Medical Waste Management During COVID-19 Pandemic

Valensia Fanny Ludya Liap[1]*, Melita Michele[2], Elisha Sanjaya[3], Yusra I. M. Dadoui[4], Vidia Naldly Putri[5]

[1] *Postgraduate Master of Management, Tarumanagara University*
[2] *Faculty of Architecture, Tarumanagara University*
[3] *Faculty of Engineering, Tarumanagara University*
[4] *Faculty of Integrated Arts, Sunway University*
[5] *Faculty of Communication, Tarumanagara University*
**Corresponding author. email: valensia.117182059@stu.untar.ac.id*

ABSTRACT
One of the major concerns that came along with the Covid-19 pandemic is the environmental issue caused by the high consumption of medical supplies, more particularly the plastic single use ones (PSUs). A pandemic of this magnitude has resulted in untenable volumes of medical waste. To this end, it is now more vital than ever to properly dispose of infectious medical waste.
The purpose of this study is to address medical waste management, and analyse the disposal systems in several case studies: Medical Waste Management in Surabaya, Indonesia, medical waste management in Seberang Jaya Hospital, Penang, Malaysia, and medical waste management by Poland government.
Keywords: *medical waste management; COVID-19; pandemic*

1. INTRODUCTION

The world has been immensely affected since the Covid-19 outbreak in 2019. Day by day, the number of people reported to be positive with Covid-19 around the world kept increasing and so is the number of deaths. Covid-19 is an infectious viral disease. The name is an abbreviation from Corona(CO) Virus(VI) Disease(D), (19) refers to the first recorded case in 2019. Covid virus is an airborne new strain of Corona viruses. It spreads from the infected person's saliva or nose discharge through air droplets when an infected person sneezes, coughs, or is in physical contact with others [1]. The rapid spread of Covid-19 has affected all life aspects from social, to economical, environmental, and health. To stop the infection spreading WHO among other agencies released a set of preventative measures to be followed in public spaces, starting from wearing medical masks,to keeping physical distance between individuals, to regularly washing hands and sanitizing them with alcohol-based hand sanitizers. On the other hand, many governments around the world were obliged to create new rules and protocols in an attempt to control the spread of the Covid-19. For instance, it is compulsory for individuals to wear masks in public, and for facilities/organizations to provide sanitizers. Moreover, the governments had to allocate facilities for treating the infected and quarinting individuals who were in touch with positive cases, or people who were traveling.

Hospitals are one of the main facilities that

played a big role during this pandemic in treating patients. During the treatment cycle, hospitals use various equipment and medical supplies such as masks, face shields, medical gloves, medical suits, surgical and isolation gowns, shoe covers, syringes/needles, hand sanitizer bottles, disposal blades and scalpels, etc. Many medical equipment, supplies and products used are made of single-use plastic (SUP), and are non-reusable for hygienic reasons. Since the number of patients are directly proportional to the amount of waste produced, environmental issues arise with the spread of the virusc. In addition, the recent production and distribution of vaccines has been a main factor in increasing the medical waste, along with the heavy use from the public of medical products such as needles/syringes, medical gloves, and masks. According to Benson, Bassey and Palanisami (2021), the estimated medical waste generated around the globe in this pandemic exceeded one and half million tons per day [2].

According to WHO about 85% of the waste created by health-care activities is non-hazardous waste, while the remaining 15% is classified as hazardous waste, which could be a source of infectious, toxic, or radioactive pollutants. In some cases, combustion of medical waste can result in the release of dioxins, furans, and particulate matter. It is highly crucial to manage and dispose of this wastage in a safe manner to deter negative health and environmental effects, such as the unintended release of chemical or biological hazards into the environment, including drug-resistant microorganisms, thus protecting the health of patients, health care workers, and the general public. These days, during the Covid-19 pandemic the medical wastage amount has noticeably increased. Individuals, organisations, and governments all need to be aware of this issue in order to overcome it.

There has been a plethora of research focusing on medical waste disposal prior to the Covid-19 pandemic. However, during the pandemic the focus on this matter has noticeably increased. For the purpose of this paper the focus will be on medical waste disposal during Covid-19.

According to WHO, failure in dealing with medical waste is associated with many factors, such as insufficient experience and knowledge about the health risks linked to it, inadequate training in proper handling of the wastage, lack of disposal management and appropriate disposal systems, and deficient financial and human resources [3]. Despite these challenges, research has been moving forward suggesting various creative ways to overcome this global struggle. For instance, Lakhouit (2020) discusses in detail the temporary storage of medical waste option and the criteria behind this storage, based on the hazardous classification of the medical waste, the seizing and the exposure of the storage location, the compatibility of the waste and compatibility of the wastge with the container its put in, and the climate in the storage location [4]. While Benson, Bassey and Palanisami (2021) analyze the probable consequences of plastic contamination based on the significant disruption in the supply chain and waste disposal system. They propose resurrecting new enterprises capable of developing new reusable or non-plastic PPEs in an attempt to create awareness about the importance of using dynamic waste management solutions aimed at minimising plastic pollution in the environment. Tirkolaee, Abbasian, and Weber (2020) developed a mixed-integer linear programming (MILP) to formulate the sustainable multi-trip location-routing problem with time windows for medical waste management in the COVID-19 pandemic employing a case study in Sari city of Iran to test the performance and applicability of their proposed model, intending to reduce total trip time, total violations of time windows/service priority, and total infection/environmental risk posed to the community in the vicinity of

disposal sites at the same time [5]. Akila V. et al. (2021) designed a BIOBIN, which is an IoT (internet of things) enabled device that can assist in tracking and maintaining databases in a cloud-assisted environment or on any central server to perform regression analysis in finding the dependent variables in analysing future waste deposition, which greatly aids in deciding how to dispose of the waste collected [6].

This paper aims to shed light on the medical waste disposal struggle during the pandemic. A comparison will be held between different cases of disposal of medical waste in various countries. This comparison aims to highlight the best ways to dispose of the medical waste based on real-life experiences, to provide strategic guidance during these difficult times and for future challenging times.

2. METHOD

This research is based on qualitative methods, it is obtaining information regarding how medical waste is processed and disposed of during the Covid-19 pandemic.

Several health and environmental agencies have regulations and laws regarding the disposal of medical waste such as WHO (World Health Organization), The Federal Health Agency in Germany, EPA (United States Environmental Agency), EC (European Commission), and SWANA (Solid Waste Association of North America). But with the rise of the Covid-19 pandemic, these agencies along with the governments have struggled to cope with the environmental and health issues this pandemic brought. On one hand, different countries enforced different regulations to manage medical waste disposal. One the other hand, researchers and innovators around the world have proposed variant solutions for this issue.

In this paper, several medical waste management and protocols case studies are acquired to observe it and compare it with WHO regulations and recommendations to test effectiveness in resolving this escalating issue.

3. RESULTS AND DISCUSSION

The World Health Organization has made many recommendations and requirements hospitals around the world should follow in order to prevent spreading infectious pathogens from medical wastes. Since the recent Covid-19 outbreak, WHO made further changes regarding waste management protocols such as [7]:

- Training medical staffs and collecting workers on constant tight health protocols due to Covid-19
- All Covid-19 medical wastes are considered infectious and are to be stored in separate yellow bags with ‘Covid-19 Biomedical Waste’ labelled.
- All wastes are to be treated before collecting and storing; by using chemical disinfectant, Centralized treatment (autoclave, microwaves), hybrid stream systems, and eco-friendly treatment methods
- Bins and other products in contact with waste should be disinfected and cleaned frequently
- Masks and gloves should be cut before disposal to prevent being reused

WHO also made several recommendations on different ways the wastes could be treated before reusing or disposal:

- Washable equipment could be cleaned and disinfected using ethyl alcohol, sodium hypochlorite, or hydrogen peroxide
- Steam based treatment; autoclaving or microwaving

Tracking the medical waste is also important

to prevent incinerations as that process produces secondary wastes. After treatment, the wastes that could be reused or recycled will continue the recycling process, while other non-recyclable or non-reused wastes shall be disposed of.

Waste Management in Surabaya, Indonesia

Currently, there are about 3 million Covid-19 positive cases in Indonesia, with a number of 30.000 new cases since the drastic increase in positive cases in July 2021. With the large number of positive cases, hospitals and isolation centres are filled with patients each day. The large increase of cases has an effect on the total waste produced by the patients and staff involved. Surabaya, one of the cities in Indonesia also has an increase in cases. The amount of wastes in Indonesia had an increase between 30%-50% after the pandemic reached 1.600 tons as of October, 2020[8].

Hospitals in Surabaya follow WHO health protocols as regards to PPE for staff, visitors, and patients, and the medical waste management from wards used by staff and patients to the last step of disposal.

Sorting and packing process of solid medical waste at the Covid-19 referral hospital are implemented by distinguishing solid medical waste that is being placed into a container or bin coated with a yellow plastic bag with the symbol “biohazard” and later on by making sure that the container was tightly bound. The medical waste produced was divided into two types, there are soft medical waste which later will be disposed of into a yellow plastic bag in a yellow trash can and sharp medical waste using a yellow plastic bag in a yellow trash can. In the sorting and packing stages there are keeping, labelling, cleaning, and process collecting.

From the results of monitoring carried out by the researchers from April to June 2020, officers carrying solid medical waste are always carrying the waste consistently according to their schedule without being absent. There were no complaints of Covid-19 symptoms arising from the officers carrying the solid medical waste up to the current date. There has never been any evidence that the officer handling the solid medical waste could be infected with the Covid-19 virus. Trolley disinfection is also carried out when solid medical waste has been relegated to a Temporary Disposal Site (TDS). that is in accordance with guidelines which is then placed and dried with the direct sunlight

Storage process of solid medical waste is already appropriate, that is, it must be done no more than 2x24 hours to the TDS. The need for proper planning in the management of solid medical waste because solid medical waste cannot be left full, if a container reaches ¾ then the container must be packed in tightly bound and must be transported immediately. In addition, potential hazards can also impact human health. Determination of landfill location was an important consideration of the impact on groundwater because it would have been caused by the formation of leachate.

Incinerators were used to reduce the volume of waste produced. Waste management using incinerators could protect humans and the environment from hazardous and toxic waste. This incineration could reduce the volume of waste by up to 90% so as to minimize the landfill area. ‘Combusting’ is one of the most widely used annihilation technologies, especially in several developing countries including the technology used by the COVID-19 referral hospital.

Seberang Jaya Hospital, Malaysia

As mentioned above, the hospital in Surabaya, Indonesia followed the medical waste management as recommended by

WHO. Another example is a government hospital located in Pulau Pinang, Malaysia that uses several ways to treat medical wastes as recommended by WHO before disposing the waste products for incineration.

Seberang Jaya Hospital is one of the referral hospitals in Malaysia that accepts admissions for several cases including Covid-19 patients. There are rooms and areas provided especially for Covid-19 medical wastes in the severe acute respiratory infection (SARI) ward, the emergency department, the paediatric ward and central sterile services department (CSSD).

Each ward has cleaners helping in cleaning, collecting, and managing specifically Covid-19 medical wastes; three cleaners for the SARI ward, one for the emergency department, the three more for the CSSD ward. Covid-19 medical wastes are separated from any other medical wastes by collecting them in yellow medical waste bags with Covid-19 medical waste labelled on it. Only designated Covid-19 cleaners mentioned have access to the room where these wastes are collected. These rooms are cold storages where Covid-19 medical wastes are put while waiting for the lorry to transport them to the incinerator outside the hospital.

The amount of daily waste produced in Seberang Jaya Hospital is about 800kg to 1000kg each day. About 120kg of the wastes are Covid-19 medical wastes. These Covid-19 medical wastes include needles, scalpels, knives, and blades. Infectious wastes that can transmit to human beings that may contain pathogens include swabs, gauzes, bandages, and pathology waste such as human tissue or fluid, body parts, blood, and body fluids; and chemical waste such as laboratory reagents, disinfectant or pharmaceutical waste-expired drugs.

Medical wastes are separated according to the guidelines given by the government. [9]

a. Sharps – needles, scalpels, knives, and blades.
b. Infectious waste which may transmit infection to human beings and waste suspected to contain pathogens – laboratory cultures, swabs, gauzes, and bandages.
c. Pathology waste, human tissue or fluid, body parts, blood, and body fluids.
d. Chemical waste – laboratory reagents and disinfectants.
e. Pharmaceutical waste – expired drugs.

All medical wastes are stored in cold storage rooms that can only be accessed by designated cleaners. The medical wastes are stored while waiting to be picked up by lorry to be transported to the incinerator site.

Treatment and disposal of healthcare waste may pose health risks indirectly through the release of pathogens and toxic pollutants into the environment (World Health Organization, 2018)[10]. All the medical wastes including the bins are treated by chemical disinfecting, autoclave, or incineration. After being transported, all the medical wastes will be incinerated and the ashes will be disposed after.

Both case studies have similar medical waste management as the both of them follows recommendations from WHO, and since both countries face similar issues regarding Covid-19, both countries take similar steps. As mentioned by WHO, making sure wastes are sorted by different colored bins, and different bags are important to prevent contamination especially wastes from Covid-19 patients. Both countries separate hazardous and infectious bags to collect different types of wastes. Both countries also use the incineration process to dispose of the medical waste products to reduce the volume of waste and is one of the safest ways to dispose of infectious wastes.

One of the differences between both countries is that Seberang Jaya Hospital in Malaysia has strict guidelines regarding the storing and accessibility to that waste storage. Seberang Jaya Hospital stores their wastes in cold storage rooms while waiting to be transferred to the incineration site. These storage rooms are also accessible only to designated workers. On the other hand, Surabaya Hospital in Indonesia stores their medical waste in direct sunlight to dry and must not be done for more than 2x24 hours. After that, the medical wastes are transferred to the incineration site.

Poland case study

Pikoń et al. (2021) explained that prior to Covid-19 Pandemic, the European Union (EU) was aiming to achieve a recycling percentage of: 55% by 2025, 60% by 2030 and 65% by 2035 as an environmental solution for waste disposal [11]. Poland was moving forward with treating the general waste problem; it gradually raised the amount of rubbish that was collected selectively. This was leading to a spike in the percentage of garbage that is recycled and returned to the loop of consumption. Unfortunately, coronavirus has halted this growing trend. With over 2.88 million positive Covid-19 cases, Poland now is facing the challenge of fulfilling the recycling percentage required by the EU, while successfully managing the spike in medical waste due to the pandemic.

In 2019, Poland collected 114.1 million tonnes of industrial garbage and 12.8 million tonnes of municipal waste. This indicates that the volume of industrial garbage collected was nearly nine times that of municipal waste. However, due to the pandemic there was a considerable fall in industrial waste creation. Even with the increase of municipal waste. Surprisingly this had a favourable influence on waste minimization in Poland.

In light of the Covid crisis, the prime minister of Poland made amendments to the Act of 13 September 1996, and issued The Act of 19 July 2019 amending the Act on maintaining cleanliness and order in municipalities and certain other acts. The new Act allows for more flexible waste management. The Act's offered alternatives are frequently less expensive and easier ways to manage waste. Unfortunately, this could lead to a decrease in garbage sent for recycling, which is incompatible with the Poland goal to follow the EU recycling plan. One of the waste treatment methods the government is following is anaerobic digestion, and even though it is done in degrees below 65 C, the virus will not survive any kind of fermentation as the shortest is about 15 days.

Although thermal treatment is a viable option during the pandemic for many countries, Poland still lacks enough intermediate and, most importantly, final facility capacity. Furthermore, the Covid-19 epidemic has caused a delay in new investments and plant modernization. Additionally, this option is not environmentally friendly as it results in secondary waste that is difficult to be processed and cannot be recycled.

Another medical waste disposal solution that Poland has been looking into is landfilling. Despite not being environmentally friendly. There are plans to phase out the storage of combustible garbage in landfills, which stimulates the use of this technique as a waste management option.

Disregarding these disposal options, Poland is still suffering from the sudden increase of medical waste due to the pandemic. Currently, there is insufficient capacity at final facilities for 1.9 million tons of combustible waste. In addition to that, the delay in the development of Waste Database (BDO in Polish) has resulted in uncontrolled waste treatment, with unlawful dumping,

burial, river discharge, and waste incineration all being commonplace. Inspections by authorised institutions are becoming less frequent, which has led to an increase in illegal disposal practises.

In conclusion, all these practices whether being applied or suggested have possible contamination risks, and are not environmentally friendly

4. CONCLUSION

From all the explanation above, we can conclude that:

1. One of the major concerns in Covid-19 pandemic is the environmental issue caused by the high consumption of medical supplies (more particularly the PSUs).
2. The purpose of this study is to address medical waste management and analyse the disposal systems in several countries and cities.
3. There are a lot of ways to manage the medical wastes, for example: making sure wastes are sorted by different colored bins (separate the hazardous and infectious bags) and different bags are important to prevent contamination, placed the medical wastes on low temperature storage or storage that got the direct sunlight before getting picked up and lock the storage so that only accessible by designated workers, do the disinfecting to the wastes, use the incineration process to dispose of the medical waste products.
4. Even though there are a lot of ways to dispose of medical waste products, we should implement those ways that are environmentally friendly.

REFERENCES

[1] World Health Organization. 2020. Key Messages and Actions for COVID-19 Prevention and Control in Schools. https://www.who.int, March 2020.

[2] Benson, N. U., Bassey, D. E., Palanisami. 2021. COVID pollution: Impact of COVID-19 pandemic on GLOBAL plastic waste footprint. Heliyon.

[3] World Health Organization. 2018. Health-care Waste. WHO. https://www.who.int/news-room/fact-sheets/detail/health-care-waste, 4 August.

[4] Lakhouit, A. (2020). Practical recommendations for temporary storage of medical wastes during the COVID-19 pandemic. *Indoor and Built Environment*, *29*(8), 1186–1188. https://doi.org/10.1177/1420326x20950432

[5] Tirkolaee, E. B., Abbasian, P., & Weber, G. W. (2021). Sustainable fuzzy multi-trip location-routing problem for medical waste management during the COVID-19 outbreak. *Science of The Total Environment*, *756*, 143607. https://doi.org/10.1016/j.scitotenv.2020.143 607

[6] A. V, G. B, A. J, T. K, R. Amirtharaja and P. Praveenkumar. 2021. BIOBIN for Safe handling and disposing of Biomedical waste during COVID '19. *International Conference on Computer Communication and Informatics (ICCCI)* pp. 1-4. https://doi: 10.1109/ICCCI50826.2021.9402682.

[7] Capoor, M .R. Health-Care Waste Management in COVID-19 Context : Best and Sustainable Practices. WHO. https://www.who.int/docs/default-source/searo/wsh-och-searo/malini-final-who-searo-shortest-hcwm-covid-sustainable.pdf?sfvrsn=3fcbc7c3_2

[8] Setiawan, V. N. 2020. Limbah Medis Akibat COVID-19 Tercatat Capai 1.662,75 Ton. Katadata. https://katadata.co.id/sortatobing/berita/5fae2113c8020/limbah-medis-akibat-covid-19-tercatat-capai-1662-75-ton

[9] Agamuthu, P., & Barasarathi, J. (2020). Clinical waste management under COVID-19 scenario in Malaysia. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, *39*(1_suppl), 18–26. https://doi.org/10.1177/0734242x20959701

[10] World Health Organization. 2018. Health Care Waste. https://www.who.int/news-room/fact-sheets/detail/health-care-waste

[11] Pikoń, K., Poranek, N., Czajkowski, A., & Łaźniewska-Piekarczyk, B. (2021). Poland's Proposal for a Safe Solution of Waste Treatment during the COVID-19 Pandemic and Circular Economy Connection. *Applied Sciences*, *11*(9), 3939. https://doi.org/10.3390/app11093939