

Analysis of Solid Medical Waste Management



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Abstract

Background: The management of solid medical waste is a crucial aspect in ensuring the safety of patients, staff, and the public, as well as in preventing environmental pollution. Purpose : This study aims To explore the implementation of temporary storage of solid medical waste at RSI Gunungkidul based on the Ministry of Environment and Forestry Regulation P.56/2015 and the Ministry of Health Decree HK.01.07/2020. **Methods:** The research employed a qualitative approach through in-depth interviews, observations, and document reviews, with informants from hospital management, Infection Prevention and Control Nurses (IPCN), cleaning staff, and healthcare workers. **Results:** The results show that solid medical waste management at RSI Gunungkidul generally complies with regulations, as indicated by the segregation of infectious, non-infectious, and sharp waste, as well as the availability of an adequate hazardous waste temporary storage facility (TPS B3). Supporting factors include the availability of facilities, personal protective equipment (PPE), a routine budget, the active role of IPCN, and collaboration with third parties. Identified obstacles include limited availability of yellow bags, restricted TPS capacity, delays in waste collection, and inconsistent placement of standard operating procedures (SOPs). **Conclusion:** Solid medical waste management at RSI Gunungkidul is running relatively well in accordance with standards, but still requires enhanced operational consistency and technical management for optimal performance.

Keywords: Solid medical waste, Management, Hospital, RSI Gunungkidul

1. Introduction

Hospitals play a central role in improving public health by providing preventive, curative, and rehabilitative services. However, as complex institutions integrating infrastructure, medical technologies, healthcare personnel, patients, and visitors, hospitals also generate substantial amounts of waste that may pose serious environmental and public health risks if not properly managed. Inadequate healthcare waste management can contribute to environmental contamination, occupational exposure, and the transmission of infectious diseases within healthcare settings and surrounding communities (Ministry of Health, 2019).

Healthcare waste consists of medical and non-medical waste in solid, liquid, and gaseous forms. A portion of this waste is classified as hazardous and toxic (B3), including infectious waste, sharps, pathological waste, pharmaceutical waste, chemical waste, and radioactive materials (Prüss & Rushbrook, 2020). Although hazardous medical waste typically accounts for only 10–20% of total healthcare waste, it poses disproportionately high risks due to its infectious, toxic, and injury-causing potential. Improper handling and disposal may result in the transmission of bloodborne pathogens such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) (WHO, 2024).

In Indonesia, medical waste is regulated under Government Regulation No. 22 of 2021 concerning Environmental Protection and Management, which classifies healthcare waste as hazardous and toxic (B3) waste. National data indicate that healthcare facilities generate significant quantities of solid medical waste, averaging 3.2 kg per bed per day. Despite the existence of comprehensive regulations, implementation remains suboptimal, with only a proportion of healthcare facilities meeting the required standards (Ministry of Health, 2022). Persistent challenges include inadequate segregation practices, limited infrastructure, insufficient availability of color-coded containers, lack of certified waste management personnel, and restricted access to licensed treatment facilities. This gap between regulatory requirements and operational practice highlights the need for institutional-level evaluations.

Effective solid medical waste management requires a comprehensive cradle-to-grave approach, encompassing segregation at source, labeling, collection, internal transportation, temporary storage, treatment, and final disposal in accordance with environmental and health standards (Ministry of Health, 2019). Temporary storage facilities (TPS B3) are

particularly critical, as improper storage conditions may increase environmental contamination risks and occupational exposure among waste handlers.

RSI Gunungkidul, a private hospital in Gunungkidul Regency, generated 115.781 kg of solid medical waste in 2023, with the operating room contributing the largest proportion. Although waste segregation, collection, temporary storage, and final disposal through a licensed incinerator have been implemented, preliminary observations indicate several operational limitations, including shortages of yellow waste bags, inconsistent adherence to standard operating procedures (SOPs), and the absence of competency certification among waste handlers. These conditions suggest potential discrepancies between regulatory standards and field implementation.

Therefore, this study aims to analyze the implementation of solid medical waste management—particularly temporary storage practices at RSI Gunungkidul in reference to the Ministry of Environment and Forestry Regulation No. P.56/Menlhk-Setjen/2015 and the Ministry of Health Decree No. HK.01.07/2020, as well as to identify factors influencing compliance with established standards.

2. Materials and Methods

This study employed a descriptive qualitative design to obtain an in-depth and comprehensive understanding of solid medical waste management practices at RSI Gunungkidul. A qualitative approach was selected to explore implementation processes, institutional compliance, and contextual factors influencing waste management practices within the hospital setting. Primary data were collected through direct observation, in-depth interviews, and document review. Observations were conducted using structured observation checklists to systematically assess waste segregation, transportation, temporary storage, and treatment processes. In-depth interviews were guided by semi-structured interview protocols to ensure consistency while allowing flexibility for participants to elaborate on operational practices and challenges. Secondary data, including hospital reports, regulatory documents, and institutional records, were reviewed to complement and validate primary findings.

Participants were selected using purposive sampling based on their roles and involvement in medical waste management. Key informants included the Head of the Sanitation Department, the officer responsible for the Temporary Storage Facility for Hazardous and Toxic Waste (TPS B3), and the Infection Prevention and Control Nurse (IPCN). To enhance data credibility, triangulation informants were recruited from cleaning staff, healthcare workers across multiple units (emergency department, inpatient wards, operating room, laboratory, and pharmacy), as well as hospital management representatives.

The study focused on four main components of solid medical waste management: segregation and containment at the source, internal transportation, temporary storage, and final treatment using an incinerator. Data were analyzed using the interactive model of Miles and Huberman, which involves data reduction, data display, and conclusion drawing with continuous verification. Data validity and trustworthiness were strengthened through source triangulation and methodological triangulation by comparing findings from observations, interviews, and document analysis across different informants.

The study was conducted from August to September 2025 at RSI Gunungkidul. Ethical principles were strictly observed, including voluntary participation, informed consent, anonymity, confidentiality, and respect for participants' rights and dignity. The study also considered potential risks and benefits to ensure compliance with ethical standards in health research.

3. Results

Observation Results

Observations were conducted in various service units including the Emergency Department (ED), laboratory, delivery room, inpatient/nurse stations, pharmacy, and at the B3 Temporary Storage Facility (TPS B3). The purpose of observation was to directly see how segregation, transport, storage, record-keeping, and cooperation with third parties were carried out. The observation results are presented in the table below and further described in narrative form following the table.

Interview Results

Interviews were conducted with eight main informants, including the head of the sanitation/environment department, IPCN, TPS B3 officers, cleaning service staff, and representatives from several service units. The interviews were conducted concurrently with observation so the researchers could obtain a full picture of how solid medical waste management is implemented at RSI Gunungkidul. The interview data were then presented and analyzed to determine compliance with Permen LHK P.56/2015 and KMK HK.01.07/2020. Below are the questions and interview results from informants regarding the implementation of solid medical waste management at RSI Gunungkidu. Results;

a. Compliance with Solid Medical Waste Segregation

Observations across clinical units—including the Emergency Department, laboratory, delivery room, inpatient wards, and pharmacy—indicated that color-coded segregation practices were generally implemented in accordance with national

regulations. Infectious waste was placed in yellow bags, non-medical waste in black or green bags, and sharps in safety boxes. Most units were equipped with appropriate containers and labeling systems.

Interview data confirmed that staff understood segregation protocols. As one emergency nurse stated, “Sharps go directly into safety boxes, and blood-contaminated materials into yellow bags.” Cleaning staff also reported routinely checking segregation accuracy before waste transport.

However, operational inconsistencies were identified. Several informants reported intermittent shortages of yellow bags, leading to temporary use of black bags before re-segregation. Additionally, standard operating procedures (SOPs) were not visibly posted in all units, requiring staff to rely on prior training or supervision from the Infection Prevention and Control Nurse (IPCN). Despite these limitations, overall segregation practices were functionally compliant with Permen LHK P.56/2015 and KMK HK.01.07/2020.

Table 1 Observation Results of Solid Medical Waste Management at RSI Gunungkidul

No	Observation Location	Observed Aspect	Result	Notes
1	ED	Waste segregation	Yes	Yellow bags for infectious waste & safety boxes for sharps are available; stock of yellow bags is sometimes depleted → temporarily use black bags.
2	Laboratory	Containers & labeling	Yes	Bags and containers have labels matching standards; SOPs are not yet posted in the rooms.
3	Delivery Room	Collection & transport	Yes	Waste is tied and transported twice a day using a closed trolley.
4	Inpatient / Nurse Station	Staff PPE	Yes	Gloves and masks are used; face shields are not always complete.
5	Cleaning Service	Documentation & records	Yes	Waste quantity recording is only at TPS, not per unit.
6	IPCN Room	Supporting factors	Yes	There is routine monitoring & training by IPCN.
7	TPS B3	Temporary storage	Yes	TPS is enclosed, has ventilation, safety box racks; the room is somewhat narrow.
8	TPS B3	Cooperation with third parties	Yes	Handover reports exist & manifest is entered into the SIMPEL system.
9	TPS B3	Inhibiting factors	–	Sometimes yellow bag stocks run out; accumulation has occurred causing odor.
10	Pharmacy	Expired drug waste management	Yes	Expired drugs are collected separately; not yet handed over to a third party because the amount is still small.

b. Internal Collection and Transportation

Medical waste was collected at least twice daily using closed trolleys operated by cleaning service personnel equipped with personal protective equipment (PPE). Observations confirmed that waste bags were sealed prior to transport and that trolleys were disinfected after each use.

Staff reported that additional collection rounds were conducted during periods of high waste generation. Minor operational barriers included transportation difficulties during heavy rainfall and occasional temporary waste accumulation. Nevertheless, no evidence of leakage or unsafe handling was observed, indicating adequate compliance with internal transport standards.

c. Temporary Storage Facility (TPS B3)

The B3 Temporary Storage Facility (TPS) was located in a restricted rear area of the hospital. Observational assessment showed that the facility was enclosed, ventilated, equipped with digital weighing scales, safety box racks, and handwashing facilities. Access was limited to authorized personnel. Despite meeting most technical criteria, spatial capacity was limited. Informants reported occasional overcrowding when waste volume increased, resulting in temporary odor issues. Nevertheless, structural and procedural requirements for temporary storage were largely fulfilled.

d. Documentation and Reporting System

Waste quantities were recorded collectively at the TPS using a logbook system and subsequently entered into the national SIMPEL electronic reporting platform. Each transfer to licensed third-party contractors was accompanied by a manifest and signed handover documentation. However, waste generation was not recorded per unit, limiting the hospital’s ability to monitor unit-level waste contributions. While regulatory reporting requirements were met, internal monitoring mechanisms could be further strengthened.

e. Third-Party Cooperation

RSI Gunungkidul collaborates with a licensed hazardous waste management company for off-site treatment and disposal, including incineration ash removal. Documentation procedures were consistent and regularly implemented. Informants emphasized that scheduled collection prevented prolonged accumulation of hazardous waste within the TPS.

f. Supporting and Inhibiting Factors

Key supporting factors included management commitment, budget allocation, availability of PPE and transport equipment, routine IPCN training, and structured collaboration with licensed third parties.

Identified constraints included:

- 1) Intermittent shortages of yellow infectious waste bags
- 2) Limited TPS storage capacity
- 3) Occasional improper sharps disposal
- 4) Absence of visible SOP postings in several units

These barriers were operational rather than systemic and did not indicate structural non-compliance.

g. Pharmaceutical Waste Management

Expired pharmaceutical waste was stored separately in designated containers within the pharmacy unit. Due to low accumulation volume, no third-party transfer had yet occurred. Although segregation principles were applied, a clearer procedural threshold for disposal timing would strengthen regulatory alignment..

4. Discussion

Implementation of Temporary Storage of Solid Medical Waste

The findings indicate that the implementation of temporary storage of solid medical waste at RSI Gunungkidul is largely aligned with national regulatory standards. Segregation practices were consistently applied across service units, with infectious waste placed in yellow bags, non-medical waste in black or green bags, and sharps disposed of in safety boxes. The B3 Temporary Storage Facility (TPS) was equipped with essential infrastructure, including digital weighing scales, safety box racks, ventilation, waterproof flooring, restricted access, and logbook documentation. These structural and procedural components reflect institutional compliance with the technical requirements for hazardous medical waste management.

Nevertheless, the study identified several operational inconsistencies that warrant attention. Intermittent shortages of yellow infectious waste bags resulted in temporary substitution with black plastic bags before re-segregation. Although corrective re-sorting was performed once proper bags became available, this practice introduces potential risks of misclassification and cross-contamination at the source level. The absence of visibly posted Standard Operating Procedures (SOPs) in several units further suggests reliance on informal knowledge transfer rather than system-based standardization. In high-reliability healthcare systems, visual SOP reinforcement is considered essential to minimize procedural deviations, particularly among newly assigned staff.

The limited spatial capacity of the TPS also presents a structural constraint. While the facility meets minimum regulatory requirements, occasional overcrowding during peak waste generation periods increases the risk of odor formation and operational inefficiency. Although no major safety breach was observed, the situation highlights the importance of adaptive capacity planning in waste management systems. Effective temporary storage should not only comply with technical specifications but also accommodate fluctuations in waste volume.

These findings are consistent with prior research indicating that compliance with regulatory frameworks does not automatically guarantee optimal operational performance. Studies on hospital waste management in similar contexts have reported that segregation errors, inconsistent supply logistics, and limited monitoring systems remain common implementation challenges. Therefore, while RSI Gunungkidul demonstrates structural compliance, strengthening process standardization and supply chain management would enhance system resilience.

Supporting and Inhibiting Factors

The effectiveness of solid medical waste management at RSI Gunungkidul is supported by several institutional strengths. Management commitment is evident through routine budget allocation, provision of PPE, availability of closed transport trolleys, and structured collaboration with licensed third-party waste processors. The active role of the Infection Prevention and Control Nurse (IPCN) in supervision and training contributes significantly to maintaining staff awareness and procedural adherence. These elements indicate that managerial governance and human resource engagement are critical determinants of waste management performance.

However, several inhibiting factors persist. Fluctuations in the availability of color-coded waste bags reflect supply chain vulnerabilities that can affect segregation consistency. Temporary accumulation of waste in the TPS during high-volume periods or delayed third-party collection underscores dependency on external transport schedules. Additionally, the absence of unit-

level waste recording limits internal monitoring and performance evaluation. Without granular data, it becomes difficult to identify high-generating units or implement targeted waste reduction strategies.

Occasional improper disposal of sharps into general waste containers further suggests the need for continuous behavioral reinforcement. Although these incidents were not systemic, even isolated lapses in sharps management may pose occupational risks. Therefore, strengthening compliance monitoring and reinforcing safety culture remain essential.

Institutional Response and System Strengthening

The hospital has undertaken corrective measures to address identified operational gaps. Improved coordination with licensed waste transporters aims to ensure timely collection and prevent excessive accumulation at the TPS. Efforts to stabilize the supply of yellow infectious waste bags demonstrate recognition of upstream logistical control as a key component of segregation reliability. In addition, refresher training and supervisory reinforcement have been implemented to reduce improper sharps disposal practices.

Plans to standardize and visibly post SOPs in each service unit represent a shift toward system-based reinforcement rather than reliance on informal guidance. Visual standardization is particularly important in maintaining procedural continuity amid staff turnover or rotation. These corrective measures indicate an institutional commitment not only to regulatory compliance but also to continuous quality improvement.

From a systems perspective, the findings suggest that RSI Gunungkidul has achieved foundational compliance in solid medical waste management, particularly in temporary storage practices. The remaining gaps are operational and managerial rather than structural. Addressing supply stability, expanding TPS capacity planning, enhancing unit-level monitoring, and institutionalizing SOP visibility would further strengthen system robustness and reduce vulnerability to procedural lapses.

The study demonstrates that regulatory alignment is achievable in resource-constrained settings when supported by management commitment, trained personnel, and structured third-party collaboration. However, sustained compliance requires continuous monitoring, adaptive infrastructure planning, and reinforcement of safety culture across all service units..

5. Conclusions

This study demonstrates that the implementation of solid medical waste management—particularly temporary storage practices at RSI Gunungkidul is generally in compliance with the technical and procedural requirements outlined in Minister of Environment and Forestry Regulation No. P.56/2015 and Ministry of Health Decree No. HK.01.07/2020. Segregation at source, internal transportation, temporary storage infrastructure, documentation systems, and collaboration with licensed third parties have been implemented in a structured and systematic manner.

Despite overall compliance, several operational gaps were identified, including intermittent shortages of color-coded infectious waste bags, limited storage capacity at the Temporary Storage Facility (TPS B3), absence of visibly posted SOPs in some service units, and lack of unit-level waste recording. These constraints are primarily technical and managerial rather than structural, but if left unaddressed, they may affect the consistency and sustainability of waste management performance.

The findings highlight the importance of strengthening supply chain stability, enhancing internal monitoring systems, expanding adaptive storage capacity, and institutionalizing visual SOP reinforcement to ensure more uniform implementation across all units. Continuous supervision, routine training, and sustained managerial commitment remain essential to maintaining regulatory compliance and minimizing environmental and occupational risks. RSI Gunungkidul has established a solid foundation for compliant hazardous medical waste management, with opportunities for further system optimization through operational standardization and quality improvement initiatives.

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Conflict of Interest

The authors declare no conflicts of interest.

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