Evaluation of solid medical waste management system in Undata Regional General Hospital, Palu city, Central Sulawesi Province, Indonesia

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Abstract. Waste is an environmental problem that is still not fully resolved properly even though the resulting impact has a major effect on environmental pollution, especially solid medical waste. The purpose of this study was to assess the characteristics of solid medical waste at Undata Hospital based on its sources and types, calculate the average weight of solid medical waste generated per day, and evaluate the solid medical waste management system with sorting, packaging, collection and transportation modes in accordance with the criteria of Permen of Environment and Forestry Number 56 of 2015 and Permenkes Number 2 of 2023. This research uses a qualitative approach with a descriptive research type. This research was conducted in August-September 2023. The sampling technique in this study used Purposive Sampling, with 18 informants selected from each unit/room/installation at Undata Hospital, Palu City. Based on the results of the study, it was found that every day Undata Palu Hospital produces domestic waste as much as ± 270 kg / day. The results of the evaluation of the solid medical waste management system at Undata Palu Hospital show that basically it is quite effective but not optimal, because the storage process shows non-compliance with the guidelines for medical waste management by the Ministry of Health Number 2 of 2023, namely storage in TPS which should not be more than 2x24 hours, but in fact the accumulation of solid medical waste is stored for 1 month in the LB3 TPS due to delays in transportation by third parties. This causes a large amount of solid waste in the TPS so that the TPS becomes full and dangerous because the waste undergoes a process of decomposition and decay, which is harmful to the environment and human health. Undata Hospital needs to maximize the procurement of internal medical waste processing equipment (incineration equipment) which needs to be supported by the Environmental Agency and the relevant Health Office to prevent environmental pollution from medical activities.

Keywords: Evaluation, Waste, Medical, Solid, Management, Hospital

1. Introduction

Health is a very important thing that must be considered by the government because it is closely related to the quality of human life. Health aspects greatly affect the high and low quality of human life (Purnaweni, 2004). For this reason, the government has built hospital facilities throughout Indonesia. Hospitals as one of the service industries sectors that provide health services to the community is a sector that is growing rapidly along with the increasing population and increasing public awareness of the importance of maintaining health.

Hospital activities not only provide great benefits or positive impacts on the social environment of the community, but also have a negative impact related to environmental pollution because they can produce waste that has a risk of adverse effects on the physical and human environment. Environmental pollution can originate from activities inside and outside the hospital, which can then have an impact on public health. However, in addition to the community,
hospital employees also need protection from this negative influence (Asmarhany, 2014; Habibi, 2020), if environmental management is not appropriate.

Pollution is very potential to come from medical waste which can affect the environment. Hospitals as health care facilities must pay attention to the link between their business activities and the environment (Habibi, 2020), in this case, medical waste management. According to Wilhemina et al (2022) the management and treatment of medical waste is a major concern for hospitals because of its potential to endanger human health and the environment, especially in developing countries. According to data from the Ministry of Environment and Forestry through the Directorate of Performance Assessment of Hazardous and Non-Hazardous Waste Management in 2018 before the Covid-19 pandemic, waste generated from health service facilities (fasyankes) reached 100.45 tons/day from 2,870 hospitals throughout Indonesia.

The rapid increase in hazardous waste generation from health facilities occurred during the Covid-19 pandemic in 2020, especially in hospitals that are referrals for covid patients. The increase in hazardous waste generation occurred very rapidly in referral hospitals, such as hospitals in DKI Jakarta which produced 18,270.304 tons of hazardous waste in 2020 (MENLHK, 2021), Surabaya City in April 2020 produced 45,533 kg of medical hazardous waste, while in June 2020 there was an increase to 50,056 kg (Wardani et al., 2020). This also happened in many hospitals in Indonesia, including the Undata Regional General Hospital (RSUD) located in Palu City, Central Sulawesi Province.

RSUD Undata, located on Jalan R.E Martadinata, Tondo, Mantikulore District, Palu City, is one of the referral hospitals in Central Sulawesi Province. RSUD Undata, which was established in 1972, is a provincial government-owned hospital with a class B type. In addition to providing health services to the general public, this RSUD is also the main teaching hospital in Palu City as a student practice area for academic purposes, so it has facilities with complete medical equipment and professional medical personnel.

Undata Hospital has 344 inpatient beds. With this high number of inpatient beds, it shows that there are many inpatients every day, which in daily activities certainly does not escape the problem of increasing solid medical waste generation. Based on geometric projection calculations, it is predicted that solid medical waste generated will increase by 1% - 3% every year. This number can be seen from the presence of inpatients who continue to increase every year (RSUD Undata, 2023). This medical waste comes from inpatient treatment rooms, polyclinic rooms, operating rooms, laboratory rooms, pharmaceutical installations, emergency rooms, radiology units and others.

Undata Hospital produces ± 270 kg/day of solid medical waste. In accordance with regulations, this waste should be treated based on the solid medical waste environmental management system with the methods of sorting, packaging, collecting and transporting according to the criteria of each type of waste.

There have been quite a number of studies that focus on hospital waste management, such as Putri (2018) which states that hospital waste disposal must be in line with regulations, so as not to have a negative impact on the environment. However, Habibi's research on Medical Waste Management at Sahabat Hospital, Pasuruan Regency (2020) states that some medical waste management in various hospitals in Indonesia has not met the requirements.

As the largest hospital in Central Sulawesi Province, Undata Hospital should manage its waste properly and correctly, so that it does not cause pollution to the environment.

Therefore, this study aims to (1) Assess the characteristics of solid medical waste at Undata Hospital based on its source and type; (2) Calculate the average weight of solid medical waste based on its type and the average weight generated per day; and (3) Conduct an evaluation study of the environmental management system for solid medical waste by sorting, packaging, collecting and transporting methods in accordance with the criteria of the Minister of Environment and Forestry Regulation Number 56 of 2015 concerning Procedures and Technical Requirements for Hazardous and Toxic Waste Management from Health Service Facilities and Minister of Health Regulation Number 2 of 2023 concerning Implementation Regulations of Government Regulation Number 66 of 2014 concerning Environmental Health.

2. Method

2.1 Type of research

This research uses a descriptive type of qualitative research. Qualitative research is used to explore and understand individuals and groups that are considered part of a social problem. Research with descriptive qualitative nature is to describe the management of solid medical waste at Undata Hospital. Researchers try to explore the truth by giving accurate explanations to the data with the intention of building descriptions, analytical depictions and the truth about real phenomena or problems under study (Creswell et al., 2018).
2.2 Data Collection Technique

Primary data was obtained by conducting interviews and distributing questionnaires to 18 selected informants. Direct observation was carried out to observe the sorting of solid waste types, transportation to LB3 TPS and observe the condition of facilities in temporary storage at LB3 TPS.

Secondary data in this study in the form of the amount of solid medical waste per day obtained from the logbook of the Sanitation Installation Section, and data on the number of inpatients per day from the Medical Records Section, as well as the Undata Hospital profile obtained from the General and Equipment Section.

2.3 Sampling Technique

The sampling technique used to determine informants in data collection in this study was purposive sampling. This technique allows researchers to select informants based on the experiences experienced by the informants (Creswell et al., 2018). From this research there are 18 selected informants, namely the Head of Section and 3 staff from the Sanitation Installation, 2 medical waste transporters and 12 cleaning services from each room/unit/installation.

3. Result and Discussion

3.1 Sources and Types of Solid Medical Waste

The potential for environmental pollution, especially in medical activities, can produce solid waste that is harmful to the environment and health. Based on the results of observations and data review from the Sanitation Installation section that has been carried out, data on waste characteristics in the form of sources and types of solid waste generated at Undata Palu Hospital are presented in Table 1.

<table>
<thead>
<tr>
<th>Sources of Solid Waste</th>
<th>Type of Solid Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inpatient Room</td>
<td>- Medical Waste:</td>
</tr>
<tr>
<td></td>
<td>- Masks, gloves, syringes, infusion bottles, used cotton, blood bags, infusion</td>
</tr>
<tr>
<td></td>
<td>tubes, operating threads, scalpels, blood transfusion tubes, chemicals, gauze,</td>
</tr>
<tr>
<td></td>
<td>used cloths, catheter tissue, used dressings, bandages, baby diapers.</td>
</tr>
<tr>
<td></td>
<td>- Domestic (non-medical) waste:</td>
</tr>
<tr>
<td></td>
<td>- Paper, tissue, plastic, used food and beverage packaging, beverage bottles,</td>
</tr>
<tr>
<td></td>
<td>pipettes/straws.</td>
</tr>
<tr>
<td>Outpatient Group</td>
<td>- Medical Waste:</td>
</tr>
<tr>
<td></td>
<td>- Syringes, gloves, masks, cotton wool, used rags, pasteur pipettes, used</td>
</tr>
<tr>
<td></td>
<td>surgical tissues, hoses and infusion bottles.</td>
</tr>
<tr>
<td></td>
<td>- Domestic (non-medical) waste:</td>
</tr>
<tr>
<td></td>
<td>- Paper, tissue, food wrappers and visitor beverage bottles.</td>
</tr>
<tr>
<td>Medical Support Services</td>
<td>- Medical Waste:</td>
</tr>
<tr>
<td></td>
<td>- Pharmaceutical: Medicine packaging, medical masks, syrups, bottles, ampules,</td>
</tr>
<tr>
<td></td>
<td>expired medicines (tablets, caplets and pills).</td>
</tr>
<tr>
<td></td>
<td>Laboratory: Sputum plots, syringes, urine pots, chemicals, glass slides, broken</td>
</tr>
<tr>
<td></td>
<td>pipette tips, serum, used cotton, filter paper gloves, specimen containers, cups.</td>
</tr>
<tr>
<td></td>
<td>- Radiology: x-ray film, paper.</td>
</tr>
<tr>
<td></td>
<td>- Hemodialysis: used blood bags.</td>
</tr>
<tr>
<td></td>
<td>- All rooms: Gloves, syringes, tissues, googles, masks, hazmat.</td>
</tr>
<tr>
<td>Non-Medical Services</td>
<td>- Domestic waste (non-medical):</td>
</tr>
<tr>
<td>Corridor, Mosque, Parking</td>
<td>- Paper, tissue, used bottles, plastic.</td>
</tr>
<tr>
<td>Lot, Waiting Room, Garden</td>
<td>- Domestic (non-medical) waste:</td>
</tr>
<tr>
<td></td>
<td>- All unused stationery waste such as, paper, pens, tipex containers, used ink</td>
</tr>
<tr>
<td></td>
<td>bottles.</td>
</tr>
<tr>
<td></td>
<td>- Domestic (non-medical) waste:</td>
</tr>
<tr>
<td></td>
<td>- Food wrappers, visitor beverage bottles, parking tickets, plastic bags.</td>
</tr>
<tr>
<td></td>
<td>- Garden: tree branches and dry leaves.</td>
</tr>
</tbody>
</table>
From **Table 1** we know that medical waste is generated in the form of solid medical waste and domestic waste. Solid medical waste consists of used syringes, plastic materials, broken materials/glass, gloves, masks and other infectious wastes. Domestic waste consists of plastic bottle waste, used cardboard, paper, hand sanitizer bottles and snack wrappers. This waste is dominated by solid medical waste generated from medical activities. Waste is transported twice a day to the LB3 TPS.

### 3.2. Average Generation Amount of Solid Waste

#### 3.2.1. Average Weight by Waste Type

Based on the results of observations and review of B3 waste logbook data conducted on August 08 - September 08, 2023, the average weight of solid medical waste per day based on its type is presented in **Figure 1** below:

**Figure 1.** Weight of Solid Medical Waste in Undata Hospital (Logbook Sanitation Section, 2023)

From **Figure 1** above, it can be seen that average weight solid medical waste generated by the type are, Used Syringes (708 Kg), Gloves and Masks (794 Kg), Plastic Materials (6,595 Kg), Broken Materials/Glass (831 Kg), and Chemotherapy/postoperative waste (58 Kg). Solid medical waste of plastic materials is generated the most with a weight of 6,595 kg. The least solid medical waste generated is the type of solid medical waste from chemotherapy activities (waste generated after cancer surgery) amounting to 58 kg.

#### 3.2.2. Average Weight per Day

Based on the daily data on the number of patients obtained from the Medical Records Section of Undata Hospital, a correlation can be made to the number of patients and the average amount of solid medical waste generated in determining the average amount of solid medical waste generated in accordance with the results of field observations and review of hazardous waste logbook data on August 08 - September 08, 2023, it can be seen that the total weight of solid medical waste generated was 8,987 kg, the total number of patients as a whole amounted to 2,733 people and the results of the calculation of the average weight of solid medical waste (kg / patient) were obtained at 111.392 kg / patient.

The results of the calculation of the average weight of medical waste per day are then presented in the form of a chart distribution shown in **Figure 2**. **Figure 2** calculates the average weight of medical waste per day, it can be seen that the largest average weight occurred on August 17, 2023 with an average total of 7.558 kg/patient, while the smallest average weight occurred on September 4, 2023 with an average total of 2.032 kg/patient.
Figure 2. Average Solid Medical Waste Per Day (Logbook Sanitation Section, 2023)

3.3. Evaluation of the Environmental Management System at Undata Hospital

Based on the results of observations and interviews that have been conducted with 18 selected informants, solid medical waste management at Undata Palu Hospital is obtained, which is presented in Table 4. The evaluation results in Table 4 are guided by the policies of Permen LHK Number 56 of 2015, Permen LHK Number 6 of 2021 and Permenkes Number 2 of 2023.

From the evaluation results, the management of solid medical waste at Undata Palu Hospital is basically quite effective but not optimal, because the storage process is not in accordance with government policies in the form of medical waste management by the Ministry of Health Number 2 of 2023, namely storage in TPS should not exceed 2x24 hours, because it can cause environmental impacts such as environmental pollution, including health impacts for humans such as being punctured by sharp objects or broken glass contaminated with certain diseases. In the storage process at Undata Palu Hospital, it was found that there was a buildup of solid medical waste in the TPS which was stored for 1 month, due to delays in transportation by a third party, PT Tenang Jaya Sejahtera.

Based on direct observation and interviews with one of the Sanitation Staff employees conducted on August 10, 2023, data were obtained that one of the main problems at Undata Hospital is the excessive accumulation of solid medical waste in the LB3 TPS at this RSUD, which is caused by delays in transportation to the landfill. This accumulation of waste causes a lot of waste generation in the TPS so that the RSUD TPS becomes full and dangerous for the environment, because the waste undergoes a process of decomposition and decay.

Table 2. Policy Evaluation Results

<table>
<thead>
<tr>
<th>No</th>
<th>Minister of Environment and Forestry Regulation No. 56 of 2015 and Minister of Health Regulation No. 2 of 2023</th>
<th>Observation Results of Existing Conditions at Undata Hospital Palu</th>
<th>Appropriate/Not suitable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sorting Method</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Segregation of medical and non-medical waste</td>
<td>RSUD Undata Palu conducts a waste sorting process, such as sorting types of solid medical waste and non-medical/domestic waste.</td>
<td>Appropriate</td>
</tr>
<tr>
<td>2</td>
<td>Separating B3 waste based on its characteristics, type and group</td>
<td>Waste is sorted by type and group. Hazardous waste consists of solid medical waste, non-medical/domestic waste, infectious waste and pathology waste.</td>
<td>Appropriate</td>
</tr>
</tbody>
</table>
Dumping Method

1. Contain B3 waste according to group and type
   B3 waste that has been separated based on its type is then contained in plastic bags (yellow color for medical and black color for domestic waste), safety boxes and used jerry cans to contain sharps waste. 
   Appropriate

2. The container is made of strong, fairly lightweight, rustproof, watertight, leak-proof and puncture-proof material.
   Waste containers made of plastic materials, such as safety boxes and used jerry cans. 
   Appropriate

3. Each container is labeled
   Each solid waste that has been containerized is then labeled based on its type. 
   Appropriate

4. Sharps are collected using a special place (safety box)
   Palu Hospital utilizes containers from jerry cans used as pharmaceutical waste that has been disinfected before use. 
   Appropriate

Collection method

1. Daily or periodic collection
   Collection is done twice a day, in the morning and afternoon. 
   Appropriate

2. Waste containment or collection areas do not leak or spill.
   Shelters are made of strong, water-repellent materials and closed containers. 
   Appropriate

3. TPS is far away from the food preparation area
   TPS is far away, not served by the food delivery route to the treatment room and not served by visitors. 
   Appropriate

4. Recording the amount of medical hazardous waste generated is carried out.
   Each waste that has been collected is then weighed and the amount of medical waste is recorded in the B3 waste logbook. 
   Appropriate

5. Storage of medical waste in TPS should not exceed 2 x 24 hours.
   Storage for more than 2 x 24 hours. 
   Not Appropriate

6. Hazardous waste collection using specialized transporters
   Collection is carried out using a special trolley for waste transportation. 
   Appropriate

Transportation Method

1. Appointment of responsible personnel for each zone or area.
   RSUD Undata Palu has special officers/personnel in overseeing the transportation process in each area of the hospital. 
   Appropriate

2. During transportation, personnel use PPE (Personal Protective Equipment).
   Transport personnel use hazmat, sepatu boots, masks dan googles. 
   Appropriate

3. Medical B3 waste must be transported to the TPS at least once a day.
   Transportation is carried out every day, in the morning and evening. 
   Appropriate

4. Transportation of B3 medical waste uses a special route that is away from the crowd in the hospital.
   Waste transportation paths do not cross or do not pass through public / crowd paths in the hospital. 
   Appropriate

5. After transporting waste, the transport equipment is cleaned using disinfectant.
   Every piece of transportation equipment is always cleaned with disinfectant. 
   Appropriate

4. Conclusion

Environmental pollution in medical activities can come from inpatient care, outpatient/polyclinic and other medical support rooms that have the potential to produce solid medical waste that is harmful to the environment and human health. The characteristics of the types of solid medical waste that are most commonly generated in the Undata Hospital environment are used syringes, masks, gloves, broken / glass materials, plastic materials and postoperative waste (chemotherapy). Each type of medical waste is sorted and separated so that the medical waste does not mix and does not pollute the surrounding environment.

Overall, the weight of solid medical waste at Undata Palu Hospital per day can reach ± 270 kg / day. The average weight of solid waste by type is 8,987 kg which comes from masks, gloves, plastic materials, broken materials and postoperative waste. Meanwhile, the average weight of solid waste per day (August 8 - September 8) was 111.392
kg/patient. The results of the evaluation of the environmental management system for solid medical waste show that the process of sorting, packaging, collecting, processing and storage facilities for hazardous waste has met the policy criteria in the Regulation of the Minister of Environment and Forestry Number 56 of 2015, Regulation of the Minister of Health Number 2 of 2023 and Regulation of the Minister of Environment and Forestry Number 6 of 2023.

However, the storage process at the TPS is not in accordance with the guidelines for environmental management of medical waste by the Ministry of Health Number 2 of 2023, namely storage at the TPS should not exceed 2x24 hours, because the storage process at Undata Palu Hospital was found to have accumulated solid medical waste in the TPS and stored for 1 month. This can cause waste to decompose and rot which can pollute the environment and environmental health. It is recommended that Undata Hospital needs to maximize its waste management by procuring medical waste processing equipment internally in the form of an incinerator, which needs to be supported by the Environmental Service and the relevant Health Service to prevent environmental pollution from medical activities.

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