

## EVALUATION OF SOLID MEDICAL WASTE MANAGEMENT AT PASAMAN BARAT REGIONAL HOSPITAL, INDONESIA: CHALLENGES AND ENVIRONMENTAL IMPACT SOLUTIONS

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**Abstract:** This study aims to assess the current condition of solid medical waste management at Pasaman Barat Regional Hospital, identify the challenges faced in waste management, evaluate the steps already taken by the hospital, and propose more effective solutions. A qualitative descriptive method with a case study approach involved observations, interviews, and document analysis. Notably, the evaluation covered the stages of waste management, including sorting, transportation, storage, and disposal. The results indicate that the management of solid medical waste at Pasaman Barat Regional Hospital remains suboptimal, with several non-compliances with applicable regulations. This includes the Ministry of Health Decree No. 1204/2004 and the Ministry of Environment Regulation No. 56/2015. The main challenges include a shortage of sanitation officers, malfunctioning incinerator facilities, and improper use of Personal Protective Equipment (PPE). Additionally, temporary waste storage facilities are inadequate and waste transportation routes pass through areas frequently used by patients. In conclusion, solid medical waste management at Pasaman Barat Regional Hospital requires improvement in several areas, including proper use of PPE, enhanced storage facilities, and improved waste transportation routes. In line with this, stricter supervision and regulation compliance are essential in improving environmental safety and public health protection.

Keywords: Solid medical waste, waste management, environmental safety, Pasaman Barat Regional Hospital, Personal Protective Equipment (PPE).

### Introduction

Decree of the Minister of Health of the Republic of Indonesia No. 1204/2004 concerning "Hospital Environmental Requirements" stipulates standards for environmental management in hospitals to prevent the transmission of diseases and the pollution of the environment. As a health service centre that addresses various health conditions, hospitals are at high risk of generating medical waste, including hazardous and toxic materials. If not properly managed, this waste can become a major source of environmental pollution, directly impacting public health and environmental quality. From an environmental perspective, improperly managed medical waste can lead to pollution of water, soil, and air. Furthermore, the degradation process of medical waste, particularly waste containing hazardous and toxic materials can

produce toxic chemical compounds that affect the quality of the surrounding environment (Sidiq & Nurkayah, 2023). In addition, medical waste that comes into contact with air or water can spread infectious diseases, posing a high risk to the community living near the hospital.

The Pasaman Barat Regional General Hospital is a type C hospital that provides various medical services to the community in Pasaman Barat Regency, located in Luhak Nan Duo, Koto Baru, Luhak Nan Duo Sub-district (Dauly *et al.*, 2024). This hospital offers a wide range of facilities, including polyclinics, operating rooms, emergency rooms, laboratories, ICUs, and inpatient and outpatient services. According to the 2021 report, the number of inpatient visits reached 13,951 while outpatient visits amounted

to 109,535 (BPS-Statistics, 2024). Due to the high volume of patients, Pasaman Barat Regional Hospital also generates significant medical waste.

The medical waste produced includes sharp objects, infectious, body tissue, chemical, and pharmaceutical waste. In particular, Pasaman Barat Regional Hospital generates 30 kg to 40 kg of solid medical waste daily (Pitri, 2019; Kurnia & Zulhelmi, 2024). Accordingly, medical waste management at this hospital involves sorting, transportation, and disposal. However, various challenges arise during implementation that can increase the risk of environmental pollution (Arlym *et al.*, 2019; Marni *et al.*, 2023). One of the main issues is the inefficient medical waste sorting process. Consequently, Dewata *et al.* (2023) added that medical and non-medical waste are often mixed, which increases the risk of disease transmission and exacerbates environmental pollution.

One of the main challenges in medical waste management at Pasaman Barat Regional Hospital is the shortage of sanitarian officers. These officers play a crucial role in medical waste management, overseeing tasks ranging from supervising the sorting process to ensure proper final disposal (Kuswantari *et al.*, 2019). Without qualified sanitarian officers, the hospital is unable to meet the standards outlined in the Decree of the Minister of Health No. 1204/2004.

Additionally, the medical waste disposal facilities at Pasaman Barat Regional Hospital such as the incinerator are damaged and lack an operational permit. Consequently, the hospital cannot dispose of its medical waste independently and must depend on a third party for the waste disposal process. Medical waste is transported by a third party every two months, requiring it to be stored on-site during that period. This situation is further aggravated by inadequate medical waste storage facilities. As such, the temporary storage area for medical waste at the hospital still has a dirt floor and some waste is not properly sealed in yellow plastic bags, as prescribed by medical waste management protocols.

This problem has the potential to significantly increase the risk of disease transmission, especially as wild animals can enter the storage area and carry waste out. For example, stray dogs or cats are often observed scavenging in the vicinity of the temporary medical waste storage area. These animals can come into direct contact with hazardous medical waste such as used needles or contaminated gauze and potentially spread pathogens to humans through bites, scratches, or indirect contact.

Additionally, in rainy seasons, the dirt floor of the storage area becomes muddy and facilitates the leaching of contaminants into nearby water sources, increasing the likelihood of waterborne diseases in the local community. This poses a serious health risk to the community, particularly those near the hospital. Moreover, the hospital's proximity to residential areas heightens the urgency for proper medical waste management, as pollutants can easily infiltrate groundwater sources, impact air quality, and indirectly harm local biodiversity. From an environmental standpoint, the poor management of medical waste at Pasaman Barat Regional Hospital requires comprehensive solutions to minimise the negative impacts on the environment and public health.

Several solutions can be implemented to address this issue, including: (1) Strengthening the role of sanitarians: Pasaman Barat Regional Hospital needs to urgently fill the vacant sanitarian positions to ensure that medical waste management, from sorting to disposal, complies with established standards. In addition, sanitarians play a key role in supervising the separation of medical and non-medical waste, managing storage areas, and coordinating with third parties (Gohr, 1960). (2) Improving temporary waste storage facilities: The hospital's temporary medical waste storage facilities must be improved by ensuring the floor is suitable and the storage area is secure from wild animals. In accordance with this, waste must also be properly sealed and stored according to the required procedures (Taslimi *et al.*, 2020). (3) Repairing

the incinerator: The damaged incinerator should be repaired promptly to ensure that Pasaman Barat Regional Hospital can independently oversee waste disposal, reducing its reliance on third parties and preventing the accumulation of waste (Chiang & Lee, 2022; Yulius *et al.*, 2023). (4) Enhancing cooperation with third parties: Pasaman Barat Regional Hospital must review its current waste transportation schedule every two months. This includes increasing the frequency of waste transportation or finding partners who can provide more timely services, which is essential (Johnson, 2014).

This study aims to assess the current condition of solid medical waste management at Pasaman Barat Regional Hospital, identify the challenges faced in waste management, evaluate the steps already taken by the hospital, and propose more effective solutions. Notably, the novelty of this study lies in its in-depth analysis of the medical waste management issues at Pasaman Barat Regional Hospital, particularly regarding its impact on the environment and public health. Additionally, this study offers specific solutions tailored to the context of hospitals in rural areas, which often face limitations in facilities and resources for managing medical waste.

## Methods

Solid medical waste management is critical in protecting public health and the environment, especially in healthcare facilities like hospitals. Minister of Health Decree No. 1204/2004 and Government Regulation No. 101/2014 establish standards for medical waste management to prevent environmental pollution and disease transmission. As such, Pasaman Barat Regional General Hospital, as a type C hospital, faces substantial challenges in managing medical waste, including a shortage of sanitarian officers and damaged waste disposal facilities.

### *Design, Population, and Sample*

This study employs a qualitative descriptive design with a case study approach. Through this approach, researchers can explore in-

depth various aspects of solid medical waste management, from sorting, transportation, and storage to disposal and evaluate the challenges encountered in its implementation (Sawalem & Herbell, 2009; Manga *et al.*, 2011; Nyampundu *et al.*, 2020). The observation process was conducted over two months (April-May 2024), with detailed daily observations to monitor waste management activities in key service units, including emergency, inpatient, outpatient, and surgical departments. Each unit was observed for a minimum of four hours each day to ensure comprehensive data collection. Meanwhile, data were collected through observations, interviews, and documentation studies.

The population in this study consisted of all officers involved in solid medical waste management at Pasaman Barat Regional Hospital, which included: (1) Health workers (doctors, nurses, and medical student interns) in various service units. (2) Cleaning service staff responsible for collecting and transporting waste. (3) Medical waste management officers in charge of overseeing the waste disposal process. The interviews were conducted over three weeks, each lasting approximately 45 minutes to 60 minutes. They covered questions with regard to the policy implementation, technical challenges, and personal experiences related to waste management. Building on this, purposive sampling was used to select participants relevant to the study (Regassa *et al.*, 2011; Shabani *et al.*, 2024; Yanti *et al.*, 2024; Asman *et al.*, 2024). Specifically, the sample included 10 health workers from the medical service unit, five cleaning service officers, and three waste management officers.

### *Instruments*

The instruments utilised in this study include: (1) Observation guidelines used to directly record the process of solid medical waste management, including sorting, transportation, storage, and disposal. The observations were structured to capture both compliances with regulations and deviations in daily practices, noting specific times and locations for waste handling activities. (2) Interview guidelines consisting of 29

questions (Table 1) that cover key aspects of solid medical waste management such as policies, facilities, training, use of Personal Protective Equipment (PPE), and adherence to waste management standards. The semi-structured interviews allowed participants to elaborate on issues beyond the prepared questions, ensuring a richer understanding of the practices and challenges faced. (3) Documentation consisting

of data from internal hospital records, including reports on the amount of waste generated, the use of PPE, and established waste management procedures. This included reviewing monthly waste generation reports, incident logs related to waste management, and training attendance records from 2022 to 2024. Additional details can be referred to in Table 1, which provides the question guide.

Table 1: Interview guide for solid medical waste management

No.	Interview Guide Questions
1	Are there policies that underlie the management of solid medical waste at Pasaman Barat Regional Hospital? If so, please specify.
2	What facilities and equipment does the hospital provide to facilitate the solid medical waste transportation process?
3	Do the various facilities and equipment provided function properly?
4	Has the equipment provided been sufficient to meet the hospital's needs?
5	Has any training been provided on solid medical waste management for the waste management staff at Pasaman Barat Regional Hospital? If so, how was the training conducted and what challenges did you encounter?
6	How many workers are involved in the waste transportation process at Pasaman Barat Regional Hospital?
7	Is there a designated solid medical waste collection point at the hospital? If so, how many collection points are there?
8	What method is applied for transporting solid medical waste at the hospital?
9	Who is responsible for sorting or separating solid medical waste by type and nature before disposal?
10	Are the trash bins lined with different coloured bags based on the type of waste?
11	How many solid medical waste trolleys are available at the hospital?
12	How many of these solid medical waste trolleys are currently operational?
13	Are the used medical waste trolleys cleaned or washed? What type of cleaning solution is used (e.g., disinfectant such as chlorine, formaldehyde, phenolics, or acids)?
14	Are the trolleys used for transporting solid medical waste and non-medical waste kept separate?
15	Are there designated routes for transporting solid medical waste trolleys? If so, why were these routes selected and do staff adhere to the designated routes?
16	How often is solid medical waste collected from the hospital each day?
17	What is the schedule for solid medical waste transportation?
18	Have there ever been delays in collecting solid medical waste? If so, how was the situation resolved?
19	Does the equipment used for solid medical waste transportation meet the required standards (leak-proof, puncture-resistant, and secure)?
20	How is solid medical waste processed at Pasaman Barat Regional Hospital and how frequently is the waste processed each day?

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21	Have you conducted any training or socialisation on the correct use of PPE for the waste management staff at Pasaman Barat Regional Hospital?
22	Do the waste management staff use PPE properly? If so, what PPE is typically used?
23	In your opinion, is the PPE complete and following regulations? Have you ever observed staff not wearing PPE during monitoring?
24	Has there been any socialisation or explanation about the importance of using PPE correctly at Pasaman Barat Regional Hospital? What is your opinion of this initiative?
25	Have you provided socialisation or explanations on Occupational Health and Safety (OHS) to the waste management staff at Pasaman Barat Regional Hospital?
26	Has there been any socialisation or explanation regarding OHS? If so, how was it conducted?
27	Have you attended any training on the technical aspects of hospital waste management? If so, how was the training conducted and were there any challenges in understanding it?
28	In your opinion, has the management of solid medical waste at Pasaman Barat Regional Hospital been carried out properly? If so, how and if not, why? What challenges were encountered?
29	In your opinion, has the management of solid medical waste at Pasaman Barat Regional Hospital been executed effectively? If not, what challenges were encountered?

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This study also considers 12 criteria waste, as detailed in Table 2. These criteria were outlined in Government Regulation No. 10/2014 and the Regulation of the Minister of Environment and Forestry No. 56 of 2015 to evaluate the management of hazardous and toxic waste, as detailed in Table 2. These criteria were analysed using a content analysis approach, where predefined codes were derived directly from the regulatory documents. Additionally, the reliability of this analysis was ensured

Table 2: Criteria for managing hazardous and toxic waste

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<b>No.</b>	<b>Criteria for B3 Waste Management</b>
1	B3 waste storage areas must be located in flood-free and disaster-safe zones.
2	The floor must be impermeable, made of concrete or cement, equipped with proper drainage, and easy to clean and disinfect.
3	There should be a readily available water source or tap for cleaning purposes.
4	The storage location should be easily accessible for storing waste.
5	It must be situated far from food storage or preparation areas.
6	Cleaning tools, protective gear, and waste containers or bags should be placed as close as possible to the waste storage area.
7	The area must be easily accessible for vehicles transporting or collecting waste.
8	Emergency equipment should be available on-site.
9	B3 waste containers should securely hold waste according to its type, be lockable to prevent leaks, have strong lids to avoid spills, and be in good condition (not leaking, rusty, or damaged).
10	B3 waste containers must be labelled and marked with relevant symbols, including (a) B3 waste name, (b) the producer's identity, (c) the date the waste was generated, and (d) the date of waste packaging.
11	Transporting B3 waste in Category 1 must use fully enclosed vehicles.
12	Transporting B3 waste in Category 2 can use open vehicles, provided they have: (a) A transportation recommendation from the Ministry of Environment and Forestry, (b) a permit for B3 waste management and transportation, and (c) a special goods transportation permit from the Directorate General of Land Transportation, Ministry of Transportation.

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through an independent review by two experts in hazardous waste management to validate the categorisation and ensure consistency in interpreting the criteria.

### **Data Analysis**

Data collected through observations, interviews, and documentation were analysed using qualitative descriptive analysis methods, which include: (1) Grouping data according to themes such as sorting, transportation, storage, and disposal of medical waste. (2) Comparing waste management practices at Pasaman Barat Regional Hospital with the standards outlined in relevant regulations. (3) Evaluating the effectiveness of solid medical waste management based on information obtained from interviews and observations and identifying the challenges encountered during implementation. Concurrently, recurring patterns in interview responses were analysed to identify systemic issues such as insufficient training or lack of compliance with waste segregation protocols.

### **Results**

#### ***Existing Condition of Solid Medical Waste Management***

Pasaman Barat Regional Hospital is situated in Luhak Nan Duo, Koto Baru, Luhak Nan Duo sub-district. The hospital was founded in April 2005 (Figure 1), initially utilising the Jambak Health Centre building, which had a capacity

of 30 beds. On October 5, 2006, Pasaman Barat Regional Hospital was granted a trial permit to operate as a class D hospital by the West Sumatra Provincial Health Office (Pitri, 2019).

At present, Pasaman Barat Regional Hospital is classified as a class C hospital, as established by Regional Regulation No. 6/2005, which was enacted on April 1, 2005. It functions as a Regional Technical Institution (RTI), operating as a Regional Work Unit (RWU), and reporting directly to the Regional Head (Bupati) through the Regional Secretary (Sekda). The hospital's classification as a class C facility was officially recognised by the Indonesian Ministry of Health through Decree No. 1070/Menkes/SK/XI/2008 on November 18, 2008 and it was assigned the Hospital Code Number 1312024 on December 16, 2009. On October 14, 2011, the hospital achieved accreditation for five comprehensive services. This was followed by an evaluation using the 2012 accreditation standards, culminating in successful accreditation on December 5, 2017. Accordingly, Pasaman Barat Regional Hospital provides a range of health services.

#### ***Characteristics of Waste, Types of Waste, and Solid Medical Waste Processing***

Solid medical waste at Pasaman Barat Regional Hospital is generated from various medical services, especially those involving disposable medical materials and the outcomes of treatments or surgical procedures. This waste



Figure 1: Physical condition of the Pasaman Barat regional hospital building

includes materials contaminated with blood, body fluids, and other infectious substances. The sources of solid medical waste at Pasaman Barat Regional Hospital are divided into several medical service units, including: (1) Outpatient/ Polyclinic Services: This includes specialties such as Surgery, Orthopaedics, Obstetrics and Gynaecology (OB/GYN), Paediatrics, Neurology, Cardiology, Ophthalmology, and Ear, Nose, and Throat (ENT), to name a few. (2) Inpatient Services: Comprising various treatment rooms and other hospital facilities. (3) Emergency Units: The Delivery Room, Neonatal Intensive Care Unit (NICU), High Care Unit (HCU), Emergency Room (IGD), HCU, and Operating Rooms. (4) Medical Support Units: Comprising the Laboratory, Pharmacy, Radiology, Dental and Oral Care, and Blood Transfusion Unit.

Based on observations and interviews, Pasaman Barat Regional Hospital generates medical and non-medical waste during its healthcare activities. The types of solid medical waste produced include syringes with needles, disposable gloves, masks, infusion bottles, scalpels, surgical threads, contaminated bandages, gauze, alcohol swabs, blood bags,

infusion tubes, catheters, urine bags, medicine bottles, body tissues, body fluids, and used blood-stained bandages. These wastes are produced daily and require proper management to prevent negative impacts on the environment and public health by applicable regulations.

Pasaman Barat Regional Hospital uses an incinerator as the primary method for thermally destroying solid medical waste. The incinerator has a capacity of 50 kg/hour and the process operates at a temperature of 1,000°C to ensure optimal combustion. Accordingly, the incineration of solid medical waste is conducted for approximately five hours each day, depending on the amount of waste generated by various health service units in the hospital. Meanwhile, solid medical waste burned using the incinerator is categorised into two types, namely: (1) Solid medical waste (Such as bandages, gauze, and other contaminated materials) and (2) sharps waste (Such as syringes, scalpels, and other sharp objects). The following is a summary table of the quantity of solid medical waste, the volume of sharp objects, and the residual ash produced by the incinerator, as summarised in Table 3 and Figure 2.

Table 3: Recapitulation of the amount of solid medical waste, sharp medical waste, and incinerator residue 2023

No.	Month	Solid Medical Waste (kg)	Sharp Medical Waste (kg)	Incineration Residue (kg)
1	January	930	31	699
2	February	840	32	606
3	March	930	35	705
4	April	900	34	741
5	May	930	33	739
6	June	900	31	687
7	July	930	34	838
8	August	930	36	880
9	September	900	30	877
10	October	930	32	902
11	November	900	33	892
12	December	930	35	1.2
<b>TOTAL</b>		<b>10,950</b>	<b>396</b>	<b>8,567.2</b>

Source: IPSL Documentation of Pasaman Barat Regional Hospital (2023)

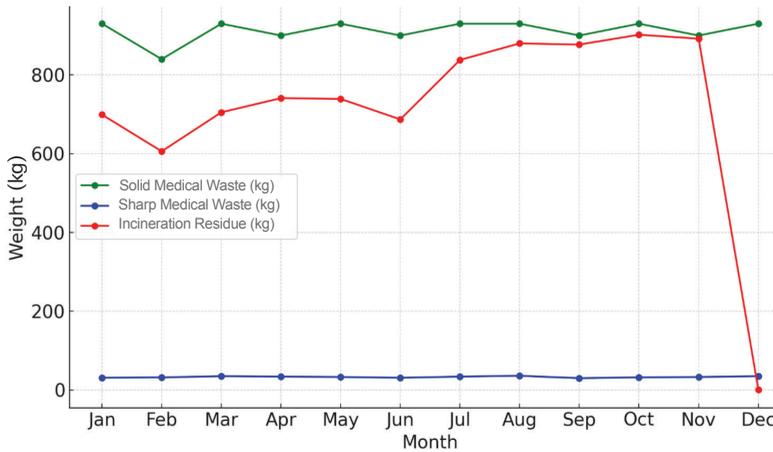


Figure 2: Graph of the amount of solid medical waste, sharp medical waste, and incinerator residue at Pasaman Barat Regional Hospital in 2023

Based on the data recap of solid medical waste generated by Pasaman Barat Regional Hospital from January to December 2023, the highest amount was recorded in December, totalling 930 kg. This increase was due to the accumulation of waste caused by the suspension of incineration processes between September and November while the incinerator was under repair. Factors influencing medical waste generation include the level of medical services, the average daily number of patient visits, the type of diseases treated, and the number of inpatient cases at the hospital. Conversely, the largest amount of sharp medical waste was recorded in August, totalling 36 kg. Additionally, the highest incineration residue for both solid medical waste and sharp medical waste was observed in December, amounting to 1.2 kg, due to the significant volume of waste incinerated that month.

The incineration of solid medical waste produces residue (fly ash), which is classified as Category 2 hazardous waste and must be handled with care to prevent environmental contamination. According to interviews and documentation studies, the fly ash is managed externally, away from healthcare facilities. Pasaman Barat Regional Hospital collaborates with PT Wastec International and PT Biuteknika Bina Prima, companies specialising in hazardous

waste transportation services, to safely transport fly ash to certified hazardous waste processing facilities.

**Evaluation of Solid Medical Waste Management**

The PPE refers to protective clothing used by all personnel involved in the medical waste management process in healthcare facilities. Based on field observations, medical waste transport officers and cleaning service staff conduct solid medical waste management at Pasaman Barat Regional Hospital. The complete list of PPE used by these officers is presented in Table 4.

Medical waste management officers and cleaning service personnel at Pasaman Barat Regional Hospital are still frequently observed not using complete PPE while handling solid medical waste. The PPE items most often neglected by medical waste management officers include helmets or hats and eye protection. Similarly, cleaning service staff commonly omit safety shoes, helmets or hats, and eye protection. This practice does not comply with the regulations outlined in Minister of Environment Regulation No. 56/2015, which mandates using full and appropriate PPE during medical waste management to ensure occupational safety and health.

Table 4: Evaluation of PPE usage in solid medical waste management

No.	Criteria	Medical Waste Management Officer	Cleaning Service	Note from Waste Management Officer	Note from Cleaning Service
1	 Safety helmet	-	-	Not suitable	Not suitable
2	 Face mask	 Face mask	 Face mask	Suitable	Suitable
3	 Eye protection	-	-	Not suitable	Not suitable
4	 Hooded coveralls long sleeve coverall	 Hooded coveralls long sleeve coverall	 Hooded coveralls long sleeve coverall	Suitable	Suitable
5	 Appropriate apron or apron	-	-	Not suitable	Not suitable
6	 Foot protection or safety shoes	 Foot protection or safety shoes	-	Suitable	Not suitable
7	 Gloves	 Gloves	 Gloves	Suitable	Suitable

At Pasaman Barat Regional Hospital, the sorting of solid medical waste is primarily conducted by the nursing staff. While separate trash bins have been provided for different types of waste, non-medical waste is still frequently observed in the designated medical waste bins. This practice does not align with the guidelines outlined in Minister of Environment Regulation No. 56/2015. Additional detailed information on this issue is presented in Table 5.

The sorting of solid medical waste at Pasaman Barat Regional Hospital is performed by the hospital's medical nurses. Although separate trash bins have been provided for solid medical waste, non-medical waste is frequently observed during the sorting process. Note that this practice does not comply with the guidelines outlined in Minister of Environment Regulation No. 56/2015. Additionally, the containers for holding solid medical waste after disposal are not cleaned with disinfectant solutions such as chlorine compounds, formaldehyde, phenolics, or acids.

The collection of solid medical waste at Pasaman Barat Regional General Hospital is

conducted more than twice a day to prevent the accumulation of waste at the source. This practice complies with the guidelines outlined in Minister of Environment Regulation No. 56/2015, which mandates the regular collection of solid medical waste to minimise the risk of pollution and maintain facility cleanliness. Further details are provided in Table 6.

Medical waste storage is conducted at a designated collection point, a room specifically constructed as a Temporary Storage Place (TSP) for solid medical waste. In essence, proper waste storage in this area is essential to prevent mixing medical and non-medical waste and minimise the risk of infection and contamination.

Note that the medical waste storage process is conducted at the collection point, a room specifically constructed as the TSP for solid medical waste. The following is an evaluation of solid medical waste storage based on the criteria outlined in Minister of Environment Regulation No. 56/2015. Further details are provided in Table 7.

Table 5: Results of the evaluation of solid medical waste sorting

No.	Criteria from Minister of Environment Regulation No. 56/2015	Implementation at Pasaman Barat Regional Hospital	Remarks
1	Separate hazardous waste (B3) based on type, group, and/or characteristics.	Medical and non-medical waste are still not fully separated.	Not suitable
2	Provide containers for B3 waste according to its group.	The solid medical waste segregation process has provided three separate containers.	Suitable
3	Containers must be made of strong, lightweight, rustproof, waterproof materials with smooth surfaces.	Waste containers are made of fibreglass and stainless steel and equipped with lids.	Suitable
4	Containers must be labelled and cleaned regularly.	Containers have been labelled according to the waste group and are cleaned regularly.	Suitable
5	Sharp waste should be stored in a special container (safety box) such as bottles or safe cartons.	A 5-litre safety box has been provided for sharp medical waste.	Suitable
6	Infectious and cytotoxic waste containers that do not come into direct contact with waste must be cleaned with a disinfectant solution.	Containers are cleaned with water only, without disinfectant. Used plastic bags are immediately replaced with new ones.	Not suitable

Table 6: Results of the evaluation of solid medical waste collection

No.	Criteria from Minister of Environment Regulation No. 56/2015	Implementation at Pasaman Barat Regional Hospital	Remarks
1	Waste collection for each waste category must begin at the start of each new shift.	The collection is done twice a day following the shift changes of cleaning service staff.	Suitable
2	Waste bags must be securely closed or tied when they are $\frac{3}{4}$ full.	Cleaning service staff tie the solid medical waste bags when they are $\frac{3}{4}$ full.	Suitable

Table 7: Results of the evaluation of solid medical waste storage

No.	Criteria from Minister of Environment Regulation No. 56/2015	Implementation at Pasaman Barat Regional Hospital	Remarks
1	The hospital must have an incinerator on-site and burn waste within 24 hours.	Pasaman Barat Regional Hospital has an incinerator that burns solid medical waste once daily.	Suitable
2	Storage areas must be labelled with symbols.	Among the three collection points, only one has a symbol.	Not suitable
3	The floor must be impermeable, made of concrete or cement, with a good drainage system, and easy to clean and disinfect.	The collection point has a concrete floor but lacks a drainage system.	Not suitable
4	Storage areas must be easily accessible.	The collection point is not separated from the main healthcare facility, making it easily accessible, which is allowed since waste is processed within 48 hours.	Suitable
5	Storage areas must be lockable to prevent unauthorised access.	Some collection points are not locked due to insufficient hospital oversight.	Not suitable
6	Storage areas must be protected from sunlight, rain, strong winds, floods, and other hazards.	Only three rooms meet the criteria while some temporary or emergency collection points do not.	Not suitable
7	The walls, floors, and ceilings of storage areas must be kept clean, including daily floor cleaning.	The collection point is poorly maintained and has been repurposed as a storage area or is not used as intended.	Not suitable

Based on the evaluation in Table 7, several inconsistencies were identified in the storage of solid medical waste at Pasaman Barat Regional Hospital. The collection point lacks adequate symbols and labels, with only one location properly marked. Although the collection point has a concrete floor, it lacks a drainage system. Furthermore, solid medical waste spills are handled using water and floor cleaning fluid, which does not comply with Minister

of Environment Regulation No. 56/2015. Additionally, while the collection point door can be locked, some rooms remain open, allowing unauthorised access. The collection point is also not utilised optimally, indicating that many aspects do not meet the established criteria for a TSP building. Consequently, the lack of proper supervision by the hospital has resulted in the collection point becoming unkempt.

The process of transporting solid medical waste at Pasaman Barat Regional Hospital needs to be evaluated to ensure that all procedures comply with the applicable regulations. The following is an evaluation of the transport of solid medical waste based on the criteria outlined in Minister of Environment Regulation No. 56/2015. Further details can be observed in Table 8.

Based on the evaluation in Table 8, several discrepancies were discovered in transporting solid medical waste at Pasaman Barat Regional

Hospital. In particular, there is no dedicated route for the transportation of solid medical waste, suggesting that the waste is still being transported through the main corridors, posing a health risk. In addition, disinfectant compounds are not used to clean the trolleys for transporting solid medical waste, which does not comply with the regulations outlined in Minister of Environment Regulation No. 56/2015. Therefore, increased supervision and improvements to these procedures are urgently required to ensure safety and health within the hospital environment.

Table 8: Results of the evaluation of solid medical transportation

No.	Criteria from Minister of Environment Regulation No. 56/2015	Implementation at Pasaman Barat Regional Hospital	Remarks
1	Appointment of personnel responsible for each zone or area.	Personnel for all zones have been assigned, with two people in charge.	Suitable
2	Solid medical waste bags must be placed in strong, sealed containers before being transported to the vehicle.	Solid medical waste bags are placed in closed trolleys made of strong, thick fibre material.	Suitable
3	Transport equipment must not have sharp edges that could damage the bags and must be sealed to prevent fluid leakage.	Solid medical waste transport trolleys have curved edges, are tightly sealed, and do not leak or damage the bags.	Suitable
4	Solid medical waste bags must be kept out of reach of humans and animals.	Solid medical waste bags are securely tied before being transported and the transport trolleys are closed.	Suitable
5	Equipment must be labelled and coloured according to the waste category.	Waste transport trolleys are yellow, labelled, and marked with symbols.	Suitable
6	Waste transport routes must be safe for the environment and health and far from activity centres (not passing through patient, nursing, or kitchen areas). Transport is to be carried out when no activities are taking place.	There are no designated routes for solid medical waste transport. The current route still passes through the hospital's main corridor, which is frequently used for hospital activities. Waste transport scheduling has been set, but staff often perform their tasks late.	Not suitable
7	Waste loading and unloading should be easy.	Waste transport trolleys have capacities of 240 litres and 660 litres, making loading and unloading easy.	Suitable
8	After waste transport, the transport equipment must be cleaned using disinfectants such as chlorine compounds, formaldehyde, phenolics, and acids.	Waste transport trolleys are cleaned with water, but no disinfectant is used.	Not suitable

The management of solid medical waste is a crucial step in waste management at Pasaman Barat General Hospital to ensure that the waste is processed safely and in compliance with applicable regulations. This evaluation aims to assess the extent to which the hospital's solid medical waste management practices meet the criteria established in Minister of Environment Regulation No. 56/2015. Further details can be observed in Table 9.

In the final stages of solid medical waste management at Pasaman Barat Regional Hospital, incineration is crucial in significantly reducing waste volume by approximately 80% to 90%. This method is widely employed in healthcare due to its effectiveness in eliminating hazardous organic materials. However, incineration generates byproducts such as fly ash and bottom ash, which are classified as hazardous waste. Pérez-Lucas *et al.* (2024) noted in their study that these byproducts must be carefully managed due to the presence of toxic substances, including heavy metals, chlorines, and dioxins.

Medical Waste Incinerator Fly Ash (MWIFA), which comprises approximately 3% to 5% of the total mass of incinerated waste, poses significant challenges due to its highly toxic nature. Aslam *et al.* (2024) highlighted that fly ash contains harmful elements such as cadmium, lead, and mercury, which can leach into the environment, contaminating

soil and water if not properly managed. At Pasaman Barat, fly ash is managed according to Government Regulation No. 101/2014, which mandates strict control over the transportation and disposal of hazardous waste. The hospital collaborates with certified companies like PT Wastec International and PT Biuteknika Bina Prima to ensure the proper handling of B3 waste.

The incineration process at Pasaman Barat operates at a temperature of 1,000°C, which is within the optimal range of 800°C to 1,200°C, ensuring the thorough destruction of harmful organic compounds, particularly dioxins (Vambol & Vambol, 2024). While proper incineration helps reduce the risks associated with toxic emissions, managing the residue, especially fly ash, remains critical. Techniques such as Solidification/Stabilisation (S/S) are employed to reduce the leaching potential of hazardous substances, transforming fly ash into a more stable and less toxic material before disposal. Moreover, the hospital's partnership with specialised companies, including PT Prasadha Pamunah Limbah Industri, ensures that hazardous waste, including incineration residues is handled by international best practices (Fitriyani *et al.*, 2024; Nada *et al.*, 2024). This collaboration is vital in preventing environmental contamination and ensuring compliance with government regulations. Nonetheless, while incineration effectively manages medical waste, addressing hazardous

Table 9: Results of the evaluation of solid medical waste treatment

No.	Criteria from Minister of Environment Regulation No. 56/2015	Implementation at Pasaman Barat Regional Hospital	Remarks
1	Solid medical waste must not be disposed of directly into final disposal sites or domestic waste facilities before undergoing safe processing.	Solid medical waste is processed by PT Wastec International and PT Biuteknika Bina Prima before reaching the final disposal site.	Suitable
2	B3 waste from healthcare facilities can be treated using thermal or non-thermal methods.	Solid medical waste at Pasaman Barat Regional Hospital is processed thermally using an incinerator.	Suitable
3	Incineration must be conducted at temperatures between 800°C and 1,200°C.	The waste incineration process at Pasaman Barat Regional Hospital is carried out at 1,000°C.	Suitable

byproducts like fly ash is critical. Pasaman Barat Regional Hospital exemplifies a comprehensive approach by adhering to regulations, utilising high-temperature incineration, and partnering with certified waste management companies to ensure safe and compliant disposal.

## Conclusions

Based on the evaluation results, the management of solid medical waste at Pasaman Barat General Hospital remains suboptimal. The hospital generates solid medical waste from various service units, including Outpatient Services, Inpatient Care, the Emergency Unit, and Medical Support Units, with waste quantities varying each month. Meanwhile, the waste management includes sorting, collecting, transporting, storing, and processing. However, several non-compliances with applicable regulations such as Ministry of Health Decree No. 1204/2004 and Ministry of Environment and Forestry Regulation No. 56/2015 were observed.

Correspondingly, most of the solid medical waste at Pasaman Barat General Hospital is incinerated using an incinerator with a capacity of 50 kg/hour. The incineration process is conducted at a temperature of 1,000°C to ensure optimal waste destruction. Nevertheless, the incineration process leaves residues in the form of fly ash, categorised as hazardous waste, which is managed by third-party companies: PT Wastec International and PT Biuteknika Bina Prima. Furthermore, an evaluation of PPE usage revealed that the medical waste handlers and cleaning service personnel often do not wear complete PPE such as helmets and eye protection. However, this practice does not comply with the safety standards outlined in Ministry of Environment and Forestry Regulation No. 56/2015.

The waste management process also demonstrated inconsistencies in waste sorting, with medical and non-medical waste frequently mixed and waste containers not always cleaned

with the proper disinfectant solution. Regarding the collection process, Pasaman Barat General Hospital conducts waste collection more than twice daily, according to the regulations. However, there are deficiencies in storage practices such as collection points that lack symbols and labels, floors without proper drainage, and doors that are often left unlocked. This indicates the need for enhanced supervision to maintain the security and cleanliness of the TSP.

In addition, the transportation of solid medical waste at Pasaman Barat General Hospital also requires improvement. Although waste transport equipment meets the standards, the transportation routes are poorly organised and still pass through areas frequently used by patients and hospital staff. Additionally, the waste transport equipment is not cleaned with disinfectant, increasing the risk of contamination. Overall, the management of solid medical waste at Pasaman Barat General Hospital requires improvements in various aspects, particularly in the use of PPE, waste sorting, storage, and transportation. Nevertheless, enhanced supervision and compliance with government regulations are essential to ensuring safe, efficient, and environmentally friendly waste management.

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## Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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