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Assessment of Infectious Solid Medical Waste Management Practices at Hospital X Surabaya

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ABSTRACT The hospital played a crucial role in treating health conditions but can negatively impact the environment through generated medical waste. Based on the preliminary survey indicated that the management of infectious solid medical waste at Hospital X Surabaya did not meet requirements for containment, transportation, temporary storage, human resources, and infrastructure. This study aimed to assess the management of infectious solid medical waste at Hospital X in 2024. The method used was descriptive cross-sectional, collecting data through direct observations and interviews with waste management personnel. The data obtained was compared with Minister of Health Regulation Number 2 of 2023. The results indicated that the hospital generated an average of 5.34 kg/day over seven days. The assessment found that containment, transportation, and temporary storage processes did not meet requirements. The assessment of supporting factors for managing infectious solid medical waste including human resources and facilities also did not meet the criteria. The recommendations include ensuring medical waste does not exceed ¾ of its maximum volume and is securely tied, using trolleys for transportation, employing freezers for storage, providing training for personnel on medical waste handling, and ensuring complete PPE procurement for waste management personnel

INDEX TERMS Medical Waste, Infectious Waste Management

I. INTRODUCTION

A hospital is a health care facility where individuals who suffer from a number of disease conditions receive medical care. As a center for health service providers, hospitals play a crucial role by having diverse health resources to support the implementation of health efforts. Although hospitals make a positive contribution to providing much-needed health services for individuals, it needs to be recognized that it also has the potential to have negative impacts on the environment and human health. Therefore, it is necessary to make efforts to manage and minimize these negative impacts, while continuing to improve the quality of health services provided to patients [1].

These negative impacts can arise in the form of medical waste pollution, if medical waste generated from hospital activities is not managed effectively [2]. Medical waste is potential waste that contains hazardous and infectious agents, generally originating from patient care and health examination activities. Minister of Health Regulation Number 2 of 2023 explains that health service facilities are required to manage their waste, especially medical waste. This management includes the stages of sorting, containerization, transportation, temporary storage, and processing. Proper waste management aims to minimize the risk of injury, environmental pollution, and nosocomial diseases [3].

WHO in Seprina et al., (2021) stated that medical waste in developing countries produces an average of 1-3 kg per bed (TT) per day, while in developed countries such as Europe and America, this figure can increase to 5-8 kg per bed per day [4]. Referring to data from the Indonesian Ministry of Health in 2022, of the 13,446 registered health service facilities, 5,224 of which include hospitals and health centers, have implemented medical waste treatment standards. In the same year, around 38.9% of the total health facilities have implemented medical waste management that is in line with the standards enacted. This figure indicates an increase of 26.7% compared to the previous year [5].

Most of the solid waste generated by sanitation facilities between 70% and 90% comes from household waste which includes the category of non-hazardous domestic waste. On the other hand, about 10% to 25% of the solid waste is medical waste that causes harm and is able to form a number of health problems. In Indonesia, it is estimated that hospitals produce around 376 thousand tons of solid medical waste every day [6].

Referring to the study by Ronald et al., (2018) regarding the Management of B3 Solid Medical Waste at Piru Hospital, Seram Regency, Maluku, indicates that there are serious obstacles in the stages of reducing and sorting B3 solid waste. These obstacles arise due to the lack of facilities and infrastructure, as well as limited resource capacity, both in terms of labor and financing. The waste storage stage is not carried out optimally, and waste transportation also faces obstacles. Similarly, the stage of treatment, burial, and landfill of B3 solid medical waste, which is not implemented in accordance with the regulations imposed [7].

A study by Hanako & Trihadiningrum (2021) on the Study of B3 Solid Waste Management at Hospital X Surabaya revealed that infectious waste, sharp objects, and pathological waste were stored at room temperature for 1-2 days at the polling station. After checking, there was a problem that allowed small animals to enter the B3 Waste Landfill due to improper management. On the other hand, the container capacity provided is also insufficient to accommodate all B3 waste effectively. The B3 waste TPS does not have clear SOPs and definite rules, especially in handling emergencies when unwanted things occur. The existence of strong SOPs and adequate places is urgently needed [8].

The Fitrianingsih (2023) study on the Analysis of Solid Medical Waste Management in Hospitals revealed that regarding the solid waste treated, there are findings that indicate that the facilities imposed have not fully complied with the regulations in place. For example, the trolley worn is not equipped with symbol and color differences to distinguish between non-medical and medical waste trolleys. The stages of waste management during transportation still indicate inconsistencies because it is found that waste is scattered due to exceeding the capacity of waste packaging plastic. In addition, waste storage is not appropriate because there is no room temperature determined during storage [9].

Hospital X is a hospital located in the city of Surabaya. The hospital has a capacity of 50 Bed with a Bed Occupancy Ratio (BOR) of 10.13%. The generation of infectious medical waste at Hospital X was recorded at 100 kg in September, 150 kg in October, and 130 kg in November, with an average of 3-5 kg per day. In the management of medical waste at Hospital X, it is carried out by the coordinator of the sanitation installation as a supervisor and the room management officer as the waste manager from the source of the room to transportation to TPS B3. It is known that the preliminary survey in November 2023 at Hospital X indicated that there were problems related to solid waste management that did not meet the requirements.

The problem found was that at the stage of containerizing infectious medical waste exceeded 3/4 of the packaging capacity and was not tied singlely, which resulted in the waste spilling in the TPS B3 area. At the stage of transportation, they do not wear a means of transportation in the form of a trolley, but are directly transported by hand. At the storage stage, infectious medical waste at TPS B3 is not stored in the freezer. Management officers have not all received training related to infectious medical waste management. In addition, the facilities for managing infectious medical waste have not been fulfilled so that officers in managing waste only wear masks and gloves.

Based on the problems described in the background, the researcher is interested in conducting research with the title "Assessment of Infectious Solid Medical Waste Management Practices at Hospital X Surabaya"..

II. METHODS

This study employs an assessment approach to evaluate the management of infectious solid medical waste at Hospital X Surabaya. A cross-sectional design was utilized, allowing for observations at a specific point in time.

Data collection involved direct observations using an observation checklist and interviews with waste management personnel to assess compliance with Minister of Health Regulation Number 2 of 2023. The volume of infectious solid medical waste was measured directly in the field over a period of seven days, using a scale to record measurements in kilograms.

The collected data were analyzed descriptively and evaluated against established regulatory criteria. Results were summarized in tables and discussed in relation to compliance with environmental health standards.

III. RESULT

A. Volume of Infectious Solid Medical Waste Generation at Hospital X Surabaya

The health service facilities at Hospital X Surabaya produce infectious solid medical waste every day. The waste is measured for 7 days based on the source of waste generation. Measurements are carried out to determine the fluctuation in the amount of waste produced. The following are the results of infectious medical waste measurements that have been carried out for 7 days based on the source:

TABLE 1
Results of Measurement of Infectious Solid Medical Waste Generation from the Source Room at Hospital X Surabaya in 2024

Room	Waste Generation Per Day (kg)							Total
	1	2	3	4	5	6	7	
IGD	2,7	2,3	2,5	0	0	0	0	7,5
Inpatient	4,8	3,3	3,5	3,0	2,8	2,6	0	20
Laboratory	2,7	0	2,4	0	0	0	0	5,1
Verlos Kamer	0	0	0	0	0	0	0	0
Surgery	0	0	0	0	0	0	0	0
Outpatient	0	2,5	0	2,3	0	0	0	4,8
Total waste per day (kg)	10,2	8,1	8,4	5,3	2,8	2,6	0	37,4
Average waste per day (kg)								5,34

Based on TABLE 1, the results of the measurement of infectious solid medical waste in six chambers for 7 days indicated that the amount generated was 37.4 kg with an average of 5.34 kg/day. It is known that inpatient rooms produce the most waste with a total of 20 kg per week. Waste was found at least in the verlos kamer and surgery room with

an average of 0 kg per week because there were no medical actions that produced infectious solid waste during the measurement period.

B. Management of Infectious Solid Medical Waste

TABLE 2
Management of Infectious Solid Medical Waste at Hospital X Surabaya in 2024

Variable	Criterion Qualify	Not Eligible
Management Process		
Waste sorting	√	
Waste containers		√
Waste transportation		√
Temporary storage		√
External processing	√	
Supporting Factors		
Human resources		√
Facilities and infrastructure		√

Based on TABLE 2, the criteria for managing infectious solid medical waste at Hospital X Surabaya have mostly not met the requirements. Based on the TABLE 2 there are only two variables that are eligible, namely the sorting stage and the external processing stage. A variable is considered eligible if all points in the criteria are met. On the other hand, if there is only one point that is not met, then the variable is categorized as ineligible

VI. DISCUSSION

A. Generation of Infectious Solid Medical Waste at Hospital X Surabaya

The measurement of infectious medical waste generation at Hospital X Surabaya was carried out for 7 consecutive days with a morning schedule from 05.30 to 06.30. The measurement aims to measure the daily amount of infectious solid waste produced by hospitals. Referring to the measurement findings, the inpatient installation was recorded as the largest producer of infectious medical waste with a daily average of 2.86 kg/day, while the verlos kamer and surgical installation did not produce medical waste during the data collection period, because no medical action was taken. A similar study by Masgode et al., (2023), also found that verlos kamer installations produce little solid waste due to low patient visits during the study period [10]. When compared to the WHO threshold value, Hospital X Surabaya is still below the threshold decided, which does not exceed 1-3 kg/bed/day for the developing country category [11].

Although the waste generation standard is eligible, the paradigm in waste management is to reduce the entry of hazardous substances into the waste management scheme or stream. This aims to save workers and the working environment in hospitals by reducing the risk of exposure to hazardous waste [12]. A similar concept was explained by Osman et al., (2023), waste that is not selected from a producing source can be at risk of becoming a source of infection for waste workers during the sorting period [13]. Thus, the existence of a concept or understanding, for example, is a long-term investment to reduce the risk of hazardous waste to health and the environment.

B. Management of Infectious Solid Medical Waste at Hospital X Surabaya

1. Sorting

Based on the research, the stage of sorting infectious solid waste at Hospital X Surabaya includes eligibility criteria. Each unit in the hospital has provided separate trash cans for medical and non-medical waste that are coated with packaging according to the type of waste. The bin is waterproof, strong, easy to empty and clean, and equipped with a clear lid and label.

Based on Permenkes Number 2 of 2023 concerning Environmental Health, medical waste that falls into the B3 category must be sorted to avoid harm to the environment. Hospital X Surabaya has implemented waste sorting procedures well. The procedure includes the use of stickers to distinguish infectious and non-infectious waste, the use of yellow plastic for infectious medical waste, black plastic for non-infectious waste, and the provision of *safety boxes* for sharp infectious medical waste.

The results of this study are in line with the research of Ramon et al., (2019) which shows that, Mukomuko Regency Hospital at the stage of waste sorting activities starts from the source of waste, namely from each room a garbage bin is provided that distinguishes between medical and non-medical waste which is lined with yellow and black plastic bags and *a safety box* for infectious waste of sharp objects [14].

2. Containers

Based on the results of the research, Hospital X Surabaya at the stage of storage has distinguished between infectious and non-infectious medical waste. The infectious waste container that is worn has characteristics including a lid, made of strong material, anti-rust, waterproof, and easy to clean. Infectious medical waste containers have a biohazard symbol and are equipped with a label describing "infectious waste". The placement of infectious waste containers is placed in hard-to-reach areas so that it does not harm the environment and the potential to mix with domestic waste can be avoided.

However, at the stage of infective solid waste containers at Hospital X Surabaya, the part of the infectious medical waste container coated with yellow packaging was filled with more than 3/4 of its maximum volume and was not tied to form a single braid, so it was declared ineligible. Referring to these findings, the overall stages of infective solid waste containers at Hospital X Surabaya include criteria for not meeting the requirements of the Minister of Health Regulation Number 2 of 2023.

Infectious waste containers based on their type can be categorized into sharp and non-sharp infectious. In sharp infectious waste, the container must meet the requirements, namely rigid, puncture-resistant, leak-proof, and able to be closed. In addition, the container must also be equipped with an airtight seal with a hole that allows the entry of dangerous

goods and must have a biohazard label and be labeled a "sharp object". Meanwhile, non-sharp objects can use waterproof and leak-proof packaging and fill a maximum of 3/4 of the maximum volume. All containers that have an infectious risk must have a biohazard symbol and be labeled specifically [15].

Waste that exceeds 3/4 of the container and is not properly tied can be at risk of being scattered, spilled, or unable to be closed tightly so that it risks contaminating staff or the hospital environment. Based on a study by Büchner et al., (2021), containers that are not tightly closed can be a source of infection. The scattered waste is able to risk spreading pathogens in the air [16]. Therefore, it is recommended that the container is filled not exceeding the packaging capacity and tied firmly to form a single braid so as not to trigger spills.

3. Transport

Based on the results of the research, the stages of transporting infectious medical waste at Hospital X Surabaya do not meet the requirements managed in Permenkes Number 2 of 2023. The transportation stage is carried out by the room manager who has been scheduled, but the transportation of infectious medical waste does not have a special trolley. Permenkes Number 2 of 2023 requires health facilities to wear certain trolleys labeled infectious waste and equipped with biohazard symbol. Exceptions to the use of certain trolleys are only applied to small-scale healthcare facilities that do not allow the use of trolleys, provided that they still ensure the safety of transportation.

The use of certain trolleys aims to prevent infectious medical waste from being scattered during the transportation stage. Scattered waste can result in an increased risk of environmental pollution and the spread of disease, so that it can have a bad impact on health workers in the facility and visitors who come [17]. The stages of transporting Hospital X Surabaya are carried out by the room manager who has been scheduled, but the transportation of infectious medical waste does not have a special trolley. The standard for the use of symbol on trolleys is also recommended by WHO with the aim of avoiding errors in sorting and mixing hazardous waste. Infectious waste must be separated from other hazardous wastes to prevent potentially harmful mixing [11]. Therefore, improvements in the stage of transporting infectious solid medical waste from the space source to the B3 waste TPS must be carried out by providing certain trolleys labeled as infectious waste and equipped with biohazard symbol.

At the stage of transporting infectious solid waste to the B3 waste TPS, officers only wear PPE which includes masks and gloves. This is not in line with the management of Permenkes Number 2 of 2023, that the stages of transportation must be carried out by wearing qualified PPE consisting of helmets, masks, protective glasses, protective clothing, gloves, and boots. The proper use of PPE must be carried out by all medical waste management officers so that when carrying out management, contamination and work accidents in officers are avoided [18]. The person in charge of infectious solid waste management should add PPE facilities so that management officers comply with regulations and ensure their safety.

4. Temporary Storage

Based on the results of the study, the temporary storage of infectious solid medical waste is stored for 14 days before being transported, transportation is carried out by working similarly to PT. Triarta. During this period, infectious waste is not stored in a freezer with a temperature below or similar to 0°C, but is stored at room temperature. This happens because the freezer has been damaged, so that waste that is not sufficiently stored in the storage container is placed on the floor and cleaning cannot be carried out periodically. Referring to Health Regulation Number 2 of 2023, medical waste is recommended to be stored at temperatures below or similar to 0°C if stored for more than 7 days. Therefore, based on this, it is known that the stages of temporary storage of infectious waste at Hospital X Surabaya include the criteria of not meeting the requirements.

Referring to WHO, temporary storage of infectious solid medical waste is not allowed to exceed 24 hours at room temperature for tropical climates [11]. The storage of infectious waste that exceeds the 48 hour period can have a negative impact on the environment around health facilities. These impacts include disturbing aesthetics, the emergence of unpleasant odors, and the potential for pollution of surface water sources. In addition, this condition also allows the growth and development of a number of microorganisms such as bacteria and viruses, as well as disease vectors that are able to transmit infections to visitors who come to the facility, and are able to trigger the accumulation of waste [19]. Hospitals should immediately replace damaged freezer with new ones to ensure the safety of waste in accordance with the specified temperature and storage time.

Cleaning of infectious waste must be done regularly and periodically, if left in a dirty state for too long, the hospital will no longer be a place of health services but can be a source of the spread of disease infections. In medical terms, infections obtained from hospitals are dubbed as nosocomial infections. Nosocomial infections or often dubbed as *hospital-acquired infections* are infections that occur during the stage of receiving health care that did not previously occur when the patient was admitted [20]. Hospitals should make a regular cleaning schedule for B3 waste TPS to minimize the risk of transmission of nosocomial infections.

5. External Processing

In the last stage in the management of infectious medical waste, namely processing. The processing carried out by Hospital X Surabaya is carried out externally because the hospital does not have an incinerator to destroy B3 waste. At this stage, the category of meeting the requirements according to Health Regulation Number 2 of 2023 concerning environmental health is obtained.

The external processing of Hospital X Surabaya works similarly to PT. Triarta as the carrier and PT. Artama as a

processor. The transporter has an official permit from the Ministry of Environment and Forestry, while the processor has an official permit as a B3 waste destruction company. In carrying out transportation and processing, the two agreed to pour a similar work agreement (MOU) in three parts between the carrier, processor, and hospital. The making of the agreement is directed to ensure that B3 waste treatment entities fulfill their obligations in accordance with the agreed stages and regulations, which ultimately aims to ensure that the B3 waste treatment stage takes place safely and efficiently [21].

PT. Triarta distributes infectious medical waste every two weeks. PT. Triarta carries out medical waste weighing by wearing complete PPE before loading waste into transport vehicles. The weighing was carried out to record the amount of waste produced by the hospital, which was then reported to the Surabaya Health Office and Environment Office. PT. Triarta distributes waste from hospitals and sends it to PT. Artama by including manifest evidence. The manifest was filled out by Hospital X Sanitarians through the Siraja application and printed using the Festronik application, containing data on waste scales, transport vehicle numbers, and waste codes. Sanitarians are able to monitor waste shipments through the Festronik application to ensure that the waste has arrived at PT. Artama to be processed or stockpiled.

C. Supporting Factors for the Management of Infectious Solid Medical Waste at Hospital X Surabaya

1. Human Resources

Referring to the findings of the interview, it is known that the human resources for the purpose of infectious solid medical waste management at Hospital X Surabaya are 1 coordinator with D3 environmental health education. The coordinator is assisted by each room manager who includes nurses, midwives, and analysts for the purpose of managing infectious medical waste. The room manager is also tasked with helping sanitarians because there is no *cleaning service* that helps the implementation of waste management.

Regarding roles and responsibilities, the coordinator is responsible for monitoring the implementation of infectious medical waste management and the availability of facilities and infrastructure. The coordinator has fulfilled the competency because he has previously undergone B3 waste handling training and has 2 years of work experience. However, in its implementation, infectious medical waste management officers in each room have not run well. This is because none of the management staff in each room have taken part in the B3 waste management training. So that the assessment of the human resource aspect is included in the criteria of not meeting the requirements because the medical officer who manages the room has not received B3 medical waste management competency training.

Based on a study conducted by Suhermi et al., (2020), it is indicated that hospital medical waste management is very crucial to maintain public health in the hospital environment [22]. Therefore, training for hospital medical waste management staff is urgently needed so that they are able to understand and apply environmental health quality standards properly. Supported by a study by Sari et al., (2018), it is explained that the waste management training factors obtained will affect the knowledge of health workers on this matter, so that the management of solid medical waste is also not optimal [23]. The hospital should hold training for medical waste management staff. Although most workers have a health background, good solid waste management practices will not be achieved without specific training.

2. Facilities and Infrastructure

Based on the results of the study, it is known that the facilities for managing infectious solid medical waste at Hospital X Surabaya include the criteria of not meeting the requirements. Regarding a number of aspects of facilities that meet the standards of the Minister of Health Regulation Number 2 of 2023, including infectious waste containers that are still functioning properly, have lids, are made of strong materials, and are quick to clean. In addition, yellow packaging and safety boxes for each infectious medical waste generating room have been met. The infrastructure for storing infectious solid medical waste has also been equipped with a B3 waste TPS. The placement location is far from the crowd so it is not easy for anyone to reach.

A number of aspects of facilities that do not meet the criteria of Permenkes Number 2 of 2023 are the absence of special trolleys that are worn to distribute waste from the source of the room to the TPS. In addition, there is no complete PPE for officers who distribute waste. The absence of trolleys can cause medical waste to be scattered, so there is a risk of exposure to pathogens into the air or direct contact with the staff and hospital environment that passes. In this case, Hospital X Surabaya has not met the general requirements in the provision of waste management facilities.

Completeness of facilities is a crucial element in reducing the risks posed by infectious medical waste and increasing the effectiveness of waste management. The willingness of hospitals to provide adequate infrastructure for waste management has a significant impact on the waste management practices of cleaners. This facility also plays a crucial role in preventing the spread of nosocomial infections in the hospital environment [24].

Completeness of facilities is a crucial element in reducing the risks posed by infectious medical waste and increasing the effectiveness of waste management. The willingness of hospitals to provide adequate infrastructure for waste management has a significant impact on the waste management practices of cleaners. This facility also plays a crucial role in preventing the spread of nosocomial infections in the hospital environment [24].

As a crucial indicator in the evaluation of hospital service quality, a low rate of nosocomial infection indicates success in infection prevention. Effective infection prevention focuses on protecting patients against infectious diseases as well as complications arising from medical interventions received in hospitals [25]. The risk of spreading infections among health

workers, especially those working in medical waste treatment units, is very high. Therefore, the availability and adequacy of facilities in the unit is crucial to reduce these risks, through proper cleaning, disinfection, and waste treatment practices.

D. Assessment of Overall Practice of Infectious Solid Medical Waste Management at Hospital X Surabaya

Based on the results of the research, it is known that there are two indicators that meet the requirements and five indicators that do not meet the requirements. In waste management, aspects of one and the other are interrelated. Overall, waste management efforts at Hospital X Surabaya still need further improvements. At the sorting stage, the hospital has held a separate disposal for non-medical or medical waste in each unit, complete with labels and packaging that are consistent with the waste type. At the container stage, even though the type of container worn is in line with the standard, there is a discrepancy in the practice of filling packaging that exceeds the capacity and is not properly tied.

The transportation process has not met the requirements because they do not wear special trolleys labeled with biohazard symbol and officers do not use PPE completely. Meanwhile, the temporary storage of infectious medical waste is stored for 14 days before being transported by a third party. However, the waste is not stored in a cooler with a temperature that is consistent with the standard due to freezer damage. The external processing stage is already running well, the hospital works similarly to a third party that has an official permit to distribute and treat infectious solid waste.

For supporting factors, there is a competent coordinator and room manager who helps in waste management. However, the room manager has not received certain training related to B3 waste management. A number of facilities have also met the standards, for example waste containers and the construction of the B3 Waste Landfill. However, there are no special trolleys for transporting medical waste and complete PPE for officers.

Overall, Hospital X Surabaya needs to carry out improvements in terms of housing, transportation, temporary storage, training of human resources for room management and the provision of adequate facilities. In minimizing the risks posed by infectious waste, optimal medical waste management is needed. This management begins by controlling the amount of waste produced, then focusing on the management stages [26].

VII. CONCLUSION

Based on the results of the study on the management of infectious solid medical waste at Hospital X Surabaya, it can be concluded that the volume of infectious solid medical waste generation at Hospital X Surabaya for 7 days is an average of 5.34 kg/day. The management of infectious solid medical waste at Hospital X Surabaya at the stage of sorting and external processing has met the requirements. However, at the stage of containerization, transportation, and temporary storage are not eligible. Supporting factors for the management of infectious solid medical waste at Hospital X Surabaya include human resources and infrastructure facilities that do not meet the requirements. The Assessment of Infectious Solid Medical Waste Management Practices at Hospital X Surabaya indicates that there are still unqualified criteria that include the stages of containerization, transportation, temporary storage, human resources, and facilities and infrastructure. So that overall it can be concluded that the stages of infectious solid medical waste management need further improvement.

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