

Research Article

Solid Medical Waste Management of Hazardous and Toxic at UNS Hospital Surakarta

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Abstract

In the era of the COVID-19 Pandemic, medical waste is increasing in various hospitals, including UNS Hospital. The variables studied in the hazardous and toxic solid medical waste flow treatment. Primary data was obtained from an analysis of waste amount in 2021 and interviews with incinerator managers. Secondary data in the form of waste types, impacts, and incinerator residue were obtained from the literature study. This research aims to identify solid medical waste management with hazardous and toxic materials compared with Regulation of Environment and Forestry Minister of Republic Indonesia 56/2015. After analysis, it was found that there is dangerous and harmful solid medical waste flow management, distinguished by type. Particular colored medical waste is managed by reducing, sorting, storing, transporting, and destroying. Destruction is conducted with an incinerator. Arah Environmental Indonesia Company operates infectious medical waste. The potential impact of that waste can attack health, damage the environment quality, increase the degradation that has occurred, and pose a threat to microplastic. Completing waste management is done by tightening hospital regulations to produce output according to quality standards, limiting hazardous and toxic waste use, and selecting the waste.

Keywords: Hazardous and toxic waste; hospital waste; solid medical waste management; UNS hospital

1. Introduction

Hospital operations generate medical waste that is harmful to the environment. Inappropriate hospital waste management can decrease environmental quality (Hasibuan and Hazairin, 2011). Hazardous waste can be defined as residue from activities containing dangerous and toxic materials that can directly or indirectly pollute the environment (Lestianingrum, 2021). Hazardous and toxic waste generated from hospital activities includes the rest of the healing process for sick people, such as dialysis, surgical practice, residue from incineration, and others (Hery Setyobudiarso, 2018). Characteristics that harm the environment require every party or person who produces hazardous and

toxic waste to manage their waste. Dangerous and poisonous waste attributes include being explosive and flammable, causing infection and causing rust, being unhealthy, etc. If the party that produces the waste cannot manage hazardous and toxic waste, the management handed over to another party with a permit. If dangerous and toxic waste is not treated correctly, it will have a worse impact than other types of waste (Kurniawan, 2019). It is described in the Government Regulation of the Republic of Indonesia Number 101 of 2014 Article 123 about the management of hazardous and toxic waste. Waste-producing parties unable to carry out processing can submit processing to third parties who have permits. However, in reality, only a few hospitals can meet the requirements for hazardous and toxic waste treatment, namely the location, equipment, and technical operation of dangerous and harmful waste treatment thermally with incinerators (Yolarita and Kusuma, 2020)

Health development is focused on increasing awareness of healthy living for all levels of society so that the level of public health will also improve. However, this dramatically affects the quality of human resources. Good quality human resources will facilitate the level of productivity in life. By increasing the knowledge and awareness of the community, the need for better hospital services will be increasingly needed. That has dramatically impacted improving the quality of hospitals in Indonesia.

But on the other hand, this also increases the waste generated by hospitals. The more hospitals that are built, the more waste will be generated. Waste generated from hospitals is dangerous medical waste. It needs good management. It does not have a destructive environmental impact (Purwanti, 2018). Good waste management is necessary to reduce the potential for waste from hospitals to pollute the atmosphere, which can also cause work accidents for hospital employees (Vinidia et al., 2017). This management is a problem in some hospitals.

In the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 56 of 2015, a hospital is a community service facility obliged to carry out hazardous and toxic materials processing. Such processing includes reduction, sorting, storage, transportation, processing, burial, and collection of hazardous and toxic waste. According to (Triana and Keman, 2006), medical and non-medical waste management is mandatory to maintain the comfort and cleanliness of the hospital. It can also break the chain of the spread of infectious diseases. This study aimed to identify the flow of hospital hazardous and toxic materials waste management at UNS Hospital in accordance with applicable regulations. Then, find the potential impacts and solutions for dangerous and harmful waste management at UNS Hospital.

2. Methods

Research on the solid waste management of hazardous and toxic waste was conducted at the UNS Hospital, Jalan Ahmad Yani No. 200, Dusun II, Makamhaji, Kec. Kartasura, Sukoharjo Regency, Central Java. This hospital is managed and sheltered by Universitas Sebelas Maret, which aims as a job training place for medical students.

This study used a descriptive observational type where observations were made on solid waste management at UNS Hospital. This descriptive study explains and describes the research purpose of solid medical waste management. The variables studied in this study are the flow of hazardous and toxic waste treatment, including reduction, sorting, storage, transportation, and processing. The data used in this study used primary and secondary data. Preliminary data were obtained from observations of the amount of waste generated at the UNS Hospital in 2021. The interview was conducted using a purposive sampling method. The selected sample was the party who best understood the problems of solid medical waste management at UNS Hospital, namely incinerator managers and staff. Interviews also determine the safety and impact (risk of infection, chemical toxicity) of hazardous and toxic solid medical waste on the environment and health. Meanwhile, the literature study obtained secondary data on concrete waste types, the impact of dangerous and toxic solid medical waste, and the incinerator residue analysis results. Primary and secondary data obtained were processed and analyzed descriptively.

3. Result and Discussion

3.1. Development of UNS Hospital and Incinerators

UNS hospital is a teaching hospital owned by UNS, whose construction was initiated in 2004 and carried out in March 2014, until completed in 2016. UNS Hospital has already received an operating permit for Class C Hospital. That is by the Decree Head of Sukoharjo District Health Office Number 445/8426/VI/2016 dated 28 June 2016. Thus, UNS Hospital has a solid legal basis to become a health service provider in the hospital sector. The task and purpose of establishing the UNS Hospital are to produce medical graduates at UNS, especially the Faculty of Medicine, who can achieve competence and master traditional skills, and also as a place to provide quality education supported by research without neglecting quality health services for the community around the City Surakarta and Sukoharjo Regency.

The implementation of technical activities and the organizational structure of the UNS Hospital have been arranged after being built. Along with the establishment of the UNS Hospital, wastewater management (WWTP) was installed to manage liquid medical waste so as not to pollute the surrounding environment. Sanitation and environmental installations are under the Directorate General, Human Resources and Education, in the non-structural sub-unit. Has the task of managing facilities and implementing waste treatment and environmental sanitation activities at the end of 2016 RS. UNS received funds to purchase an Incinerator and build a temporary dump special for hazardous and toxic materials. The incinerator belonging to UNS Hospital is branded Baite Oil Burner (Cahaya Mas Cemerlang Company), with a capacity of 150kg/hour with a combustion chamber temperature of 1 800 °C and a combustion chamber temperature of 2 1200 °C, 1 hour of incinerator use requires 20 liters of diesel. The height of the 15-meter incinerator chimney will allow the emission smoke to move laminar into the air. That year, there was no high shade for the incinerator chimney, but the Siti Walidah UMS Main Building stood across the road, higher than the incinerator chimney. It could become a new shade affected by the smoke from the combustion from the incinerator.

In the COVID-19 pandemic that hit, it could cause more infectious medical waste. Therefore the Environmental Service gave a temporary operation permit for the Incinerator at the UNS Hospital. However, the UNS Hospital incinerator has not yet operated optimally and is still being simulated. That is because there is no permit from the surrounding community and internal technical from UNS Hospital is not ready, with the factor of the channel to the WWTP and the changing room diesel pump after the operational incinerator process does not yet exist.

3.2. Medical Hazardous and Toxic Waste in UNS Hospital

Table 1. Waste generation of hazardous and toxic solid medical waste in the first semester of 2021.

Month	Amount of Onset (Kg)
January	4,030
February	3,612
March	3,968
April	3,810
May	3,906
June	3,750
Average	3,846

Table 1. shows the amount of hazardous and toxic solid medical waste produced by UNS Hospital with an average of 120-130 kg/day. The highest incidence occurred in January with the amount of 4,030 kg when COVID-19 cases peaked. Like China, which experienced an increase in waste generation during the COVID-19 pandemic, where previously it was only around 4,900.8 tons/day, increasing to 6,066.8 tons/day during the COVID-19 pandemic (Sitompul, 2021). The highest waste incidence is due to UNS Hospital being the 2nd referral hospital after dr. Moewardi Surakarta Hospital.

The incidence of hazardous and toxic solid medical waste decreased dramatically in February, and June became the last month to produce it in the first semester of 2021. However, it is inconclusive that the incidence of hazardous and toxic solid medical waste daily in February decreased. That is because the calculation of January days (31 days) has three more days than February (28 days). Most waste arises from infectious waste used in the handling of COVID-19 patients.

Types of hazardous and toxic solid medical waste can be divided into five based on the revelation and category, namely: soft medical waste using garbage tubs and yellow plastic bags, sharp medical waste such as syringes using garbage tubs and yellow plastic bags, cytotoxic medical waste using garbage tubs and purple plastic bags, medical waste radiology uses garbage tubs and red garbage bags, pharmaceutical, medical waste with garbage tubs and brown plastic bags, as well as an infectious waste derived from handling COVID-19 using garbage tubs and yellow plastic bags. The composition related to the type of medical, solid waste is listed in Table 2. as follows.

According to Rachmawati et al., (2018), hazardous and toxic materials waste produced by uns hospitals comes from service activities and medical support. There are six types of medical waste: (1) sharp medical waste consisting of the syringe, syringe + sputit, broken glass/bottle/ampoules, lancet, cartridge/razor. (2) Soft medical waste consists of cotton, bandages, blood hoses, plasters, catheters, blood transfusion bags/fluids, sanitary pads, lids and Cotton, and body tissues. (3) Toxic waste consisting of used bottles of chemotherapy. (4) Radiological waste consists of fixers and developers. (5) Pharmaceutical waste is derived from expired drugs and laboratory activities. (6) Infectious waste used in the treatment of COVID-19 patients consists of the used asker, contaminated used gloves, used bandages, contaminated used tissues, used beverage plastic, and contaminated food, used paper food and beverages, used syringes, used infusion sets, used Personal Protective Equipment. At the time of a pandemic like this, infectious waste from handling COVID-19 became the most significant contributor to the emergence of hazardous and toxic medical solid waste at UNS Hospital.

An overview of the process flow of hazardous and toxic waste management can be seen in the following figure:



Figure 1. Flow of hazardous and toxic solid medical waste: **a)** In the waste bin, obtained from the unit where there is waste generation; **b)** Transportation from generating unit to temporary disposal and processing unit (incinerator); **c)** Process of destroying waste by incinerator (combustion method).

3.4. Types of Hazardous and Toxic Solid Medical Waste in UNS Hospital

Medical, solid waste is divided into five types based on the category and its container: sharp medical waste that uses yellow plastic trash bins and bags, soft medical waste that uses yellow trash bins and plastic bags, toxic waste or cytotoxic waste that uses garbage bins and backpacks. Purple plastic and radiological waste use garbage bins and red plastic bags, and pharmaceutical waste uses trash bins and brown plastic bags (Purwanti, 2018).

Table 2. Types of solid medical waste at UNS hospital

Types of Medical Waste	Composition	Sorting Container Color
Sharp medical waste	Syringe, broken glass/bottle. cartridge, lancet	Yellow
Soft medical waste	Cotton, bandages, blood tubes, plasters, catheters, blood or fluid transfusion bags, sanitary napkins, sticks and cotton, body tissues	Yellow
Toxic waste	Chemotherapy bottles	Yellow
Radiological waste	Fixer and Developer	Red
Pharmaceutical Waste	Expired drugs and laboratory activities	Brown
Infectious waste (derived from contamination in the treatment of COVID-19 patients)	Used masker, contaminated used gloves, used bandages, contaminated used tissues, used beverage plastic and food contaminated, used food and beverage paper, used syringes, used infusion sets, used Personal Protective Equipment	Yellow

The composition of solid medical waste at the UNS Surakarta Hospital can be seen in Table 2. From the type of sharp medical waste consisting of syringes, broken glass/bottles, cartridges, and lancets. Types of soft medical waste include cotton, bandages, blood tubes, plasters, catheters, blood or fluid transfusion bags, sanitary napkins, sticks and cotton, and body tissues. The type of toxic waste consists of used chemotherapy bottles. The radiological waste consists of fixers and developers, as well as pharmaceutical waste consisting of drugs and consumables that have expired. Solid medical waste is mostly generated from hospital activities such as polyclinics, laboratories, inpatient rooms, emergency units, hemodialysis, delivery rooms, and pharmacy warehouses (Rahno et al., 2015). Sharp medical waste is mainly found in all hospital rooms except for pharmacy installations. Cytotoxic or toxic waste is sourced from the chemotherapy room, radiology waste is primarily not generated because it uses a digital system, and pharmaceutical waste is sourced from pharmaceutical installations where the hospital pharmacy is responsible for its management. The types of waste produced by hospitals differ because it depends on the specialization of the hospital, the type of hospital, the socio-economic community, culture, the use of single-use equipment, packaging materials, and waste management practices (Himayati et al., 2018). The sorting and storage carried out by UNS Hospital are by the regulations set by the Minister of Environment and Forestry of the Republic of Indonesia Number 56 of 2015 so that UNS Hospital is in a safe condition from hazardous and toxic solid medical waste.

3.5. Hazardous and Toxic Materials Waste Segregation and Reduction

Hazardous and toxic materials solid waste reduction is achieved through good management of any materials or materials that can cause environmental pollution and health problems (Purwanti, 2018). UNS Hospital carries out this activity by managing solid medical waste from health service activities, and household waste that is non-infectious if contaminated with medical waste must be addressed as medical waste so that the initial effort is to prevent pollution. The sorting of waste must be a priority from the start (Kementerian Lingkungan Hidup, 2014). At UNS Hospital, sorting is done by separating the infectious medical waste shelters/containers using yellow plastic and yellow storage tanks and non-infectious waste using black plastic and black storage tanks. UNS Hospital's policy is not to use mercury-containing devices such as thermometers and sphygmomanometers that contain mercury. Instead of using digital devices. That is because mercury is one of the materials that can be corrosive if exposed to the skin. This UNS Hospital policy is in line with a statement conducted by

(Purwanti, 2018) in Jurnal Kesehatan Lingkungan, which can reduce the potential for pollution to the environment and health problems for both UNS Hospital staff and the surrounding community.

Table 3. Data temporary dump for hazardous and toxic materials waste in UNS hospital

Temporary Dump Name	Types of Hazardous and Toxic Waste Stored	Coordinate Point
Temporary Dump for Hazardous and Toxic Materials Waste	Expired pharmaceutical waste, infectious medical waste, cytotoxic waste, medical solid waste such as used disposable masks, personal protective equipment, and syringes	7'33'32.1'S 110'46'24.0'L

Based on Table 3, the temporary dump for hazardous and toxic materials waste at UNS Hospital is located at coordinates 7'33'32.1'S 110'46'24.0'L, which is close to the incinerator. However, this garbage dump does not accommodate radiological hazardous and toxic materials waste. Radiological dangerous and poisonous materials waste is stored in a particular room before being transported to the manager because radiological dangerous and toxic materials waste needs to be explicitly handled and in small quantities. The hazardous and poisonous materials waste is stored for less than 48 hours. According to (Kementerian Lingkungan Hidup, 2014), the limit for storing infectious, unsafe, and poisonous materials waste is only up to 48 hours. Meanwhile, radiological dangerous and toxic materials waste is adjusted according to the agreement from Bapeten, which is usually transported every six months.

3.6. Hazardous and Toxic Materials Waste Transport and Management

Hazardous and toxic materials waste transportation consists of transportation from UNS Hospital to temporary dump dangerous and poisonous materials Waste and transportation from quick dump unsafe and toxic materials waste at UNS Hospital to third parties as managers. Vehicle of hazardous and poisonous materials waste to TPS for dangerous and harmful materials waste uses a tightly closed container. That is intended to prevent dangerous and toxic materials waste in containers from falling out or hitting other people. The transportation uses a unique waste transportation line carried out by a cleaning service that has received directions. This transfer is carried out every time the container is full or at least once a day. Transportation from the temporary dump of hazardous and toxic materials waste at UNS Hospital to a third party uses the services of the third party, namely Arah Environmental Indonesia Company. Waste is transported using a truck-type vehicle adjusted to the applicable provisions. The third party already has a valid permit. Transportation has also been adapted to the current regulations. This transportation is carried out every four times a week according to the storage time, which avoids significant and dangerous accumulations. The waste transported by third-party services consists of garbage stored in a temporary dump and bottom ash from the combustion of the UNS incinerator. After being stored and transported, the hazardous and toxic materials solid wastes will be processed by the UNS Hospital independently and involving third parties. Independent management using a tool, namely an incinerator that already has an operational permit. Meanwhile, radiological waste will be processed by the Badan Pengawas Tenaga Nuklir (Bapeten). The summarized information can be seen in Table 4.

Table 4. Name of hazardous and toxic waste management in UNS hospital

No.	Name of waste management	Types of waste treated
1	UNS Hospital	Infectious medical waste, solid hazardous and toxic waste
2	Arah Environmental Indonesia Company	Infectious medical waste, solid hazardous and toxic waste, and bottom ash
3	Bapeten	Radiological waste

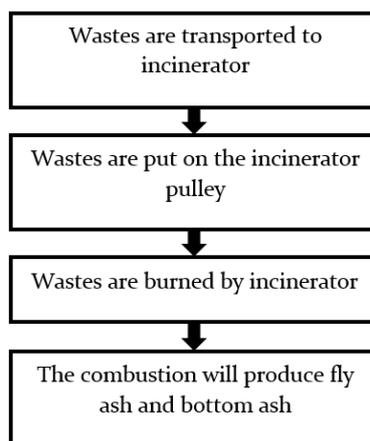


Figure 4. Management hazardous and toxic solid medical waste with incinerator

Based on Figure 4, management with the incinerator begins with transporting waste from the garbage dump to the incinerator and then placing it on the incinerator pulley. The pulley will go up to the inlet of the incinerator and put the trash. After that, the combustion process will run for approximately 1 hour for as much as 120kg of waste. The combustion was completed and produced residues from fly ash and bottom ash. Fly ash will be discharged through a 15-meter-long chimney in which there is a white scrubber so that the residue is less polluted. Meanwhile, bottom ash will be transported and processed by a third party. However, at this time, the incinerator is not running due to incomplete technicalities. It cannot run properly. The UNS Hospital is also trying to repair the incinerator so it can manage its waste independently. Other management involves the involvement of a third party, namely Arah Environmental Indonesia Company. A third party will process waste management. Hazardous and toxic materials waste are transported to a third-party incinerator. In addition, a third party will also manage the residue on the side of the UNS Hospital incinerator. This management is quite costly, so it is hoped that UNS Hospital has other alternatives and can run the incinerator independently. Independent control and involving third parties are expected to be able to overcome all hazardous and toxic materials in solid waste piles. The decision by (Kementerian Lingkungan Hidup, 2014). The Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 56 of 2015 states that a hospital must manage its waste correctly by the established regulations. Suppose it is unable to process the generated waste. In that case, it is submitted to a registered third party with a waste processing permit, and the hospital and the third party must have a cooperation agreement.

3.7. Hazardous and Toxic Materials Waste Impact for Environment

UNS Hospital produces soft medical waste, toxic waste, radiology waste, pharmaceutical waste, and infectious waste (derived from contamination in handling COVID-19 patients). Medical hazardous and toxic materials waste from hospitals is at risk of causing various kinds of diseases and health impacts so it is considered dangerous and must be managed and paid attention properly (Purwanti, 2018).

1. Infection or contamination of medical substances caused by excessive exposure caused by medical waste to human skin, intentional or unintentional. An example of this infection can be caused by using used needles that can potentially infect Hepatitis or HIV. Contamination can also cause effects such as irritation to the skin or eyes.
2. Cancer can be caused mainly by carcinogenic substances such as Pb (chemical lead). Cancer is usually a cumulative effect after continuous exposure, where carcinogenic substances that have accumulated cause cancer that attacks the patient's body.
3. Respiratory problems and other health problems. Infectious medical waste with a pungent odor and at high levels can cause respiratory problems and disturbances in other systems, which are side effects of medical chemicals on the body. Such as the use of expired drugs cause poisoning or hallucinations.
4. Damage the environment by causing various impacts such as pollution and contamination of hazardous substances. Plants can die of poisoning, the soil becomes infertile, and the water becomes polluted and unhealthy. Animals are affected because waste that enters their habitat, such as the sea, will indirectly affect the animal, such as being swallowed or stuck in their body parts. The problem of medical waste in the waters has increased in line with the pandemic where the DKI Jakarta COVID-19 Task Force noted that there was 1.94 kg of waste in Muara Cilincing in early 2020 to 6.28 kg in April 2020 (Putranto and Najicha, 2021).
5. The threat of microplastics. That comes from personal protective equipment (PPE) or disposable masks that contain microfiber and polyethylene as personal protection from chemicals and dust. These microfibers and polyethylene are tiny in size to filter fluids and particulates so that when crushed, they form small microplastics that are dangerous when scattered in the environment.
6. The potential to spread the COVID-19 virus, especially during the pandemic, has not yet been completed. The processing needs to be explicitly done and with proper handling. The incinerator as the central processing machine for infectious waste must be appropriately operated but pay attention to the operating procedures in the applicable regulations.
7. When they enter the ecosystem, it affects the food chain and the habitat of living things. That is because hazardous and toxic waste is a poison that can kill, injure, and affect the internal organs of living things that have the potential to cause injury, illness, and even death. The food chain is disrupted if an organism has harmful content. The poison will spread from one organism to another, killing many food chain species.

Solutions that we can do to reduce the impact of hospital hazardous and toxic materials waste include the following:

1. Tighten regulations on waste treatment in hospitals, especially for hazardous and toxic materials and infectious medical waste. Hospitals must implement processing and management by the latest rules compiled in PP No. 22 of 2021. That also includes monitoring and evaluating the direction carried out, especially if it involves third parties who monitor regularly so they are not misused. Tightening regulations also increase health workers' awareness in disposing of waste according to its category to avoid hazardous and toxic materials waste that is toxic, corrosive, reactive, or sensitive to shocks (Vinidia et al., 2017).
2. Implementing a single-use food and drink container system, especially during the COVID-19 pandemic. This system will indeed increase the amount of waste but will reduce the level of contamination due to exposure to infectious waste of patients in hospitals. Furthermore, this medical waste is directly processed into an incinerator to scorch the virus content and other harmful contaminating substances contained therein.
3. Spraying disinfection periodically either directly or by installing a disinfection booth. The installation of kiosks aims to eradicate viruses and harmful microorganisms and reduce contamination from existing infectious medical waste by spraying on the clothes used and in

every room (Athena et al., 2020). That is especially recommended during the COVID-19 pandemic to prevent widespread or becoming a new source of spread.

4. Selecting infectious, hazardous, and toxic materials waste or waste by using containers or plastics of different colors from domestic or non-medical waste. Infectious medical waste is placed in yellow plastic containers or bags with special symbols to facilitate further management. Waste treatment, especially those that are infectious in solid form, must be destroyed in an incinerator to kill viruses and other particulates, which in UNS Hospital has been implemented even though it has not received full permission.
5. Reducing the use of hazardous and toxic substances in the hospital environment, for example, by replacing thermometers with mercury with digital thermometers. This reduction minimizes the presence of dangerous and poisonous materials waste in hospitals, especially those made of metal at risk of exposure to body parts (Noor, 2020).
6. Improve health protocols while in the hospital area to prevent transmission of COVID-19 from infectious medical waste, inpatients, or symptomatic individuals. Health protocols tightened with regular checks at every level of the hospital or initial statements by the security forces as the front line in preventing the spread of the COVID-19 virus in this hospital.
7. Improve management regularly. Therefore it does not enter the surrounding ecosystem to avoid potentially poisoning humans, animals, and plants. The control described in the material above should continue to be carried out at the applicable operational standards with experienced experts in their respective fields.

3.8. Deficiency of Hazardous and Toxic Materials Waste in UNS Hospital

Procedures about applicable regulations have carried out hazardous and toxic waste management at UNS Hospital. However, in its control, there are still shortcomings that can interfere with the technical implementation of the management field and the laws and regulations. These shortcomings include:

1. The incinerator does not yet have a processing permit by standard regulation, PMK number 7 of 2019, so incinerator use is not optimal.
2. Available data regarding waste treatment in incinerators is still limited.
3. Temporary disposal sites are only available for hazardous and toxic waste, not selectively between toxic metal or infectious medical materials.
4. Hazardous and toxic waste at UNS Hospital is further processed using the services of a third party. That creates dependence on an agency because the UNS Hospital does not yet have a hazardous and toxic waste processing permit, impacting the bottom ash output from the Ministry of Health.

4. Conclusions

The flow of hazardous and toxic materials waste management at UNS Hospital consists of several processes, namely for solid medical waste to be collected in a unique yellow medical waste bin. Then transportation is carried out from the generating unit to the temporary dump for hazardous and toxic materials Waste and for an independent processing unit in the form of an incinerator devoted to treating waste. Infectious medical waste is then destroying medical waste by incineration or combustion. Waste in a temporary dump special for hazardous and toxic materials then be transported to a third party, Baeten Company directly handles Arah Environmental Indonesia directives for radiological waste. The potential impact of dangerous and poisonous materials waste can attack health such as contamination of medical substances, cancer, respiratory disorders, to physical health problems. The environment damages the quality of the environment, increases the degradation that has occurred, and poses a threat to microplastic waste due to poor incinerator processing. The solution for hazardous and toxic materials waste management is to tighten hospital regulations to manage dangerous and poisonous

materials waste to produce output according to quality standards. Then restricting the use of dangerous and toxic materials and selecting hazardous and poisonous materials to waste strictly. Need further research on the sustainability of harmful and toxic solid medical waste management, especially after the end of the pandemic towards a new everyday life.

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