JURNAL KESEHATAN LINGKUNGAN
JURNAL DAN APLIKASI TEKNIK KESEHATAN LINGKUNGAN

ISSN 1829-9407 (Print)
ISSN 2581-0898 (Online)

Volume 23, No. 1, January 2026 ; Page: 167-174; DOI: https://doi.org/10.31964/jkl.v23i1.1113

Original Research

ANALYSIS OF HAZARDOUS AND TOXIC MEDICAL WASTE MANAGEMENT AT HOSPITAL

Candra Ferdian Handriyanto[1], Eska Distia Permatasari[2], Avita Fitri Agustin[3], Salwa Dwi Sabrina[4], Triya Amanda Setiawati[5], Irhamsyah Adji[6], Ahmad Dwi Septian[7]

[1,2,3,4,5,6,7] Occupational Safety and Health Study Program, Faculty of Health Sciences, University of Gresik
Arif Rahman Hakim Street No. 2B, Kramatandap, Gapurosukolilo, Gresik Regency, East Java, Indonesia.
E-mail: eskadistia@gmail.com

Article Info

Article history:

Received January 10, 2026
Revised January 30, 2026
Accepted January 31, 2026

Keywords:

Medical hazardous waste
Hospital
Environmental safety
Hazardous waste management
Occupational health and safety

ABSTRACT

Analysis of Hazardous and Toxic Medical Waste Management at Hospital. *Hospital X in Surabaya generates various types of hazardous and toxic (B3) medical waste that pose potential risks to healthcare workers, patients, the community, and the environment. This study analyzes the B3 medical waste management process, encompassing source segregation, packaging, storage at the temporary hazardous waste storage facility (TPS B3), transportation, and final treatment by licensed third parties. The results indicate that the hospital has implemented waste management practices in accordance with applicable standards and regulations, supported by auxiliary systems such as a 3R temporary storage facility (TPS 3R) for non-B3 waste and a wastewater treatment plant (WWTP) for liquid waste. Nevertheless, enhanced personnel training and strengthened monitoring are still required to ensure more optimal waste management performance.*

INTRODUCTION

Hospitals are healthcare facilities that conduct a wide range of activities on a daily basis, including diagnosis, treatment, medical procedures, laboratory services, and pharmaceutical management. All of these processes generate substantial amounts of waste, including hazardous and toxic waste (Bahan Berbahaya dan Beracun/B3). B3 waste is defined as waste containing substances that are toxic, infectious, flammable, corrosive, reactive, and capable of causing health problems or environmental pollution if not properly managed. The increasing number of patients, advances in medical technology, and the extensive use of chemicals and single-use medical devices have led to a continuous rise in the volume of hospital B3 waste from year to year. Without appropriate management, such waste can result in disease transmission and environmental degradation, affecting water sources, soil, and air surrounding healthcare facilities [(12)].

In addition, government regulations such as Law No. 32 of 2009 on Environmental Protection and Management, Government Regulation No. 22 of 2021, and the Minister of Health Regulation No. 7 of 2019 on Hospital Environmental Health mandate that every hospital implement a safe B3 waste management system, covering segregation, packaging, storage, transportation, and final disposal [(12)(24)]. In response to the growing demand for safe, clean, and environmentally friendly healthcare services, hospitals are required to adopt standardized, well-monitored, and sustainable B3 waste management systems to protect patients, healthcare workers, surrounding communities, and the environment [(9)].

One hospital that demonstrates a commitment to these principles is Hospital X in Surabaya. This hospital was established by Foundation X as a form of concern for community needs for Islamic-based and professional healthcare services. At its inception, the hospital operated as a basic-level healthcare facility. However, as community needs increased, it developed into a hospital providing more comprehensive services, including outpatient care, inpatient care, emergency services, laboratory services, and pharmacy services. This development has made proper and standards-compliant B3 waste management a critical aspect of Hospital X Surabaya's operations in order to maintain the quality of healthcare services in its surrounding area [(26)].

Along with the expansion of services and the increasing complexity of medical activities, Hospital X Surabaya is also required to strengthen its B3 waste management system through the provision of adequate facilities and infrastructure, such as temporary waste storage areas, as well as collaboration with licensed waste treatment companies for final disposal. Strengthening this system must be accompanied by continuous training for all healthcare workers and sanitation personnel to ensure that waste segregation and handling are carried out in accordance with established standard operating procedures. Thus, improvements in human resources capacity and infrastructure completeness will support the implementation of safe, efficient, and sustainable B3 waste management, thereby maintaining healthcare service quality while providing protection for the community and the environment surrounding Hospital X Surabaya.

MATERIALS AND RESEARCH METHODS

This study employed a qualitative descriptive method to clearly describe the B3 medical waste management process at Hospital X in Surabaya. Data were collected through direct observations in waste-generating areas, the temporary hazardous waste storage facility (TPS B3), the 3R temporary storage facility (TPS 3R), and the wastewater treatment plant (WWTP), as well as through interviews with sanitation personnel and occupational safety and health (K3) officers, and documentation in the form of facility photographs and waste records. The outcomes of the activities were assessed using a standard operating procedure (SOP) compliance checklist, facility condition observation sheets, and interview analysis to evaluate personnel understanding of waste management procedures and the use of personal protective equipment (PPE). The level of success was determined based on changes in personnel attitudes and compliance, improvements in clean work culture, and their impacts on environmental conditions and waste management efficiency. This method was applied to assess the extent to which the hospital's B3 waste management system complies with environmental health and safety standards.

RESEARCH RESULTS AND DISCUSSION

The increase in human activities and high-risk industrial operations contributes to environmental degradation and adverse effects on human health, one of which originates from hospital activities as major waste generators. Hospital medical waste is classified as hazardous and toxic waste (Bahan Berbahaya dan Beracun/B3) that requires special handling due to its hazardous characteristics [(14)]. The toxic nature and potential severe impacts of B3 waste necessitate prompt, appropriate, and standardized management. Such management is essential to minimize, limit, and/or prevent negative impacts on human health while preserving air, water, and soil quality. Therefore, hospital B3 waste management must be implemented comprehensively and sustainably as part of health and environmental protection efforts [(16)(20)].

At Hospital X Surabaya, the B3 waste generated includes infectious waste such as syringes, bandages, and contaminated laboratory equipment; chemical waste in the form of residual

reagents, disinfectants, and certain pharmaceuticals; pharmaceutical waste consisting of expired or damaged medicines; and radioactive waste originating from the use of radiological materials. These findings are consistent with a study conducted at a type B hospital in West Java, which reported that B3 waste originates from various patient care activities, including inpatient wards, 24-hour emergency departments, central operating theaters, outpatient clinics, hemodialysis units, radiology departments, pharmacies, and the Central Sterile Service Department (CSSD). The types of waste generated include used infusion sets, used masks, used gloves, used syringes, used needles, and other waste suspected to be contaminated with patient-related pathogens. The large number of medical and non-medical service facilities directly contributes to the high generation of medical B3 waste [22].

The risks posed by medical B3 waste in hospitals are diverse and have far-reaching impacts on human health, the environment, and the reputation of healthcare institutions. Infectious waste has the potential to transmit dangerous diseases such as hepatitis and HIV through direct contact or needlestick injuries resulting from unsafe handling practices. Chemical and pharmaceutical waste may cause irritation, poisoning, respiratory disorders, and organ damage if inhaled or absorbed through the skin. In addition, uncontrolled disposal of chemical waste can contaminate soil, water, and air, disrupt environmental biota, and damage ecosystem balance. Non-compliance with waste management regulations may also result in legal sanctions, fines, and a decline in public trust in hospitals [17].

Hospital waste management is therefore critically important given its significant environmental impacts [18]. Improper disposal of medical B3 waste and wastewater without treatment in accordance with regulations can increase the presence of disease-carrying vectors and zoonoses, exacerbate environmental pollution, and contribute to environmental degradation influenced by climate change [2]. Poorly managed solid medical waste may accumulate at final disposal sites and pose health risks to surrounding communities. Meanwhile, liquid medical waste containing chemicals and toxic substances can contaminate groundwater and rivers if discharged without treatment, thereby degrading water quality, threatening aquatic life, and endangering clean water sources. These conditions may also increase Biological Oxygen Demand (BOD), reduce dissolved oxygen levels, trigger eutrophication, and disrupt aquatic ecosystem balance [21].

Each type of B3 waste has distinct characteristics and hazard levels; therefore, segregation and handling processes must be conducted in a structured manner and in accordance with safety standards to prevent risks to personnel and the environment [27]. At Hospital X Surabaya, B3 waste management is carried out systematically, encompassing segregation, containment, collection or transportation, temporary storage, destruction, and final treatment. Segregation and containment are performed directly at the source of waste generation—such as treatment rooms, laboratories, and inpatient wards—to prevent mixing and dispersion. Waste is separated according to its category, including infectious waste in yellow bags, sharps in safety boxes, and chemical waste in special reaction-resistant containers. Each container is equipped with labels containing information on waste type, date, and generating unit to support control and traceability.

This practice is consistent with a study conducted at Prof. Dr. R. D. Kandou General Hospital in Manado, which reported that waste segregation and containment begin at the source according to waste characteristics, although weaknesses were identified in the labeling system. Labeling, the use of symbols, and differentiation of waste characteristics play a crucial role in preventing disease transmission from medical waste to waste management personnel [14]. Segregated waste is placed in strong, waterproof bags differentiated by color and equipped with appropriate labels or symbols. Containers must be securely closed prior to transportation to prevent spills and exposure [6].

The collection or transportation stage of B3 waste at Hospital X Surabaya is conducted by designated personnel using closed trolleys through dedicated routes that avoid public areas. This practice aligns with a study at Medika Mulia Hospital, which reported that medical waste from each unit is transported by waste management personnel to temporary storage

facilities (TPS) using special trolleys [19]. Prior to transport, waste bags are tightly sealed to prevent leakage. However, studies conducted in one hospital in Malang and three hospitals in Jombang revealed that waste transportation routes were not separated from patient and visitor pathways, thereby increasing the risk of spills and contamination [4].

Local transportation of B3 waste is performed by personnel moving between service units, with waste transported to the TPS every two hours throughout the day. Personnel are required to use personal protective equipment (PPE) during the transportation process. Nevertheless, various procedural violations are still found in Indonesia, including the non-use of PPE, the absence of dedicated B3 waste transportation routes, inadequate trolley conditions, and low compliance with standard operating procedures among personnel [23][1]. The waste is subsequently stored temporarily at the TPS B3, which is equipped with standard facilities such as adequate ventilation, impermeable flooring, segregation racks, fire extinguishers, and restricted access. Storage duration is limited to prevent microbial growth. The selection of TPS location is also a critical factor, as demonstrated at Haji Regional General Hospital in Makassar, where the TPS is located far from healthcare service areas and is not easily accessible to the general public [25]. Ideally, a TPS should be equipped with appropriate symbols, located away from food storage and processing areas, and easily accessible to waste transport vehicles [15]. This contrasts with conditions at Ungaran Regional General Hospital, where several deficiencies were identified, including the absence of drainage systems, difficult vehicle access, inadequate lighting and ventilation, and the lack of cleaning equipment and PPE [3].

B3 waste treatment may be conducted through two mechanisms, namely internal destruction or transfer to licensed external parties [4]. At Hospital X Surabaya, B3 waste is handed over to licensed third parties and accompanied by a manifest system to ensure traceability through to final destruction. All processes are recorded and periodically evaluated as part of regulatory compliance [13]. This practice is consistent with waste management at Dr. Achmad Mochtar Regional General Hospital in Bukittinggi, which collaborates with third parties through cooperation agreements, logbooks, B3 waste manifests, and official handover reports [7]. Transportation is conducted in accordance with regulations, including waste weighing prior to transport and a collection frequency of three times per week [15].

Waste management at Hospital X Surabaya is also integrated with a 3R temporary storage facility (TPS 3R) and a wastewater treatment plant (WWTP) to prevent mixing between B3 and non-B3 waste. Non-B3 waste is managed through the TPS 3R via re-segregation, compaction, and recovery of recyclable materials. Liquid medical waste is treated in the WWTP through stages of solid separation, biological degradation, pH adjustment, and disinfection until it meets quality standards prior to discharge into the environment [26]. This is in line with findings by Karini et al., which emphasize the importance of WWTP availability in hospitals for treating liquid waste before environmental discharge [8].

Overall, B3 waste management at Hospital X Surabaya demonstrates compliance with environmental health and safety standards [10][5][11]. This is reflected in waste segregation at the source, the use of PPE by personnel, the availability of TPS B3 facilities that meet technical standards, labeling systems that support traceability, and collaboration with licensed waste destruction service providers. Routine recording and evaluation systems further indicate continuous improvement efforts. Thus, B3 waste management at Hospital X Surabaya not only fulfills regulatory requirements but also reflects a strong commitment to protecting workers, patients, the surrounding community, and the environment.

Figure 1. Domestic waste disposal container

Figure 2. Infectious medical waste container

Figure 3. 3R (Reduce, Reuse, Recycle) waste processing facility

Figure 4. Hazardous and toxic (B3) waste treatment facility

Figure 5. Domestic waste processing facility

Figure 6. Hospital wastewater treatment plant (WWTP)

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, it can be concluded that hazardous and toxic (B3) medical waste at Hospital X Surabaya poses significant risks to human health and the environment and therefore requires structured and standardized management. The hospital generates various types of B3 medical waste, including infectious, chemical, pharmaceutical, sharps, and pathological waste, which necessitate comprehensive handling in accordance with safety and environmental health standards. Overall, Hospital X Surabaya has implemented B3 waste management practices in line with applicable regulations and hospital environmental health standards. These practices include source segregation, proper labeling and containment, transportation using closed trolleys, temporary storage in a compliant TPS B3, liquid waste treatment through a wastewater treatment plant (WWTP), and separation of non-B3 waste in a 3R temporary storage facility (TPS 3R). The use of personal protective equipment (PPE), waste documentation through manifest systems, and routine evaluations indicate a commitment to occupational safety, environmental protection, and continuous improvement. To further optimize B3 waste management, it is recommended that the hospital strengthen regular training and capacity building for healthcare and sanitation personnel, enhance monitoring and evaluation of all waste management stages, maintain and improve supporting infrastructure, and reinforce management commitment through consistent policies, supervision, and resource allocation to ensure sustainable and effective waste management.

REFERENCES

1. Aju N. Evaluasi Pengelolaan Limbah Medis Bahan Berbahaya dan Beracun (B3) di RSUD X. Journal of Law and Social Politics. 2023;1(3):223–40.
2. Anggreni D, Budihardjo MA, Muhammad F. Public perception of the management of medical B3 waste and wastewater at health centers in Rejang Lebong Regency. E3S Web of Conferences. 2025;605:1–10.

3. Arlinda VP, Windraswara R, Azinar M. Analisis Pengelolaan Limbah Medis. Jurnal Penelitian dan Pengembangan Kesehatan Masyarakat Indonesia. 2022;3(1):52–61.
4. Azmi NT, Hendrasarie N. Evaluasi Pengelolaan Limbah Medis Padat B3 Rumah Sakit Kelas A, B, C, dan D. Envirous. 2023;3(2):88–92.
5. Badan Standardisasi Nasional. SNI 3242:2018-Pengelolaan Limbah B3 Rumah Sakit . BSN Jakarta; 2018.
6. Elvania NC, Purwaningrum SI. Analisis Sistem Pengolahan Limbah Medis Padat Bahan Berbahaya dan Beracun (B3) di Rumah Sakit Bojonegoro. Jurnal Teknik Silitek. 2025;4(20):146–54.
7. Iswara D, Augia T, Putri NW. Analisis Sistem Pengelolaan Limbah B3 Medis Padat Covid-19 di RSUD Dr. Achmad Mochtar Bukittinggi. Jurnal Keselamatan, Kesehatan Kerja, dan Lingkungan. 2022;3(1):36–44.
8. Karini AE, Airlangga AS, Permatasari ED, Handriyanto CF, Deviatin NS, Agustin AF. Analisis Bahaya Limbah Medis di Klinik X Gresik. Journal of Industrial Safety and Health [Internet]. 2025;2(2):8–17. Available from: https://journal.univgresik.ac.id/index.php/jish/article/view/735
9. Kementerian Kesehatan Republik Indonesia. Permenkes Nomor 269/MENKES/Per/III/2008 tentang Rekam Medis dan Pengelolaan Limbah Rumah Sakit. Kemenkes RI Jakarta; 2008.
10. Kementerian Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Nomor 7 Tahun 2019 tentang Kesehatan Lingkungan Rumah Sakit. Kemenkes RI Jakarta; 2011.
11. Kementerian Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Nomor 7 Tahun 2019 tentang Kesehatan Lingkungan Rumah Sakit. Kemenkes RI Jakarta; 2011.
12. Kementerian Kesehatan Republik Indonesia. Pedoman Pengelolaan Limbah Medis Fasilitas Pelayanan Kesehatan. Kemenkes RI Jakarta; 2019.
13. Kementerian Lingkungan Hidup dan Kehutanan. Peraturan Menteri LHK Nomor P.56/MENLHK/SETJEN/KUM 1/2015 tentang Tata Cara dan Persyaratan Teknis Pengelolaan Limbah B3. KLHK Jakarta; 2015.
14. Larasati A, Riogilang H, Riogilang H. Evaluasi Pengelolaan Limbah Medis Bahan Berbahaya Dan Beracun (B3) Di RSUP Prof. Dr. R. D. Kandou Manado. TEKNO. 2022;20(82):1021–30.
15. Nasution NA, Chania AP, Komala PS. Evaluasi Pengelolaan Limbah Bahan Berbahaya & Beracun (Limbah B3) di Rumah Sakit. Jurnal Serambi Engineering. 2025;10(2):12794–801.
16. Pavitasari KK, Najicha FU. Pertanggungjawaban Pihak Ketiga Jasa Pengolah Limbah B3 dalam Mengolah Limbah B3. Tanjungpura Law Journal. 2022;6(1):78–92.
17. Pemerintah Republik Indonesia. Permen LHK Nomor 12 Tahun 2017 tentang Pengelolaan Limbah Bahan Berbahaya dan Beracun. KLHK Jakarta; 2017.
18. Permatasari ED. Penanganan Limbah Medis dan Non Medis: Konsep dan Penerapan Kesehatan dan Keselamatan Kerja. 1st edision. Purbalingga: CV Eureka Media Aksara; 2025.
19. Rochmawati ES, Syarifah DF. Analisis Pengelolaan Limbah Medis Padat di Rumah Sakit Medika Mulia Tuban. Journal of Public Health Science Research (JPHSR). 2022;3(2).
20. Shareefdeen Z, Babar Z Bin, Haider R, Sattar H, Elkamel A, Bhojwani J, et al. Hazardous Waste Management: Advances in Chemical and Industrial Waste Treatment and Technologies. Vol. 1, Springer Nature. Sharjah; 2022. 1–207 p.
21. Sidiq AN, Nurkayah N. Analysis of The Impact of Hospital Medical Waste on The Surrounding Environment. Innovative: Journal Of Social Science Research [Internet]. 2023;3(6):7188–99. Available from: https://j-innovative.org/index.php/Innovative/article/view/7293
22. Sriwinarno H, Jumiati J, Astuti AM. Standar Teknis Sistem Pengelolaan Limbah Rumah Sakit Tipe B Jawa Barat. Jurnal Rekayasa Lingkungan. 2024 Dec 17;24(2):23–8.

23. Sutanto YS, Karianga K. Hukum Terkait Pengelolaan Limbah Bahan Berbahaya Dan Beracun Medis Rumah Sakit. Jurnal Hukum Kesehatan Indonesia. 2023 Oct 28;3(2):103–15.
24. Undang-Undang Republik Indonesia. UU No. 44 Tahun 2009 tentang Rumah Sakit. Sekretariat Negara Jakarta; 2009.
25. Windarti S, Kadir AF. Gambaran Pengelolaan Limbah B3 di RSUD Haji Kota Makassar. Jurnal Penelitian Kesehatan Pelamonia Indonesia. 2022;5(1):109–22.
26. World Health Organization. Management of Hazardous Health-care Waste in Hospitals. Geneva; 2021.
27. World Health Organization. Healthcare Waste Management: Global Guidance and Framework. Geneva; 2021.