the composition of medical waste and 121% compared to before the COVID-19 pandemic. The most important results from this study clearly show changes in medical waste generation and composition during the COVID-19 pandemic [13]. The results showed that the COVID-19 pandemic caused the quantity variations and changes in the composition of MSW. In addition, COVID-19 also significantly impacts waste recycling, medical waste management, quantity and composition of unmanaged waste [14]. On the other hand, the COVID-19 pandemic has changed waste management activities, especially medical waste. Recognizing this problem requires research that can help plan municipal solid waste management (MSWM) more efficiently to reduce the risk of virus transmission through solid waste from garbage and leachate.

The significant increase in the number of regions/countries and people infected with COVID-19 shows that the world will experience another problem, namely COVID-19 waste. This will have a significant impact on sustainable waste management in the future [15]. Medical waste, especially COVID-19 waste, contains potentially dangerous microorganisms because it can easily infect other patients, health workers or the general public if not handled and disposed of properly. In 2018, a survey was conducted on the capacity of hospital waste management. It was found that of the 94 respondent hospitals, 71% did not have waste treatment facilities. Therefore, exposure to COVID-19 waste has the potential to spread the virus by increasing the reproduction rate with a range between 2.2 and 3.58 [16]. The main transmission route of the COVID-19 virus is through droplets released during the breathing process or through sneezing from an infected person.

To date, there has not been sufficient research on the increase in solid medical waste in the city of Jakarta. Jakarta is the capital city that has experienced the most significant changes in the number of COVID-19 sufferers. This study aimed to analyze the amount of generation and composition of medical solid waste during the pandemic that was generated in a hospital in Jakarta. However, this research investigated the amount of medical waste generated during the pandemic, the transportation facilities, thethe transportation facilities, the treatment that has been carried out, and the differences in the composition of medical waste before and after the COVID-19 pandemic. The information also be obtained regarding how the effect of increasing the number of COVID-19 sufferers on the amount of medical waste produced.

2. RESEARCH METHOD

The study employed descriptive and analytic analysis. The study took place in a hospital (the name of the hospital is pseudonamed as Hospital X to protect the confidentiality) located in Jakarta City, Indonesia. This study's data sources were obtained through primary and secondary data. Secondary data in this study were obtained from documentation studies owned by the hospital. A documentation study was used to support primary data obtained through interviews and observations. The secondary data source was a logbook recording the amount of medical waste. In addition, a literature review was also carried out to see the ideal conditions and comparison with other cases. The processing method used in this research was the one-way ANOVA method. After the one-way ANOVA test, a Linear Regression test was conducted to determine the COVD-19 average daily cases level for medical waste generation.

3. RESULTS AND DISCUSSION

3.1. Waste generation

The amount of medical, solid waste generation was recorded from May 2020 to March 2021. Table 1 shows the increase of waste generation. There is also no storage with a room temperature controller. Ideally, the storage of infectious medical waste is a maximum of 2x24 hours and a maximum of 90 days before being destroyed. The transporter carried out transport of waste from the hospital varies from 7 to 12 times. In peak conditions with a high number of COVID-19 cases, the number of vehicles is also higher than usual. Medical waste that is not managed properly can potentially increase the risk of spreading disease, especially during a pandemic outbreak. Careless management will increase the risk of exposure to hazardous

waste for all individuals who work and are active in health care facilities such as patients, medical personnel, administrative and support staff [17].

Table 1. Characteristics of medical waste generation

No	Time	Medical waste generation (kg/month)	Medical waste generation (kg/day)	Medical waste generation (kg/bed.day)	Amount of transportation to waste management facilities
1	May, 20	768	25.6	0.12	7
2	Jun, 20	776	25.9	0.12	9
3	Jul, 20	984	32.8	0.15	4
4	Aug, 20	752	25.1	0.12	2
5	Sep, 20	2157	71.9	0.33	7
6	Oct, 20	4169	139	0.65	9
7	Nov, 20	3798	126.6	0.59	9
8	Dec, 20	3506	116.9	0.54	8
9	Jan, 21	5770	192.3	0.89	12
10	Feb, 21	3139	104.6	0.49	8
11	Mar, 21	3432	114.4	0.53	11

Table 1 shows that the average of waste production is 25 kg/day to 192.3 kg/day. Compared to Seberang Jaya Hospital in Malaysia, medical waste generation is still high at 120 kg/day [18], more than Hospital X, which only has 215 beds. From the maximum amount of waste generated, the average daily generation per bed is 0.9 kg/bed, and this result follows previous research in Wuhan, China, with an average daily generation of 0.6-2.5 kg/bed [19]. UNEP has collected data on the amount of medical waste generated around the world during this pandemic, which was 0.5 kg/bed/day [20]. The full comparison of medical waste generation showed in Table 2. Medical waste contains many viruses and diseases, so the current processing is destruction in the incinerator machine. From several comparisons in several locations, the COVID-19 pandemic has significantly affected the amount of medical, solid waste produced.

Table 2. Comparison of medical waste generation at study sites and other locations

Hospital	Medical waste generation (kg/bed.day)	Treatment and waste generation	Source
X Hospital, East Jakarta, Indonesia	0.9	The daily average amount of waste generated is 192.3 kg/day with 215 beds processed by third parties	This Study
Seberang Jaya Hospital, Malaysia	0.4	The COVID-19 outbreak produces medical waste of 120 kg/day.	[18]
Wuhan, China	2.5	To serve COVID-19 patients, the average waste generated is in the range of 0.6 to 2.5 kg/bed/day with 314 beds.	[19]
India	7.76	Before pandemic the rate of waste generation is 1.93 kg/bed/day; currently waste generated is 7.76 kg/ bed/day	[21]
Tepi General Hospital, Ethiopia	1.88	Waste generation during COVID-19 is 179,762.5 kg/year processed by incineration	[22]
Ghana	0.95	33% used the uncontrolled combustion process of open burning and dumping	[23]
Worldwide	0.5	The average generation of waste generated from hospitals worldwide is 0.5 kg/bed/day	[20]

Test data in One-Way ANOVA must follow a normal distribution and come from similar groups. Table 3 presents the data from the One-Way ANOVA test with a significant value less than 0.05. This indicates a significant difference in the average value of the number of infected residents in the generation of medical waste

Table 3. One-way ANOVA test results from COVID-19 average daily cases on medical waste generation

	Sum of squares	df	Mean square	F	Sig.
Between Groups	24275.55	3	8091.85	7.542	0.013
Within Groups	7509.877	7	1072.84		
Total	31785.43	10			

In addition, the average daily number of COVID-19 cases is also positively correlated with medical waste generation. In addition, the Multiple Linear Regression tests as shown in Figure 1 with a significant value less than 0.05. The statemente statemente statemente statement also supports this also supports this also

supports this also supports this that the handling of COVID-19 patients requires more medical equipment such as masks, glasses, protective clothing and so on. This factor is predicted to increase medical waste's generation significantly, sobetter management of hazardous waste management is needed to prevent re-infection from hazardous medical waste produced by health care facilities [24]. The COVID-19 pandemic brought an increased flow of patients to hospitals, leading to a high amount of waste generated; therefore, proper waste management practices [22]. Waste processing from the cradle to the grave needs to be appropriately done considering the impact on the environment may be leaking. The use of open dumping for end-of-life waste needs to be suspended [25] so there is no wider spread of the virus. Medical waste thermal processing and disinfection processes are very important for the conditions of the COVID-19 pandemic.

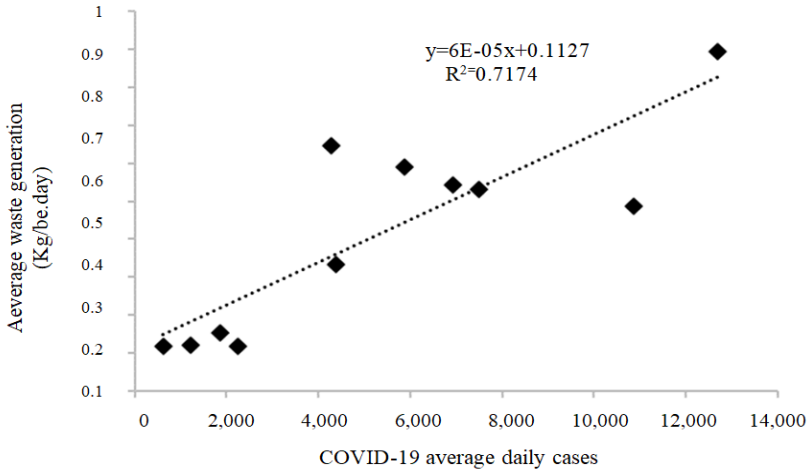

Figure 1. Correlation of COVD-19 average daily cases on medical waste generation

3.2. Medical waste composition

The composition of solid waste generation of hazardous and toxic materials in Hospital X that is sent to third parties has changed, especially the composition of infectious medical waste during the pandemic period, as shown in Table 4. The percentage of solid medical waste generation in Hospital X is assumed to have uniformity with the research in one of the houses. COVID-19 referral hospital in Surabaya with the same number of beds, as many as 200 units, and carried out during the COVID-19 period. From this study, it was quoted that the percentage of solid medical waste generation at home in hospitals consisted of sharp objects by 6.71%, infectious 88.72%, cytotoxic 0.17%, and pharmaceuticals by 4.4% [26].

The characteristics of medical, solid waste produced before and after the pandemic are sharp objects, body tissues, cytotoxics, chemical waste, and medical waste, as stated in the cooperation agreement between Hospital X and a third-party waste processor. During this pandemic, there were differences in the amount of generation, especially in the characteristics of infectious waste [27]. It is estimated that increasing in infectious waste is up to 30%. The composition of infectious medical, solid waste is experiencing a change in generation trends which include personal protective equipment (hazmat clothes), masks, gloves, medical head protection, used bandages, injection and infusion equipment, as well as eating and drinking utensils for patients exposed to COVID-19 made of plastic and paper and used swabs and rapid test kits. The increased composition mainly came from the isolation rooms of patients exposed to COVID-19.

Table 4. Composition of medical waste before and during the COVID-19 pandemic

Infectious medical waste before the pandemic	Infectious medical waste during a pandemic
Sharp object	Hazmat shirt
Cytotoxic	Mask
Chemical and pharmaceutical waste	Gloves
Infectious waste	Medical headcover
	Used bandage
	Syringes and Infusions
	Eating and drinking utensils for patients exposed to COVID-19
	Used swab and rapid test tools

Pharmaceutical medical waste and chemicals produced at Hospital X do not require alternative processing because they will be returned to the supplier to prevent any use by irresponsible parties. In addition, the return of pharmaceutical and chemical waste is one of the efforts to reduce medical waste. The handling method for the destruction and disposal of pharmaceutical waste can be done by returning it to the drug distributor. Furthermore, to find out the uniformity of the composition of infectious waste that has increased during the pandemic period, comparisons are made with several locations, as shown in Table 5. The coronavirus pandemic has had a tremendous impact on the management of municipal waste, especially medical waste, and has affected the amount and characteristics of waste.

Table 5. Comparison of medical waste composition in several locations

Location	Composition	Source
Indonesia	Waste from health facilities (health care facilities) that handle COVID-19 patients, including used masks, used gloves, used bandages, used tissues, used plastic for drinks and food, used food and beverage paper, used syringes, used infusion sets, protective equipment used self (PPE), patient food leftovers and others.	[28]
King Abdullah University Hospital, Jordan	The compositions produced during March, 2020 include gloves, glasses, face shields, toilet paper, shoes	[29]
Taiwan	Covers, N95 masks, face masks, head protection, PCR test kits and swabs, gowns, PPE	[30]
Tepi General Hospital, Ethiopia	All medical infectious wastes such as sharp materials (syringe, needles, blades, and others), anatomical wastes, used face masks, and paper towels, used batteries, broken thermometers, radioactive waste, and PVC plastic-like IV bags were not separated and disposed of properly in the vicinity, silver and X-ray films from radiotherapy.	[22]

From the composition of the generation, a comparison was made with the condition of the composition of medical, solid waste in other hospitals, as shown in Table 5, to see the uniformity of waste generation produced in Hospital X. When compared with the waste from health facilities produced in Indonesia, the composition of infectious waste during the pandemic can be seen. Has a uniform compositionindicating that the waste generation in Hospital X has a trend that follows the composition of the average generation in Indonesia. Furthermore, when compared with the composition of medical, solid waste generation at King Abdullah University Hospital, Jordan [29], it is known that the generation is in the form of gloves, glasses, face shields, toilet paper, shoe covers, N95 masks, face masks, head protection, polymerase chain reaction (PCR) test kits and swabs, gowns, as well as personal protective equipment from the generation. There is also uniformity in the composition of medical solid waste generation. However, there is more diversity for the composition in that place because the study has sorted out the type of composition so that the resulting generation is more accurate. The composition of the waste produced by hospitals is based on the classification of the type of material, so it is known that these wastes come from polyvinyl chloride, cellulose, polypropylene, and polyester. Increased consumption of plastic from the production of disposable masks and gloves, packaging of health products and also the delivery of goods for health facilities.

Risk control is carried out in health facilities by complying with standard operating procedures (SOP). However, there are still constraints due to the lack of infrastructure and the need to be improved related to storage and treatment of medical waste. Regarding infrastructure capacity, there is a need for a flexible safety factor for every management process, especially for the safety factor. Infrastructure facilities need to be improved with careful planning when facing a pandemic. Officers need to provide complete PPE for officers related to waste treatment, processing, and transportation of medical waste in the form of sharp objects using appropriate protective containers or means by using covers so that they are not scattered. The ramp for medical waste transportation is separated from patients' transport to reduce disease transmission from the environment to the patient.

4. CONCLUSION

The study revealed a correlation between the number of daily cases of COVID-19 and the generation of medical waste. In low case conditions, medical waste generation tends only to reach 0.1-0.2 kg/bed.day, while in peak COVID-19 cases, it can reach 0.9 kg/bed.day. This is estimated from changes in the composition of medical waste and the need for handling COVID-19 patients. Changes in composition occurred from hazmat shirts, masks, gloves, medical head covers, used bandages, syringes, infusions, and eating and drinking utensils for patients exposed to COVID-19. The other waste is used swabs and rapid test tools. Medical waste management planning should be carried out from flexible packaging, storage, transportation, and disposal, especially during a pandemic. During a pandemic, there is a tendency to increase medical waste generation to increase management capacity. So that there is no waste leakage, SOPs are needed regarding infrastructure and officers.

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