Description of the Characteristics of Solid Medical Waste in the Environment During the COVID - 19 Pandemic: Case Study Hospital X Covid-19 Referral in Semarang City

N Himayati*, T Joko¹ and M Raharjo¹

¹ Environmental Health, Faculty of Public Health Univeritas Diponegoro, Semarang, Indonesia ORCID ID: 0000-0002-2326-4805

*nilahimayati@students.undip.ac.id, ¹trijokoundip@gmail.com, ¹mursidraharro@lecturer.undip.ac.id

Abstract. Characteristics of Solid Medical Waste As long as the hospital as a health service provider is a source of solid medical waste generation. The current COVID-19 pandemic can potentially increase the number of medical waste generation in health care facilities. The COVID-19 pandemic has had an impact on changing the characteristics of the medical waste produced. This study describes the characteristics of hospital solid medical waste during the COVID-19 pandemic at the X Referral Covid Hospital in Semarang City. The study results show that the ratio of increasing solid medical waste during the 2020 pandemic ranges from 1.39 to 2.08 kg/bed/day. Handling medical waste in this condition is a challenge that needs to be appropriately managed.

1. Introduction
The COVID-19 pandemic hit Indonesia. The first case was found on March 2, 2020, in Depok City. On January 21, 2021, WHO data explained that Indonesia, a region from the Southeast Asia Region, was included in the category of the highest number of cases with 951,651 confirmed cases with a percentage of 15.9% active cases, 81.2% recovered, and 2.9% died [1]. Based on deployment data of COVID-19 in Indonesia in January 2021, Central Java was included in the category of the highest number of confirmed cases, namely 116,387 cases with the highest cases in the Semarang City area. Confirmed cases in Semarang City are 12,504 cases, with 1,020 active cases, 10,234 recovered, 1,250 cases died [2].

Hospitals as health service providers are a source of solid medical waste generation. The current COVID-19 pandemic can potentially increase the number of medical waste generation in health care facilities. Based on the results of a systematic review by Hendri and Fitria (2020) the potential types of medical waste during the COVID-19 pandemic were generated in the form of sharp object, infectious, pharmaceutical, and chemical waste and [3]. Research in Iran shows that one of the impacts of the COVID-19 pandemic, namely an increase in the generation of medical waste in the hospital, was studied by 0.95 to 3.52 kg/bed/day [4].

One of the COVID-19 Referral Hospitals in Semarang, with a capacity of 1,084 beds, experienced a change in health services visits during the COVID-19 pandemic, namely the number of inpatients and outpatients decreased. The inpatient BOR achievement in 2020 was 69.07%, a decrease compared to 2019, which was 84.84%. The achievement of BOR, which describes the high and low level of utilization of hospital beds, is a significant factor in the waste generated [5].
The COVID-19 pandemic impacts changes in the characteristics of medical waste produced, one of which is food waste and food packaging for COVID-19 patients, which are categorized as infectious waste [6]. The use of personal protective equipment (PPE) for health workers in hospitals has several levels according to their work location [7]. Increased use during the COVID-19 pandemic could lead to a high generation of solid medical waste in hospitals. In this study, the authors want to describe the characteristics of the source, type, and amount of hospital medical waste during the COVID-19 pandemic at the X Referral Covid Hospital, Semarang City.

2. Method
The design of this study is an observational description conducted at Hospital X Semarang City, the Covid-19 Referral Hospital, in June 2021. This research was conducted by interviewing, observing, and collecting data on the research object, namely the source, type, and amount of solid medical waste generated in 2020-2021. Interviews were conducted at the sanitation department to determine the source of medical waste in the hospital and the type of waste generated. Informants are hospital sanitarians who are responsible for medical waste management. Observations were made to determine the process of handling solid medical waste. Secondary data were obtained from hospital medical waste reports, journals, books and supporting government regulations. Data analysis is done by classifying and interpreting the data to produce the required information.

3. Result and Discussion
The Table 1 shows the type of solid medical waste

| Source           | Waste composition                                                                 |
|------------------|------------------------------------------------------------------------------------|
| Inpatient        | Masks, gloves, syringes, syringes, gauze, alcohol swabs, IV tubes, plaques, ampoules, catheters, body fluids, blood, used sanitary napkins, vials, urine bags, head coverings, gowns |
| Outpatient       | Masks, gloves, headgear, gauze, alcohol swabs, syringes, syringes, ampoules, body fluids, gowns |
| Emergency room   | Masks, gloves, headgear, gauze, alcohol swabs, syringes, syringes, ampoules, body fluids, blood, gowns |
| CSI              | Masks, gloves, headgear, gauze, bisturi, ampoules, blood, body fluids, body tissues, body parts, gowns |
| HBTU             | Syringe, syringe, gauze, blood                                                   |
| CSSD             | Syringes, blood, cultures, bandages, infectious material                          |
| Nutrition        | Personal protective equipment (PPE)                                               |
| Morgue           | Personal protective equipment                                                     |
| Laboratory       | Masks, gloves, syringes, syringes, body tissues, body fluids, blood, sample cups, contamination paper, pipettes, chemical reagents, pipettes |
| Pharmacy         | Damaged and expired drugs                                                         |
| Laundry          | Personal protective equipment                                                     |
| Radiology        | Masks, gloves, NAV-compliant radioactive waste                                    |
| Radiotherapy     | Masks, gloves, syringes, drug bags, gauze, gowns                                  |
| Hemodialysis     | Mask, gloves, gown, syringe, bandage, gauze, alcohol swab, body fluids, plabot, tube, syringe, blood, ampoule |
| TB               | Masks, gloves, gowns, syringes, ampoules, syringes                               |
| Psikiatri        | Masks, gloves, gowns, syringes, ampoules, syringes                               |
| Covid Room       | Masks, gloves, hazmats, gowns, syringes, syringes, plabots, hoses, food scraps, gauze, body fluids, food packaging |

Solid medical waste generated by hospitals comes from various units, namely inpatient, outpatient, Emergency Room, Central Surgical Installation, Hospital Blood Transfusion Unit, Obstetrics and Gynecology, CSSD, nutrition, morgue, laboratory, pharmacy, laundry, radiology, radiotherapy, hemodialysis, TB, psychiatry, COVID-19 isolation. The Covid-19 pandemic requires hospitals to provide special COVID-19 isolation rooms, thereby increasing the source of solid medical waste.
The results showed that hospitals classified waste according to categories: infectious waste, syringes, cytotoxics, pharmaceuticals, plabot, and covid. Each source has a different composition of waste, Table 1. Based on Table 1, it can be seen that each waste source has a different composition of waste. This is based on medical activities at the waste source. Infectious waste contains infective pathogens that can cause disease development, disease transmission, body fluids, blood, human waste, body tissues, laboratory cultures, and microbiological products. Sharps waste is the solid waste from used needles and syringes, knives, surgery, pipettes, and broken glass. Pharmaceutical waste is waste from the pharmacy room in the form of expired drugs and contaminated objects. Radioactive waste comes from nuclear technology activities, such as radiotherapy, nuclear medicine, and research reagents [8–10].

Characteristics of the type of solid medical waste generated during the COVID-19 pandemic experienced additional characteristics, namely in the waste of covid patients where food scraps and contaminated goods will be included in the infectious waste category. This increases the amount of medical waste produce.

| Month/year | Infectious waste (kg) | Covid waste (kg) | Total (kg) | Covid waste (%) |
|------------|-----------------------|------------------|------------|-----------------|
| Jan-20     | 35748.59              | 0                | 35748.59   | 0.00%           |
| Feb-20     | 33359.37              | 0                | 33359.37   | 0.00%           |
| Mar-20     | 33626.99              | 281.45           | 33908.44   | 0.83%           |
| Apr-20     | 22958.54              | 2297.12          | 25255.66   | 9.10%           |
| May-20     | 17660.5               | 2726.82          | 20387.32   | 13.38%          |
| Jun-20     | 26417.71              | 5063.4           | 31481.11   | 16.08%          |
| Jul-20     | 27508.22              | 10722.6          | 38230.82   | 28.05%          |
| Aug-20     | 27123.71              | 8482.3           | 35606.01   | 23.82%          |
| Sep-20     | 29676.79              | 10022.3          | 39699.09   | 25.25%          |
| Oct-20     | 30786.84              | 6921.9           | 37708.74   | 18.36%          |
| Nov-20     | 28227.4               | 9003.2           | 37230.6    | 24.18%          |
| Dec-20     | 32513.7               | 13952.5          | 46466.2    | 30.03%          |
| Jan-21     | 26819                 | 14287            | 41106      | 34.76%          |
| Feb-21     | 26690.7               | 13501.1          | 40191.8    | 33.59%          |
| Mar-21     | 35083.8               | 7625.4           | 42709.2    | 17.85%          |
| Apr-21     | 31524.1               | 7488.8           | 39012.9    | 19.20%          |
| May-21     | 27649.9               | 7533.1           | 35183      | 21.41%          |
| Jun-21     | 27203.1               | 20817.1          | 48020.2    | 43.35%          |

The results showed that during the COVID-19 pandemic, there was a change in waste generation from 2020 to June 2021. It can be seen in Table 2. Medical waste generation in the studied hospitals decreased in April and May 2020. This was due to the early occurrence of COVID-19 cases, resulting in a decrease in the number of patient visits and shifting to handling COVID-19 patients.

It can be seen that the COVID-19 waste began to increase starting in March 2020 until the following months. The percentage of Covid waste from the end of 2020 until the beginning of the year reached 30-34% of the total medical waste produced by hospitals. The average daily medical waste generation during the COVID-19 pandemic is 670 – 1600 kg per day. March-May experienced a decrease in the generation of covid waste, but in June, it rose again with the percentage of covid waste generation.
43.35% of the total medical waste produced. The increase in the generation of covid waste in June is directly proportional to the increase in active cases of COVID-19 (Figure 1).

![Figure 1. Solid Medical Waste Generation Hospital X January 2020 - June 2021.](image)

An increase in the generation of medical waste in health services during the COVID-19 pandemic was also reported in several studies [11]. The generation of medical waste in hospitals and other health services can be predicted due to increased patient visits [4]. The results of the study show that the ratio of solid medical waste increases in the pandemic period in 2020 ranges from 1.39 to 2.08 kg/bed/day.

With the increase in solid medical waste in hospitals studied in the current pandemic condition, it is necessary to manage new hospital medical waste following current conditions to reduce the possibility of disease transmission from medical waste [12]. Management of solid medical waste starting from sorting, storing, transporting, and treating waste needs to be carried out following the guidelines set by the government [13]. Excellent and correct waste management can reduce the risk of disease transmission through medical waste media.

In the future, in a pandemic, the community’s use of personal protective equipment by the community will increase the burden of infectious waste generation in an urban area [14]. The development of the PPE production industry is also being intensified due to high demand from consumers [7]. The use of PPE by the community will later change the composition of urban waste.

Solid medical waste management strategies need special attention, such as compliance with regulations, member staff responsibilities, medical waste classification, special procedures for handling medical waste, and training for workers. However, each country has different policies for managing large and infectious waste during the COVID-19 pandemic [15].

4. Conclusion
There is an additional source of solid medical waste during the pandemic, namely a particular isolation room for COVID-19 patients. Changes in the components of solid medical waste, namely the rest of COVID-19 patients, are included in the infectious waste category, including food waste, food packaging, and contaminated objects. At Hospital X, there was an increase in the ratio of solid medical waste during the 2020 pandemic, ranging from 1.39 to 2.08 kg/bed/day. Improvements and changes in the characteristics of solid medical waste require new and good handling to reduce the risk of disease transmission. The limitation of this study was that it was only conducted at one referral hospital. For further research can provide an overview for a broader scope.

Acknowledgements
The author would like to thank the Semarang City Covid Referral X Hospital for being willing to become a research site and provide data on solid medical waste used in writing this manuscript.
References

[1] Anon 2021 Peta Sebaran COVID-19 | Satgas Penanganan COVID-19
[2] Anon 2021 Jateng Tanggap COVID-19
[3] Sutrisno H and Meilasari F 2020 Review: Medical Waste Management for Covid19 J. Kesehat. Lingkung. 12 104
[4] Kalantary R R, Jamshidi A, Mofrad M M G, Jafari A J, Heidari N, Fallahizadeh S, Arani M H and Torkashvand J 2021 Effect of COVID-19 pandemic on medical waste management: a case study J. Environ. Heal. Sci. Eng. 19 831
[5] Cheng Y W, Sung F C, Yang Y, Lo Y H, Chung Y T and Li K C 2009 Medical waste production at hospitals and associated factors Waste Manag. 29 440–4
[6] Menteri Kesehatan Republik Indonesia 2020 Keputusan Menteri Kesehatan Republik Indonesia Nomor Hk.01.07/Menkes/537/2020 Tentang Pedoman Pengelolaan Limbah Medis Fasilitas Pelayanan Kesehatan Dan Limbah Dari Kegiatan Isolasi Atau Karantina Mandiri Di Masyarakat Dalam Penanganan Coronavirus Disease 2019 1–18
[7] PB IDI 2020 Pedoman Standar Perlindungan Dokter di Era Covid-19
[8] Anon Kemenperin: Mampu Penuhi Pasokan Nasional, Kemenperin Pacu Industri TPT Ekspor APD
[9] Kalogiannidou K, Nikolakopoulou E and Komilis D 2018 Generation and composition of waste from medical histopathology laboratories Waste Manag. 79 435–42
[10] Anon Safe Management of Wastes from Health-care Activities - World Health Organization - Google Buku
[11] MA Z-M, MA R and L S-A 2020 Indirect effects of COVID-19 on the environment Sci. Total Environ. 728
[12] Torkashvand J, Jafari A J, Godini K, Kazemi Z, Kazemi Z and Farzadkia M 2021 Municipal solid waste management during COVID-19 pandemic: a comparison between the current activities and guidelines J. Environ. Heal. Sci. Eng. 19 173
[13] Kementerian Kesehatan RI 2020 Pedoman Pengelolaan Limbah Rumah Sakit Rujukan Rumah Sakit darurat dan Puskesmas Yang Menangani pasien Covid-19
[14] Wang J, Shen J, Ye D, Yan X, Zhang Y, Yang W, Li X, Wang J, Zhang L and Pan L 2020 Disinfection technology of hospital wastes and wastewater: Suggestions for disinfection strategy during coronavirus Disease 2019 (COVID-19) pandemic in China Environ. Pollut. 262 114665
[15] Das A K, Islam M N, Billah M M and Sarker A 2021 COVID-19 pandemic and healthcare solid waste management strategy – A mini-review Sci. Total Environ. 778 146220