



Evaluation of hazardous waste management at a Type A Psychiatric Hospital in Riau Province, Indonesia

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ABSTRACT

Hazardous and toxic waste management is essential for ensuring safe, effective, and sustainable healthcare services. This study evaluated compliance with hazardous and toxic waste management practices at a Type A Riau Provincial Psychiatric Hospital, Indonesia, based on the Indonesian Ministry of Environment and Forestry Regulation No. 56 of 2015 concerning Procedures and Technical Requirements for Hazardous and Toxic Waste Management from Healthcare Facilities. The evaluation was conducted through field observations using a Likert scale-based checklist. The results showed an overall compliance score of 85.05%, classified as “very good” or “compliant” according to the assessment criteria. However, non-compliance was identified in the segregation and handling of sharps waste due to improper waste mixing. To improve performance, the hospital should strengthen the implementation of standard operating procedures (SOPs) for waste segregation, provide continuous training for healthcare workers and cleaning personnel, implement waste minimization at the source, and enhance coordination with licensed third-party waste management providers. These measures are expected to improve regulatory compliance, reduce occupational health and safety risks, prevent needlestick injuries, minimize exposure to infectious agents and environmental contamination, and ultimately strengthen public health protection within healthcare facilities and surrounding communities.

Keywords: Healthcare Waste, Psychiatric Hospital, Health Workers, Waste Management, Hazardous Waste

1. Introduction

Hospitals play a strategic role in improving public health through disease prevention, treatment, and recovery. Daily hospital activities generate medical and non-medical waste; medical waste is categorised as hazardous and toxic waste under Government Regulation No. 22 of 2021 (Nurbayti et al., 2024; Peraturan Pemerintah No. 22, 2021). and under Government Regulation No. 101 of 2014, solid medical waste is included as Hazardous and toxic waste that can pose risks to health, the work environment, and disease transmission (Peraturan Pemerintah No 101, 2014). Hazardous waste is material or equipment containing hazardous substances that, once disposed of, can threaten humans and the environment (M. Saleh & B. Eskander, 2020). Under Ministerial Regulation No. 56 of 2015, hazardous medical waste includes sharps, infectious, cytotoxic, chemical, pharmaceutical, and radioactive waste, pressurized containers, pathological waste, and heavy metal waste (KLHK, 2015), and can increase morbidity and mortality if mismanaged (M. Saleh & B. Eskander, 2020). Such waste must be sorted, separated, stored, transported, and disposed of safely and in accordance with regulations.

Although Indonesia had 2,877 hospitals in 2019, only 117 held permits for hazardous waste treatment by November 2020 (111 using incinerators, six using autoclaves) (Sriutamiasih et al., 2025), reflecting limited licensed treatment capacity relative to the growing number of healthcare facilities. This regulation–implementation gap is well documented: hazardous waste management at Drs. H. Amri Tambunan Regional Hospital did not fully comply with regulations (Nst et al., 2023), and similar sorting, containment, and storage shortcomings have been reported elsewhere (Ema Syarifah Rochmawati, 2024; Leon Jonas Kamule, Iin Pratama Sari, 2025; Nurul Anjana Nasution, Adinda Putri Chania, 2025), confirming that the problem is systemic across hospital classes. Beyond facilities, HR readiness remains a challenge. Studies at Hospital X, Batam City (Siddik & Wardhani, 2019) and Dr. R. Sosodoro Djatikoesoemo Regional Hospital, Bojonegoro (Abbad & Diyanah, 2022) found officers who had not followed Ministry of Environment and Forestry Regulation No. 56 of 2015, despite an otherwise appropriate waste flow underscoring the need for regular training, not just adequate facilities.

This study was conducted at a Type A public hospital owned by the Riau Provincial Government in Pekanbaru, which provides comprehensive healthcare services. The high intensity of these services generates substantial amounts of infectious hazardous medical waste. Initial observations indicated that hazardous waste management had not fully complied with regulatory requirements, particularly in waste segregation and containerization, where sharps waste was still mixed with non-hazardous and domestic waste. These practices increase the risk of biological exposure, occupational injuries, and environmental contamination, highlighting the need for a systematic evaluation of hazardous waste management.

2. Method

This study used a quantitative descriptive design at the Type A Riau Provincial Psychiatric Hospital from June 16–26, 2025, evaluating solid medical hazardous waste management through direct field observation and documentation review (SOPs, waste recapitulation, manifests, transport agreements/permits). Data were analyzed using a Likert scale against Ministry of Environment and Forestry Regulation No. 56 of 2015, comparing field conditions with regulatory criteria and classifying performance descriptively based on the Conformity Assessment Criteria.

Table 1. Conformity Assessment Criteria

No.	Category	Criteria	Weight of Value
1.	Not yet/Not suitable (NS)	hazardous and toxic waste management has not been carried out in accordance with applicable regulations.	1
2.	Less Suitable (LS)	hazardous and toxic waste management is carried out in accordance with regulations but is not yet optimal/there are still shortcomings.	2
3.	Suitable (S)	hazardous and toxic waste management is carried out in accordance with regulations and consistently.	3

3. Result

3.1. B3 Reduction and Sorting of hazardous and toxic waste

Observations found no specific measures to reduce hazardous waste at the source, likely because the hospital's psychiatric focus generates relatively low waste volumes, making reduction a lower operational priority. For segregation, the hospital provides three container types (infectious, non-infectious, sharps) in each waste-generating room, but a 10 day observation found two forms of mixing:

1. Non-infectious waste (plastic food packaging) is mixed with infectious waste (Figure 1).
2. Sharps waste (syringes) is disposed of with infectious waste, not in a special safety box (Figure 2).



Figure 1. Non-infectious waste mixed with infectious waste



Figure 2. Syringe waste mixed with infectious waste

Based on the assessment using the Likert scale, the level of compliance for the hazardous and toxic waste sorting aspect reached 77.7% (Table 2).

Table 2. Evaluation of Hazardous and Toxic Waste Sorting

No.	Evaluation Aspects	Criteria	Existing Conditions	Suitability			Weight of Value
				NC	PC	C	
1.	hazardous and toxic waste Sorting	a) Waste separation	During 10 days of observation, on June 16 and June 21, plastic food waste (non-infectious) was found mixed with infectious waste in two inpatient wards.		✓		2
		b) Use of hazardous and toxic waste containers	During 10 days of observation, on June 20, syringe waste was found mixed with infectious waste in one of the inpatient wards.		✓		2
		c) Placement of waste containers	Each room at Psychiatric Hospitals equipped with three types of waste containers, namely infectious containers, non-infectious containers, and safety boxes for sharp waste.			✓	3
Percentage of Suitability (%)							77.7%
Note: Non-compliant (NC); Partially compliant (PC); Compliant (C)							

3.2. Storage of Waste hazardous and toxic waste

3.2.1. Hazardous Waste Storage

Observations found residual packaging mixed with infectious waste containers (Figure 3); per Regulation No. 56 of 2015, infectious waste requires yellow containers and packaging waste brown containers. Containers were also found unlabeled (Figure 4) or with damaged, illegible labels (Figure 5). Compliance for the container aspect reached 50% (Table 3).



Figure 3. Residual Packaging Waste Mixed with Infectious Waste



Figure 4. Packaging of Infectious Waste



Figure 5. Hazardous Waste Container

Table 3. Evaluation of Hazardous Waste Containers

No.	Evaluation Aspects	Criteria	Existing Conditions	Suitability			Weight of Value
				NC	PC	C	
1.	Hazardous Waste Container	a) Use of color on packaging	During 10 days of observation, in every room that produced waste packaging, this waste was consistently found mixed with infectious waste and placed in yellow bags.	✓			1

(to be continued)

Table 3. Evaluation of Hazardous Waste Containers (*continued*)

No.	Evaluation Aspects	Criteria	Existing Conditions	Suitability			Weight of Value
				NC	PC	C	
1.	Hazardous Waste Container	b) Use of hazardous and toxic waste symbols and labels	During the 10-day observation period, infectious waste containers were found to comply with regulations, using yellow bags. However, some of the bags lacked the hazardous and toxic waste symbol or label. Furthermore, in one inpatient ward, an infectious waste container was found with a damaged label, making the symbol barely visible.		✓		2
Percentage of Suitability (%)							50%

Note: Non-compliant (NC); Partially compliant (PC); Compliant (C)

3.2.2. Collection of hazardous and toxic waste

Hazardous waste collection occurs twice weekly at 9:00 a.m. WIB without a fixed schedule, short of the required daily/as needed collection, based on low waste generation and operational efficiency considerations. Waste bags are labeled only by source room, not by waste type (infectious, sharps, pharmaceutical, chemical) as required by Regulation No. 56 of 2015



Figure 6. Labeling of hazardous and toxic waste

Waste was also found placed directly into containers without liner bags, and transport routes still passed through high traffic patient, visitor, and staff areas, occasionally crossing food trolley routes. Collection compliance reached 81.5% (Table 4).



Figure 7. Hazardous and Toxic Waste Transport Trolley



Figure 8. APD for Hazardous and Toxic Waste Officers

Table 4. Evaluation of Hazardous and Toxic Waste Collection

No.	Evaluation Aspects	Criteria	Existing Conditions	Suitability			Weight of Value
				NC	PC	C	
1.	Hazardous and Toxic Waste Collection	a) Waste is prevented from accumulating	Waste accumulated for up to three days at each source location.		✓		2
		b) Waste is collected at least daily	Collection occurred once every 3–4 days per room.		✓		2

(to be continued)

Table 4. Evaluation of Hazardous and Toxic Waste Collection (*Continued*)

No.	Evaluation Aspects	Criteria	Existing Conditions	Suitability			Weight of Value
				NC	PC	C	
	c)	Waste is prevented from accumulating	Waste accumulated for up to three days at each source location.		✓		2
	d)	Waste is collected at least daily	Collection occurred once every 3–4 days per room.		✓		2
	e)	Waste bags labeled by Hazardous and Toxic Waste category	Bags were labeled only with the source room; category labeling was not implemented.		✓		2
	f)	Replacing waste bags/containers with new ones	On June 18, 20, and 21, ward receptacles lacked plastic bags, so waste was placed directly into containers without liners.		✓		2
	g)	New Hazardous and Toxic Waste bags/containers are always available	Each waste producing room is provided with new bags/containers			✓	3
	h)	Transport of Hazardous and Toxic Waste using trolleys/wheeled containers	Waste is transported using a 240 liter yellow HDPE trolley (Krisbow) that is durable, non corrosive, and easy to clean.			✓	3
	i)	Hazardous and Toxic Waste Officers are equipped with PPE	Hazardous and Toxic Waste collectors have used appropriate personal protective equipment, including masks, gloves, safety shoes, long sleeved shirts, and aprons.			✓	3
	j)	Safe Hazardous and Toxic Waste transportation routes	Collection routes remained heavily traveled; on June 20 a waste trolley encountered a food trolley.		✓		2
	k)	Collection route from the most distant area	Collection proceeded from the farthest room toward the TPS.			✓	3
Percentage of Suitability (%)							81.5%

Note: Non-compliant (NC); Partially compliant (PC); Compliant (C)

3.2.3. Storage of Hazardous and Toxic Waste

Hazardous waste storage occurs at a Temporary Storage Facility (TPS) with cold storage below 0°C to limit degradation and pollution (Figures 10–11). Under Regulation No. 56 of 2015, storage is limited to 90 days, but the last transport occurred in December 2024, exceeding this limit. The TPS met most technical requirements flood free location, separation from the main building and food storage, protective roof, locking system, waterproof floor, drainage, ventilation, lighting, water supply, and cleaning/PPE availability though the floor was not consistently kept free of waste residue and spills. Storage compliance reached 91.6% (Table 6).

Table 5. Temporary Hazardous Waste Storage Facility (THWSF)

Figure	Information
	Temporary Storage Place for Hazardous and Toxic Waste
	Temporary Storage Building for Hazardous and Toxic Waste
	Cold Storage
	Temporary Storage Facility Floor for Hazardous and Toxic Waste
	Tap water
	Key Access
	Ventilation of Buildings for Temporary Storage of Hazardous and Toxic Waste
	Hygiene Equipment and Protective Clothing

Tabel 6. Evaluation of the Temporary Hazardous Waste Storage Facility

No.	Evaluation Aspects	Criteria	Existing Conditions	Suitability			Weight of Value
				NC	PC	C	
1.	Storage of Hazardous Waste at the Temporary Hazardous Waste Storage Facility	a) Max storage: 90 days at $\leq 0^{\circ}\text{C}$ if generation ≥ 50 kg/day; 180 days if < 50 kg/day.	Manifest records show the last collection was 23 December 2024; waste remained over 180 days, exceeding the permitted limit.	✓			1
		b) Located in a flood free, disaster safe area.	TPS is located in a flood free, disaster safe area.		✓		3
		c) Impermeable floor, adequate drainage, easy to clean/disinfect surfaces.	Floor uses impermeable ceramic tiles with adequate drainage and easily cleaned/disinfected surfaces.		✓		3
		d) Water supply/tap available for cleaning.	Equipped with two water taps for cleaning.		✓		3
		e) Accessible and securely locked against unauthorized access.	Equipped with a secure lock; access restricted to authorized personnel.		✓		3

(to be continued)

Tabel 6. Evaluation of the Temporary Hazardous Waste Storage Facility (*Continued*)

No.	Evaluation Aspects	Criteria	Existing Conditions	Suitability			Weight of Value
				NC	PC	C	
1.	Storage of Hazardous Waste at the Temporary Hazardous Waste Storage Facility	f) Protected from sun, rain, wind, flooding, and other weather hazards.	Protected from sun, rain, wind, flooding, and other weather hazards.			✓	3
		g) Inaccessible to animals, insects, and birds.	Designed to prevent animal, insect, and bird access.			✓	3
		h) The temporary hazardous waste storage facility is equipped with adequate ventilation and lighting.	The temporary hazardous waste storage facility is equipped with adequate ventilation and lighting.			✓	3
		i) The temporary hazardous waste storage facility is located away from food storage areas.	The temporary hazardous waste storage facility is located approximately 300 m from the food storage area.			✓	3
		j) Walls, floor, and ceiling kept clean at all times.	On June 16, plastic beverage waste was found on the floor, indicating inconsistent cleanliness; walls and ceiling remained clean.			✓	3
		k) The walls, floor, and ceiling of the temporary hazardous waste storage facility are maintained in a clean condition at all times.	During the 10 day observation period, plastic beverage waste was observed scattered on the floor of the temporary hazardous waste storage facility on 16 June, indicating that the floor was not consistently maintained in a clean condition. However, the walls and ceiling remained clean throughout the observation period.			✓	2
		l) The temporary hazardous waste storage facility is located separately from the main building.	The temporary hazardous waste storage facility is located approximately 450 m from the main building of Psychiatric Hospital.			✓	3
Percentage of Suitability (%)							91.6%

Note: Non-compliant (NC); Partially compliant (PC); Compliant (C)

3.3. Transportation of Hazardous and Toxic Waste

External transportation, from TPS to a licensed facility, fully complied with PermenLHK No. 56 of 2015. It is carried out by licensed transporter PT. Pratama Saoloan Green to the processing facility of PT. Bekasi Industrial Waste Processing, using closed four wheeled vehicles and manifest documents recording producer

identity, waste category, route, equipment, and manifest code. Transportation compliance reached 100% (Table 7).

Table 7. Evaluation of Hazardous Waste Transportation

No.	Evaluation Aspects	Criteria	Existing Conditions	Suitability			Weight of Value
				NC	PC	C	
1.	Transportation of Hazardous and Toxic Waste	a) Carried out by a licensed carrier	Conducted by licensed transporter PT. Pratama Saoloan Green.			✓	3
		b) Uses a closed 4 wheeled vehicle with symbol and transport permit.	Transportation uses a 4 wheeled vehicle with closed body, symbol, and permit.			✓	3
		c) Equipped with a Hazardous and Toxic Waste manifest	Equipped with a B3 waste manifest document.			✓	3
Percentage of Suitability (%)							100%

Note: Non-compliant (NC); Partially compliant (PC); Compliant (C)

4. Discussion

4.1. Reduction and Sorting of Hazardous and Toxic Waste

The lack of source reduction and continued mixing reflects a gap between SOPs and practice, consistent with Dr. R. Sosodoro Djatikoemo Regional Hospital, Bojonegoro and the Type B Hospital, Riau Province [13], where sorting discipline among nurses, doctors, and assistants remained low. Conversely, Siddik & Wardhani (2019) reported a 93% compliance rate for waste segregation at Hospital X, Batam City (Siddik & Wardhani, 2019), while Danhas (2021) found proper segregation practices at Dr. Reksodiwiryo Padang Army Hospital (Yunhendri Danhas, 2023). These findings indicate that effective waste segregation depends on active staff participation and consistent supervision.

Non compliance in the present study appears to result from limited understanding of waste categories among healthcare workers and inadequate supervision of SOP implementation by hospital management. Mixing sharps with infectious waste violates Regulation No. 56 of 2015, which requires sharps in sealed safety boxes destroyed together with the container to prevent injury (Ciawi et al., 2024; Nurul Anjana Nasution, Adinda Putri Chania, 2025). This practice poses a double risk by increasing the likelihood of physical injuries and transmission of blood borne infections, including Hepatitis B, Hepatitis C, and HIV (Yves Chartier et al., 2014). It also increases hazardous waste volume, management costs, downstream processing complexity, and exposure risks, underscoring the importance of proper waste segregation for infection prevention and public health protection.

4.2. Containerization

The low container compliance (50%) reflects weak risk-identification: unlabeled containers remove staff's early warning, and packaging mixed into infectious containers shows poor initial sorting, though sharps should be in a labeled yellow safety box, destroyable with its contents (KLHK, 2015; Nurul Anjana Nasution, Adinda Putri Chania, 2025; Yunhendri Danhas, 2023; Yves Chartier et al., 2014). This disrupts waste identification, preventing officers from distinguishing waste types, raising cross-contamination risk, forcing entire containers to be treated as hazardous (increasing cost), and reflecting inadequate facility maintenance. Non compliant containerization raises misidentification and exposure risk during collection, transport, and treatment (Windfeld & Brooks, 2015; WHO, 2005, 2014). and forces all mixed waste to be managed as hazardous, increasing treatment volume and cost (Windfeld & Brooks, 2015).

4.3. Hazardous and Toxic Waste Collection

Despite 81.5% collection compliance, twice weekly collection risks disease-vector proliferation, as infectious waste accumulating 3–4 days in a warm room can attract flies, cockroaches, and rats. Missing liners indicate failed barrier protection, forcing manual waste removal from contaminated containers and increasing pathogen exposure, reflecting logistical gaps or post collection negligence.

PPE use reflects the hospital's safety commitment, similar to findings at Hospital X, Malang Regency (Rosyidah et al., 2024). However, transport routes still cross patient and food cart paths, risking contamination of sterile areas or food and potential healthcare associated infections; WHO (2014) stresses that waste routes must be separate from patient, food, and linen routes to prevent cross-contamination (WHO, 2014).

4.4. Storage of Hazardous Waste at the Temporary Hazardous Waste Storage Facility

The temporary hazardous waste storage facility met most technical requirements (91.6% compliance), but the critical finding was over holding hazardous waste stored beyond six months, even under cold storage, breaches the 90 day limit in the Minister of Environment and Forestry Regulation No. P.56/MENLHK-SETJEN/2015. Similarly, Titis Arumsari et al., (2018) found prolonged THWSF a major challenge at Tebet Regional Hospital (Titis Arumsari et al., (2018). The THWSF flood free siting complies with regulatory requirements, consistent with findings at Dr. R. Sosodoro Djatikoesoemo Regional Hospital, Bojonegoro (Abbad & Diyanah, 2022).

4.5. Transportation of Hazardous and Toxic Waste

100% transportation compliance reflects effective collaboration with a licensed partner and complete manifest documentation, demonstrating strong administrative accountability a solid foundation for improving the remaining non compliant aspects: sorting, containerization, and storage duration.

4.6. Public Health and Management Implications

Proper hazardous waste management protects healthcare workers, first exposed during segregation, collection, transport, and storage. Though overall compliance reached 85.05%, segregation, containerization, collection, and storage still need improvement, as deficiencies raise needlestick and infectious exposure risk among workers (Ashenafi Woldemichael Woime, 2026; WHO, 2014). Inadequate management also affects the hospital environment: poor segregation, containerization, prolonged storage, and routes crossing patient/food pathways raise cross contamination and disease transmission risk for workers, patients, and visitors (WHO, 2014), (Arumdani, 2024; Ashenafi Woldemichael Woime, 2026; Ibáñez-Cruz et al., 2025). If unaddressed, these risks may extend to the surrounding community through waste leakage or improper handling, increasing public exposure to infectious hazards (Ashenafi Woldemichael Woime, 2026; Windfeld & Brooks, 2015; WHO, 2014). These findings call for continuous improvement in operations and oversight stronger SOPs, regular training, internal monitoring, and regulatory compliance to reduce occupational and environmental risks while promoting safer, more sustainable healthcare services.

5. Conclusion

Hazardous waste management at a Type A Riau Provincial Psychiatric Hospital, Indonesia generally complied with Regulation No. 56 of 2015, reaching 85.05% overall compliance ("very good"), though sharps segregation needs strengthening. Recommended measures: reinforce SOPs through routine monitoring, continuous staff training, source level waste minimization (e.g., reusable devices where safe), and close coordination with licensed transporters to further improve compliance, occupational safety, and sustainable waste management.

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Bibliography

- Abbad, R. S., & Diyanah, K. C. (2022). Analisis Pengelolaan Limbah Medis B3 Rumah Sakit Umum Daerah Dr. R. Sosodoro Djatikoesoemo Bojonegoro. *Media Gizi Kesmas*, 11(56), 494–499.
- Arumdani, I. S. (2024). Pengelolaan Limbah Medis, Non Medis, dan Benda Tajam di Rumah Sakit Rembang Intan. *Jurnal Penelitian Kesehatan Suara Forikes*, 15(4), 678–682.
- Ashenafi Woldemichael Woime. (2026). Medical waste disposal practices and their health consequences in resource-limited settings: a systematic review and meta-analysis. *Springer Nature Link*, 26. <https://doi.org/10.1186/s12889-026-26722-9>.
- Ciawi, Y., Dwipayanti, N. M. U., & Wouters, A. T. (2024). Pengelolaan Limbah Medis Rumah Sakit yang Berkelanjutan: Eksplorasi Strategi Ekonomis dan Ramah Lingkungan. *Jurnal Ilmu Lingkungan*, 22(2), 365–374. <https://doi.org/10.14710/jil.22.2.365-374>
- Ema Syarifah Rochmawati, D. F. S. H. (2024). Analisis Pengelolaan Limbah Medis Padat di Puskesmas

- Mambi. Analisis Pengelolaan Limbah Medis Padat Di Rumah Sakit Medika Mulia Tuban, 6(1), 401. <https://doi.org/10.35329/jp.v6i1.4731>
- Ibáñez-Cruz, A. J. A., Vergara-Florián, A. M. E., & Algoner, W. C. (2025). Hospital solid waste management strategies to prevent healthcare-associated infections from occupational exposure to bloodborne pathogens and improve occupational safety. *Frontiers in Public Health*, 13(January). <https://doi.org/10.3389/fpubh.2025.1499463>
- Kementerian Lingkungan Hidup dan Kehutanan. (2015). Peraturan menteri Lingkungan Hidup dan Kehutanan Nomor P.56/Menlhk/Setjen/2015 tentang Tata Cara Persyaratan Teknis Pengelolaan Limbah Bahan Berbahaya dan Beracun dari Fasilitas Pelayanan Kesehatan. In *Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia*. <https://peraturan.bpk.go.id/Details/322441/permen-lhk-no-p56menlhk-setjen2015-tahun-2015>
- Leon Jonas Kamule, Iin Pratama Sari, W. M. (2025). Sakit Xyz. Analisis Penyimpanan Limbah Medis Padat Pada Rumah Sakit Xyz, 11(3), 733–739.
- M. Saleh, H., & B. Eskander, S. (2020). Introductory Chapter: Hazardous Wastes. *Assessment and Management of Radioactive and Electronic Wastes*, 1–7. <https://doi.org/10.5772/intechopen.88600>
- Nst, A. S. S., Kusnanto, H., & Darwito. (2023). manajemen pengelolaan limbah B3. *Jurnal Manajemen Pelayanan Kesehatan*, VOLUME 25(04), 137–144.
- Nurbayti, M., Pramadita, S., Govira, D., & Asbanu, C. (2024). Evaluation of Hazardous and Toxic Waste Management at dr. Soedarso Regional General Hospital. *Jurnal Teknologi Lingkungan Lahan Basah*, 12(3), 573–581.
- Nurul Anjana Nasution, Adinda Putri Chania, P. S. K. (2025). Evaluasi Pengelolaan Limbah Bahan Berbahaya & Beracun (Limbah B3) di Rumah Sakit. *Jurnal Serambi Engineering*, X(2), 12794–12801. <https://doi.org/10.52364/sehati.v2i2.26>
- Peraturan Pemerintah No. 22. (2021). Peraturan Pemerintah Nomor 22 Tahun 2021 tentang Pedoman Perlindungan dan Pengelolaan Lingkungan Hidup. In *Sekretariat Negara Republik Indonesia* (Issue 085459). <http://www.jdih.setjen.kemendagri.go.id/>
- Peraturan Pemerintah No 101. (2014). Peraturan Pemerintah Republik Indonesia Nomor 101 Tahun 2014 tentang Pengelolaan Limbah Bahan Berbahaya dan Beracun. In *Sekretariat Negara Republik Indonesia*. <https://peraturan.bpk.go.id/Details/5555/pp-no-101-tahun-2014>
- Rosyidah, A. S., Hapsari, A., Al-irsyad, M., & Kurniawan, A. (2024). Analisis Pengelolaan Limbah Bahan Berbahaya dan Beracun (B3) dengan Karakteristik Infeksius di RS X Kabupaten Malang Provinsi Jawa Timur Tahun 2022. 6(11), 1217–1233. <https://doi.org/10.17977/um062v6i112024p1217-1233>
- Siddik, S. S., & Wardhani, E. (2019). Pengelolaan Limbah B3 Di Rumah Sakit X Kota Batam. *Jurnal Serambi Engineering*, 5(1), 760–767. <https://doi.org/10.32672/jse.v5i1.1602>
- Soil Survey Staff - NRCS/USDA. (2014). Keys to soil taxonomy. *Soil Conservation Service*, 12, 360. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051546.pdf
- Sriutamiasih, N. K., Doda, D. V. D., & Pinontoan, O. R. (2025). Analisis Potensi Bahaya Dengan Metode Hazard Identification and Risk Assessment (Hira) Pada Area Kerja Pengelola Limbah B3 Di Rsu Gmim Pancaran Kasih Manado. *Jurnal Kesehatan Tambusai*, 6(4), 16848–16859. <https://doi.org/10.31004/jkt.v6i4.51611>
- Titis Arumsari, Triana Srisantyorini, E. (2018). Gambaran Umum Pengelolaan Limbah Bahan Berbahaya dan Beracun (B3) di Rumah Sakit Umum Daerah Tebet Tahun 2018. *Environmental Occupational Health and Safety Journal*, 1(1), 101–107.
- Windfeld, E. S., & Brooks, M. S. L. (2015). Medical waste management - A review. *Journal of Environmental Management*, 163, 98–108. <https://doi.org/10.1016/j.jenvman.2015.08.013>
- World Health Organization. (2005). Management of Solid Health-Care Waste at Primary Health-Care Centres A Decision-Making Guide. *WHO Library Cataloguing-in-Publication Data Management*, 54. http://www.who.int/water_sanitation_health/publications/manhccwm.pdf
- World Health Organization. (2014). *Safe management of wastes from health-care activities*, 2nd ed. World Health Organization. <https://www.who.int/publications/i/item/9789241548564>
- Yunhendri Danhas, A. T. P. (2023). Gambaran Pengelolaan Limbah Bahan Berbahaya Dan Beracun (B3) Di Rumah Sakit Tentara Tk Iii Dr. Reksodiwiryo Padang Yunhendri Danhas, Agus Teguh Prihartono. 6(1), 720–725. <http://jurnal.ensiklopediaku.org>
- Yves Chartier, Jorge Emmanuel, Ute Pieper, Annette Pruss, Philip Rushbrook, Ruth Stringer, William Townend, S. W. and R. Z. (2014). Safe management of wastes from healthcare activities. In *Safe management of wastes from healthcare activities* (Second Edi). World Health Organization.