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Medical Waste In The COVID-19 Pandemic Era: Management Solutions

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ABSTRACT

The volume of waste generated due to human activities is strongly influenced by the rate of population growth. The amount of waste created in an area is proportional to the number of residents from various types of activities, and the number of material goods consumed by the community. The environmental issue that currently has no doubt is that waste management is still far from adequate. The rate of population growth has a significant impact on the amount of waste generated by human activities. There is still a low level of human awareness of the bad effects caused by waste. Indiscriminate disposal of garbage and not being managed properly will cause big problems because throwing garbage in the open will result in soil pollution which will also have an impact on groundwater and air channels. The seriousness and need for waste management begin to be studied from upstream (waste source) to downstream (final disposal site) with the application of ideas such as 3R to 5R, but in the community, more emphasis is placed on the 3R priority, Reuse, Reduce, and, Recycle. The disposal of plastic waste is one of the contaminants that harm marine life. Not only threatening the terrestrial environment, waste pollution that is not managed properly can also have an impact on the marine biota environment because waste that ends up in the sea is the result of land waste. About 10% of all new plastic that will be produced will be waste going into rivers and ending up in the ocean. Marine debris, especially inorganic waste, is the main enemy that will not decrease and its existence will continue to be avoided. In this case, community participation is necessary to create a healthy living environment. Everyone from the community and the community has the same rights, obligations, and roles in environmental management, regardless of rural, remote, or urban communities, because the scope is not only in certain places but throughout the Unitary State of the Republic of Indonesia.

Keywords: Environment, Waste Management, Population, Marine Life.

INTRODUCTION

In December 2019, an outbreak of pneumonia caused by the coronavirus occurred in Wuhan, Hubei province, and has spread rapidly throughout China. This epidemic spread so quickly throughout the world. An outbreak with the name Corona Virus Disease 2019 (COVID-19) was caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2). On January 30, 2020, as a form of international concern and support, WHO declared the SARS-CoV-2 outbreak which began to spread throughout the world, was declared a health emergency. Public. This pandemic is sad and a very heavy burden for the world community and including Indonesia. Until September 2021, the total number of COVID-19 cases reached 229.7 million people in the world, 4.7 million died and 206.4 million people recovered (Wordlmeter Info. 21 Sep 2021). In Indonesia, the population exposed to COVID-19 reached 4.2 million people with cases of death of 140.6 thousand people and nearly 4 million people declared cured (KEMENKES RI, 21 Sep 2021).

The first case related to COVID-19 caused by the coronavirus emerged at an animal and seafood market in the city of Wuhan, China at the end of December 2019. It was later reported that many patients were suffering from this virus and it was found to be related to the animal and seafood market. The first people who fell ill from this virus were also known to be traders in the market. (Quoted from the BBC, BBC health and science correspondents Michelle Roberts and James Gallager) said the wholesale market for animals and seafood sold wild animals such as snakes, bats, and chickens. They suspect that this new coronavirus almost certainly comes from snakes. It is also suspected that this virus spread from animals to humans, and then from humans to humans. China was recorded as the country that first reported cases of COVID-19 in the world. At the end of 2019, representatives of the world health organization (WHO) in China received a notification about a type of pneumonia whose cause was unknown, detected in the city of Wuhan, Hubei Province, China. According to authorities, some of the patients were traders operating at the Huanan fish market.

With the spread of COVID-19 in Indonesia, the government officially announced the first COVID-19 case on March 2, 2020. Two positive Indonesian citizens said that they had direct contact with Japanese citizens who were visiting Indonesia. On March 11, 2020, the first case of death from COVID-19 in Indonesia happened to a 59-year-old male resident of Solo.

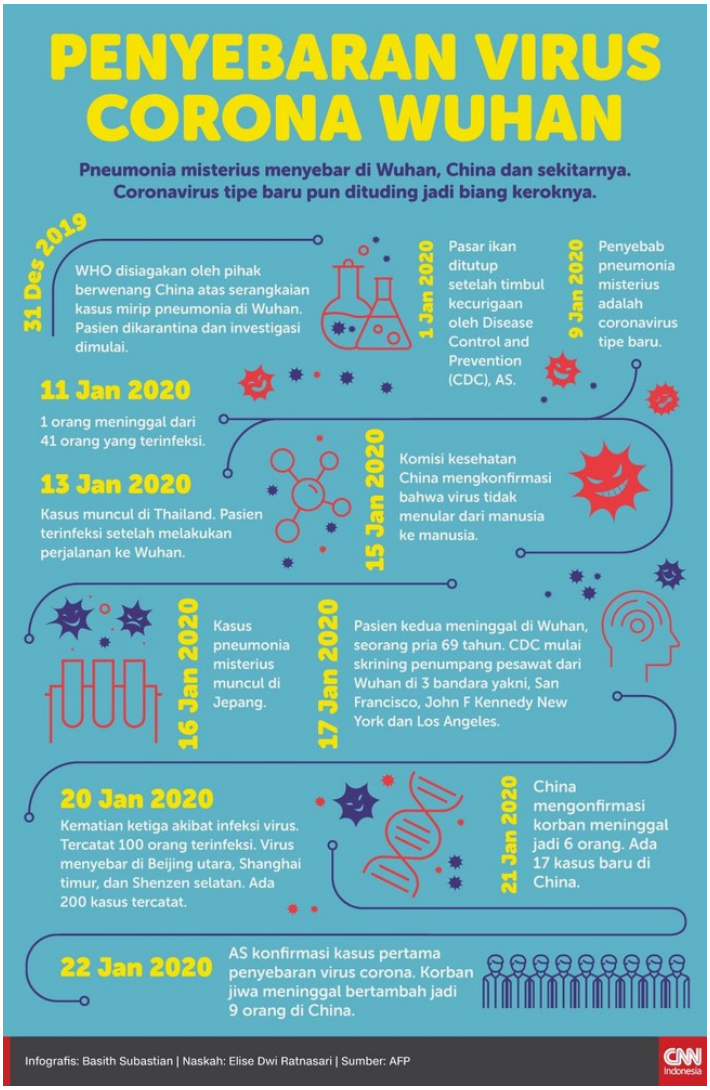


Fig 1. Pattern of the Spread of COVID-19 in Wuhan, China

LITERATURE REVIEWS

2.1 Impact of the COVID-19 Pandemic on Humans and the Environment

End of 2019, *the World Meteorological Organization* (WMO), informs that the earth has been in its hottest condition in history. This is thought to be due to the greenhouse effect caused by high carbon gas emissions as the main cause of global warming. In 2017, it was recorded that the concentration of CO2 in the atmosphere had reached 405.6 ppm and continued to increase, followed by an increase in the earth's temperature (Walhisulsel.org.id, June 8, 2020). One of the impacts of global warming in the form of sea-level rise caused by the melting of ice at the North Pole in addition to other adverse impacts in the form of climate change that triggers various hydrometeorological disasters around the world.

The same thing happened and happened to Indonesia, apart from the issue of global warming, environmental degradation that often occurs and becomes a challenge in itself. Reduction of forest area or deforestation often occurs. Indonesia experiences a large forest fire disaster every year. An area of 3.4 million hectares of land burned between 2015 and 2018 in Indonesia. In the waters, 35% of Indonesia's coral reefs are categorized as damaged, even though coral reefs can help reduce global warming because they can absorb CO2. While in the air, air pollution is often a problem, especially in big cities. The reason is the massive use of private and industrial vehicles (Greenpeace.org, 7 Feb 2020). Meanwhile, waste management, especially the issue of plastic waste.

The COVID-19 pandemic has changed the way people live in all forms of activity and adaptation to the situation is needed to slow down the spread of COVID-19. The application of lockdown in several areas that reap the pros and cons of government policies, does this policy have an impact on the environment? In general, the COVID-19 pandemic has a direct effect on global environmental conditions:

Positive Impact of the COVID-19 Pandemic on the Environment

Because population mobilization has decreased significantly during the COVID-19 pandemic, which has a positive impact on environmental conditions, among others;

- Reduced use of fossil fuels for transportation.
- Reduced consumption of natural resources and waste disposal.
- Ind activity reduced
- The sluggish tourism industry has an impact on reducing pressure on the environment.

Negative Impact of the COVID-19 Pandemic on the Environment

In addition to the positive impacts, the COVID-19 pandemic has also brought negative impacts, including;

- Increased medical waste
- Improper disposal of personal protective equipment (PPE).
- The addition of urban waste production.
- Reduced recycling activities.

2.2 Condition of Medical Waste in the Era of the COVID-19 Pandemic

The COVID-19 pandemic that has hit the whole world, apart from the number of victims exposed and the increasing number of deaths, has created other problems related to the procedures for managing waste. The problem of medical waste occurs almost all over

the world. The COVID-19 pandemic affects waste management procedures, especially medical waste management. The results showed that the COVID-19 pandemic caused an increase in waste generation in both government and private hospitals. In addition, the ratio of infectious waste in hospitals is increasing in the composition of medical waste compared to before the pandemic. During the COVID-19 pandemic, medical waste in Indonesia increased by more than 30% compared to before the pandemic. As an illustration, the volume of medical waste before the pandemic was 296 tons per day and increased to 382 tons per day during the COVID-19 pandemic. Medical waste, apart from being generated from more than 21,000 Health Service Facilities (Hospitals, Health Centers, and Clinics) in Indonesia, also comes from community activities related to the implementation of health protocols during the pandemic such as masks used daily. Medical waste management capacity in Indonesia is only able to reach 57% of the amount of waste before the pandemic, the rest is not managed properly and is scattered in shelters that manage community domestic waste such as TPS/TPA.

The amount of medical waste that is not managed, about 43% is due to the number of health facilities in Indonesia that are equipped with facilities according to regulations and laws, only 96 hospitals have incinerators, and the remaining more than 20 thousand hospitals entrust their medical waste management to third parties. Ironically, there are only 14 units of medical waste management facilities throughout Indonesia, consisting of ten companies located in the Java Pilau, two in Kalimantan, and one each in Sumatra and Sulawesi. It is certain that with the increase of 30% of medical waste during the COVID-19 pandemic, more and more medical waste is not managed and this of course creates its problems.

Various reasons were put forward regarding the small number of medical waste management facilities in Indonesia, including; the difficulty in obtaining waste processing permits, processing costs and technology are quite high, the concern for health facilities management/managers is not maximized, there are legal cases related to health facilities waste management, the implementation of medical waste management regulations has not been implemented and the imbalance between generation and processing capacity (Sofwan, 2017).

Medical waste in the laws and regulations of the Republic of Indonesia is categorized as hazardous and toxic waste (B3) so that its management is carried out with the precautionary principle and using safe and environmentally friendly waste management methods. Special treatment and facilities are required since the waste is generated (from the cradle) until it is destroyed (to the grave). Like other medical waste, waste originating from handling COVID-19 other than as B3 waste needs to be handled more seriously to avoid transmission. Research has shown that the cause of COVID-19, the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), can survive in certain conditions (temperature and humidity). It can take several days for the virus to infect humans, depending on the type of surface material on which it lives. However, with standard disinfection processes (using soap, disinfectant, or heating) the virus will be easy to inactivate or in other words not be contagious (Chin et al, 2020). In contrast to waste generated from households, medical waste affects health, environmental, economic, and social aspects, so that the management process becomes longer.

Referring to the Circular Letter of the Minister of Environment and Forestry No. SE.2/MENLHK/PSLB3.3/3/2020, several things need to be done to infectious medical waste originating from health care facilities such as; 1) Storage of infectious waste in closed packaging no later than 2 (two) days from the time it is generated; 2) Transport and/or destroy at the B3 waste treatment facility: a) Incinerator facilities with a minimum

combustion temperature of 800°C; or b) Autoclave equipped with a counter; 2) The residue resulting from combustion or autoclaved shredding is packaged and attached with a “toxic” symbol and a label for B3 waste which is then stored in a temporary storage area for B3 waste to be subsequently handed over to the B3 waste manager (Nurali, 2020).

Elements of medical waste management include sorting, storage, transportation, disinfection, and final disposal. The COVID-19 pandemic has led to increased patient and healthcare activities; One of the consequences of COVID-19 is its effect on the quantity and composition of medical waste. The COVID-19 pandemic is changing lifestyle influences on the amount and composition of urban waste; waste management in this condition is carried out according to the new guidelines.

The COVID-19 pandemic has increased the amount of infectious waste and medical waste generated at Final Disposal Sites. The worrying activity in the form of the disposal of masks and gloves by residents who have the potential to be infectious, in addition to activities to treat patients independently at home that is not controlled is suspected to be the cause of increased infectious waste products in addition to waste originating from health facilities.

Since the beginning of the pandemic in Indonesia which began in March 2020, COVID-19 medical waste has become a public health problem. Indonesia has the potential to generate more than 7,578 tons of medical waste from COVID-19 vaccination activities. (Media Indonesia, 2021). Medical waste does not only come from health facilities, but also the community, such as PPE, masks, and face shields, this waste material is plastic that takes 50-100 years to decompose. "Heaps of medical waste including masks and PPE are around 1,663 tons for the March-September 2020 period. Doni Monardo as the head of BNPB reminds us that medical waste management must be handled optimally with good and correct procedures.

Fig 2. Medical Waste Generation Impact of the COVID-19 Pandemic

2.3 Theoretical Foundations and Sources of Law

A. Definition

PP No. 22/2021 concerning the Implementation of Environmental Protection and Management, article 1 paragraph 67 defines Hazardous and Toxic Materials (B3) as substances, energy, and or other components which due to their nature, concentration, and/or amount, either directly or indirectly, can pollute and/or damage the environment, and/or endanger the environment, health, and the survival of humans and other living creatures. Meanwhile, what is meant by waste is the remainder of a business and/or activity (article 1 paragraph 68) followed by paragraph 69 which states that B3 waste is the

remainder of a business and/or activity containing B3. Meanwhile, non-hazardous and toxic waste, hereinafter referred to as non-B3 waste, is the residue of a business and/or activity that does not show the characteristics of B3 waste.

Medical waste is waste originating from medical services, dental care, pharmacy, research, treatment, care, or education that uses materials that are toxic, infectious, dangerous, or dangerous unless certain safeguards are carried out (Depkes RI, 2001). Based on the above understanding, medical waste can be grouped into several types. Most of it (about 85%) is the same as waste or garbage in general, and the remaining 15% is hazardous waste that must be managed properly to prevent the spread of disease.

The world health organization (World Health Organization, WHO) classifies medical waste into:

- Infectious waste, waste containing blood or body fluids. Usually comes from a medical procedure such as surgery or surgery sampling in the laboratory. Waste in the form of single-use materials used to absorb blood or body fluids, such as gauze or clothing fusion tube. Blood and body fluids, such as saliva, sweat, and urine, can contain bacteria, viruses, or other infectious sources of disease. Therefore, this waste is referred to as infectious waste.
- Pathological waste is medical waste in the form of human tissue, internal organs, and other body parts. This waste is usually generated after the surgical procedure is performed.
- Sharps waste, the use of sharp objects as tools for disease treatment procedures such as syringes, disposable scalpels, and razor blades is always used and there are quite a lot of them. The former sharp tools must be disposed of in a separate bright yellow box with a special label for sharp objects. The treatment for this medical waste needs to be done very carefully.
- Chemical waste, apart from being biological, medical waste can also be chemical. Examples of chemical waste from health care facilities are liquid reagents used for laboratory tests and waste disinfectant liquid.
- Pharmaceutical waste, This medical waste must be managed properly, it is feared that if it is disposed of carelessly, irresponsible parties can misuse it. Examples of pharmaceutical waste in health care facilities are medicines that have expired, or those that are no longer fit for consumption due to contamination. In addition to drugs, unused vaccines are also included in the category of pharmaceutical waste.
- Cytotoxic waste, waste, or residual products from toxic goods are very dangerous because they can trigger cancer and cause gene mutations. An example of cytotoxic waste is drugs used for chemotherapy.
- Radioactive waste is waste from radiological procedures, like x-ray, CT scan, as well as MRI. The waste can be in the form of liquids, tools, or other materials that are used and have been exposed and can emit radioactive waves.
- Ordinary waste, most medical waste is ordinary waste generated from daily activities in health care facilities hospitals, such as food for patients, plastic wrap for medical devices, and others.

If medical waste management is not carried out properly, it can pose a danger, especially for medical staff, hospital cleaners, and the surrounding community. Some of the risks that may occur, among others; 1) Wounds or incisions due to being pierced by used needles or used scalpels; 2) Exposure to toxins that harm health; 3) Chemical burns; 4) Increased air pollution when medical waste is destroyed by burning; 5) The risk of being exposed to excessive radiation without protection; and 6) Increased risk of dangerous

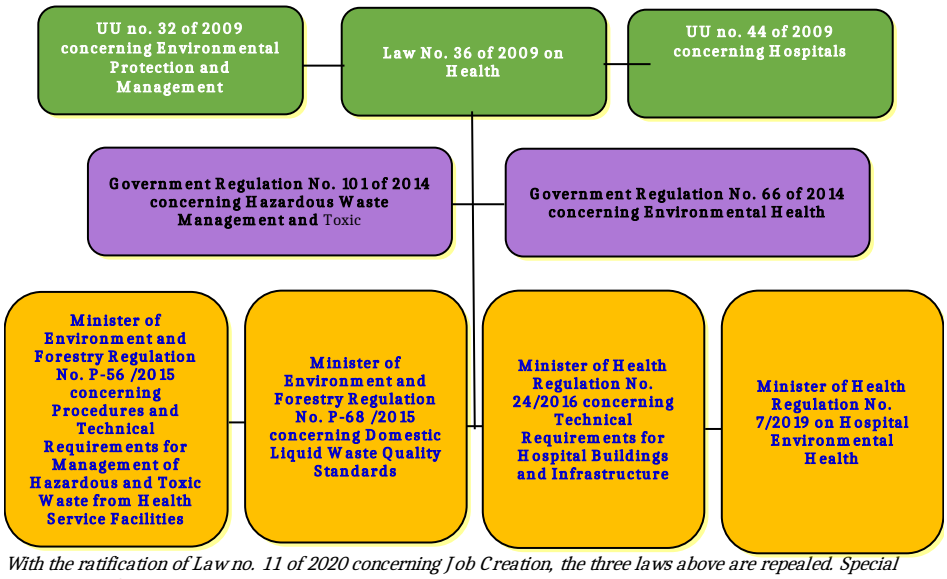
diseases such as HIV and hepatitis.

For this reason, medical waste management requires special methods. Each health care facility has a special team tasked with ensuring proper medical waste management. Broadly speaking, the medical waste management protocol is a regulated regulation of the Minister of Health of the Republic of Indonesia No. 7/2019 concerning Hospital Environmental Health.

The ministerial regulation explains that waste originating from health service facilities is included in B3 waste, it must undergo special stages in its management before being processed further. The following are some brief points contained in the Minister of Health Regulation of the Republic of Indonesia No. 7/2019; 1) Infectious waste and sharp objects before being burned and disposed of must be preceded by a sterilization process; 2) Solid pharmaceutical waste in large quantities, must be returned to the initial supplier where the material is obtained. If the amount is small and insignificant to be returned it must be destroyed or handed over to a waste management company; 3) Cytotoxic waste, whether in the form of metal or chemical or chemical liquid, must be managed especially before being disposed of. If the health care facility is unable to do so, the waste must be handed over to a company specialized in B3 waste management; 4) Liquid chemical waste is stored in strong containers so that it is not easy to crack in its management; and 5) Liquid medical waste is prohibited from being dumped directly into sewers or public waters before passing through the process at the waste handling installation of health care facilities.

B. Medical Waste in Indonesian Law

The laws and regulations related to medical waste management are regulated as follows.



With the ratification of Law no. 11 of 2020 concerning Job Creation, the three laws above are repealed. Special Law no. 36 of 2009 concerning Health, in addition to being amended by the Employment Creation Act,PERPU No. 1 Year 2020concerning State Financial Policy and Financial System Stability for Handling the Corona Virus Disease 2019 (COVID-19) Pandemic and/or in Facing Threats That Endanger the National Economy and/or Financial System Stability.

Regarding the obligation of health service facilities to manage waste, it is stated in Law No. 44/2009 concerning Hospitals is completed; installation of waste management (article 11 paragraph 1a), waste processing (article 10 paragraph 2t) and subject to complete environmental documents (article 8 paragraph 2). For completeness of hospital, infrastructure refers to the Regulation of the Minister of Health No. 24/2016 concerning

Technical Requirements for Hospital Infrastructure Building which includes the obligation to provide infrastructure for Waste Management Installations (article 18) and water installations which include the designation for dirty water or waste (article 19).

The health service facilities referred to in Law no. 44 of 2009 article 3 covers; the independent practice of health workers, Community Health centers, clinics, hospitals, pharmacies, Blood Transfusion Units, Health laboratories, Optical, Medical services facilities for legal purposes; and Traditional health care facilities. Meanwhile, Permen LHK No. P.56/MenLHK/Sekjen/2015 concerning Procedures and Technical Requirements for Hazardous Waste Management from Health Facilities, grouping health service facilities into fewer only include; Community Health Centers (Puskesmas), health service clinics or similar and hospitals. However, the emphasis of the Ministerial Regulation is more on the management of B3 waste in health facilities, which are categorized as B3 waste in health facilities, including materials with infectious characteristics, sharp objects, pathologies, expired chemicals, spills or packaging residue, radioactive, pharmaceutical, cytotoxic, medical equipment. containing high heavy metals, gas cylinders, and/or pressurized containers.

C. Medical Waste Management

Medical waste management by health service facilities refers to the Minister of Environment and Forestry No. P.56/MenLHK/Sekjen/2015 concerning Procedures and Technical Requirements for Hazardous Waste Management from Health Facilities including; Minimization/Reduction, Sorting, Shelter, Freight, Storage, Processing, and Utilization or Destruction.

- Minimization/Reduction: The most worrying thing about B3 waste is that the amount is increasing in direct proportion to the number of patient visits to health facilities. Minimizing the use of materials that are estimated to be B3 waste is very helpful as an effort to reduce the risk of B3 waste. These efforts can be carried out without limitation; 1) If there is an alternative, avoid using materials that contain hazardous and toxic materials. This can be done in line with the development of medical equipment technology such as thermometers made from non-mercury liquids, digitizing blood pressure measuring instruments; 2) Carry out good governance (good housekeeping) on any materials/materials that have the potential to cause health problems and/or environmental pollution; 3) Waste segregation as early as possible is adjusted to the types of groups, and/or waste characteristics; 4) Avoiding the accumulation of materials/chemicals in the warehouse by carrying out procurement management following good practices; and 5) Regular maintenance of medical equipment so that the use-value becomes longer.
- Sorting: The form of waste generated from health service facilities is in the form of solid, liquid, and gas waste. Since the beginning, the three forms of waste have been separated to facilitate further processing. The solid waste generated from the activities of non-medical equipment/material health service facilities such as waste from kitchens, offices, gardens, and yards known as domestic waste is categorized as non-B3 waste so

that its management is like a household or industrial domestic waste. Generally, the solid waste can be recycled or reused if possible according to the waste conditions and the technology applied. Better, if solid waste non-B3 waste is re-sorted into organic and non-organic waste before being sent to a temporary shelter (TPS). B3 solid waste can come from medical equipment and materials (infectious, pathological, and sharp objects) separated and packaged in such a way and marked as B3 waste. Likewise, non-medical B3 waste (pharmaceutical, cytotoxic, chemical, radioactive waste, pressure tubes, and waste with high heavy metal content) is treated the same before continuing its management. Liquid waste originating from health care facilities, including all wastewater (feces) which are likely to contain microorganisms, toxic and radioactive chemicals that are harmful to health, are not allowed to be directly discharged into the waterways of health care facilities without going through a screening process at the water treatment plant. waste (WWTP) belonging to health care facilities to a safe limit acceptable to the environment. The form of gaseous waste originating from the combustion of health care facilities such as incinerators, kitchens, generator equipment, anesthetics, and the manufacture of cytotoxic drugs is not permitted to be directly discharged into the air because it is feared that the burnt products still contain toxins that endanger health.

- Shelter: The next process of handling waste in health care facilities is the storage or placement of waste according to the form and type. The purpose of this receptacle is to ensure that the waste is safe from the reach of officers, patients, and visitors to health care facilities and that each type of waste is separated in such a way as to make it easier to identify the type and form of waste. The warehousing is carried out starting from the source of the waste generation by placing the appropriate content according to the shape and type and named and giving a plastic bag according to the color. Examples of medical waste using yellow containers, radioactive waste using red containers, and cytotoxic using purple containers. So that the syringe waste is not dangerous, after use, put it in a safety box or use a needle cutter/needle destroyer as a tool to separate the syringe from the syringe. Each hospital (large-scale health care facility) by the Regulation of the Minister of Health no. 24/2016 concerning Technical Requirements for Hospital Buildings and Infrastructure Article 27, waste management, if you do not have a final waste treatment unit (incinerator) at the hospital, you must instead have a temporary shelter before the waste is sent to a third party as the final waste manager. permission.
- Freight: Transportation of health care facility waste can be carried out by the health facilities themselves (internally) or in collaboration with other licensed parties (external). Waste collection in temporary shelters belonging to health care facilities is carried out at a minimum every day or as needed. Waste transportation is carried out before the waste storage container is full, the maximum capacity of the waste container is filled, transportation is carried out immediately. It is not recommended to carry out compaction or compression during waste collection before being transported, it is feared that the staff will be punctured by sharp objects from medical waste or by needles. Waste transportation by a licensed third party can be carried out from any storage

container or a temporary shelter belonging to a health facility. The mode of transportation, either three or four wheels, is made in such a way that the transported waste is not scattered on the road. Unlike the means of transporting domestic waste or garbage, the means of transporting medical waste are generally in the form of leak-proof containers.

- Storage: There are slight differences in the procedures for the temporary storage of B3 waste in health facilities based on the Minister of Environment and Forestry Regulation No. P-56/2015 concerning Procedures and Technical Requirements for Management of Hazardous and Toxic Waste from Health Service Facilities with Minister of Health Regulation No. 7/2019 concerning Hospital Environmental Health. The difference is related to the storage period for medical B3 waste (pathological, infectious, and sharp materials). The length of time allowed for storage according to the Regulation of the Minister of Environment and Forestry No. P-56 /2015 maximum of 2 days at a temperature greater than 0 degrees Celsius, while Permenkes No. 7/2019 explains that the length of time in temporary shelters can be up to 7 days at a temperature of 3-8 degrees Celsius.
- Processing: Methods for treating domestic waste, non-B3, and B3 medical waste are carried out in different ways. Domestic waste is managed as household waste management refers to Law No. 18/2008 concerning Waste Management: 1) Garbage is separated according to its type, there are 3 garbage bags for, organic waste, inorganic plastic, and inorganic non-plastic (glass, paper, metal); 2) Organic waste, processed in a simple way to be composted on a small scale. If the organic waste is not processed, the three types of waste are taken to the TPS by the community, another alternative is that the three types of waste are taken directly to the TPA by the government; 3) At the TPS, organic waste is managed into liquid and/or solid compost. The compost is used by the local community; 4) At TPS, inorganic waste is sorted. Inorganic waste that has economic value can be reused or sold. Waste that has no economic value is immediately taken to the TPA by the government; 5) At the TPA, the waste that has been sorted at the TPA is immediately processed to be used as material or commercial goods such as PLTS or recycled; and 6) At the TPA, the waste that is brought directly from the source that has been sorted, organic waste is directly turned into compost or other products (biofuel). Meanwhile, inorganic waste is separated into waste that can be reused and recycled. In addition, the term waste bank was introduced, namely procedures for managing waste starting from the source by reducing, reusing, and recycling into other products of economic value (Permen LH No. 13/2012). B3 waste generated by health facilities, the waste treatment is destroyed using own incinerator licensed from the Ministry of Environment and Forestry. The ash from the combustion is sent to a shelter and stockpiled. If the health facilities do not have their incinerator licensed by the Ministry of Environment and Forestry, the collected B3 waste is carried by transporter to a private medical waste processor (3rd party) with an incinerator licensed by the Ministry of Environment and Forestry, where the ashes from the combustion are then stockpiled.

- Utilization or Destruction: Utilization of B3 waste is an activity of reusing, recycling, and/or recovering which aims to convert B3 waste into B3 waste products that can be used as substitutes for raw materials, auxiliary materials, and/or fuels that are safe for human health and the environment (Permen LHK RI No. P.18/MENLHK/SETJEN/KUM.1/8/2020 article 1 paragraph 6). B3 waste utilization is a business entity that performs B3 waste utilization activities. The procedure for utilizing B3 waste is described and regulated in detail in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. P.18/MENLHK/SETJEN/KUM.1/8/2020 concerning Utilization of Hazardous and Toxic Waste.

D. COVID-19 Medical Waste

During the COVID-19 pandemic, medical waste generated by health care facilities increased sharply compared to before the pandemic. This has the risk of causing negative impacts on the environment and health. Circular Letter Number SE.3/MENLHK/PSLB3/PLB.3/3/2021 concerning Management of B3 Waste and Waste from Handling Corona Virus Disease-19 (COVID-19) explains in general terms related to handling waste, both B3 and non-B3 originating from handling COVID-19 and the implementation of sample testing and vaccination. Meanwhile, the source of COVID-19 waste can come from; 1) Health service facilities include hospitals, community health centers, health laboratories, health service clinics, and others; 2) Emergency hospital COVID-19; 3) Places of isolation/self-quarantine in the community include hotels, guesthouses, apartments and houses; 4) Detection test COVID-19, and 5) Vaccination site COVID-19.

Waste generated from the above places/sources can be in the form of domestic waste/garbage and B3 waste. Regarding the management of waste originating from COVID-19 cases, refer to the Decree of the Minister of Health of the Republic of Indonesia No. HK.01.07/Menkes/537/2020 concerning Guidelines for Medical Waste Management of Health Service Facilities and Waste from Isolation or Independent Quarantine Activities in the Community in Handling Corona Virus Disease 2019 (COVID-19). Guidelines for handling COVID-19 waste include; 1) Wastewater management; 2) Domestic solid waste management; 3) Solid medical hazardous and toxic waste management.

2.6 Discussion and Problem Solving

A. Medical Waste Problems and Management

Along with population growth or better known as the population and health facilities that develop and improve, coupled with the COVID-19 pandemic that hit the world, resulting in the addition of types of hospital medical waste used, among others, disposable masks that we use to prevent the spread of the virus. viruses, to bottles of medicine belonging to patients under surveillance who are self-quarantining, have increased and

become problems in handling them. The burden of medical waste is so large that it causes environmental problems where some waste such as masks are disposed of improperly and do not receive special treatment. The COVID-19 pandemic has shown us the inability of the government and health facilities and hospitals to manage medical waste such as masks and this condition is exacerbated by the public's lack of understanding about how to manage this waste.

For almost two years, the world, including Indonesia, has been hit by the COVID-19 pandemic and medical waste has become a global problem. These problems occur because 1) The method in waste management is not good where the method includes a waste management plan which includes education, training, auditing the type of waste and the volume of waste produced by each department, the community; 2) Dissemination of regulations related to medical waste management; and 3) Effective waste control measures to reduce health risks.

COVID-19 was first discovered in Wuhan, China in December 2019. As of May 21, 2020, COVID-19 has spread to 188 countries and regions. As of the end of September 2021, more than 230 million confirmed cases worldwide, and more than 4.7 million deaths have been reported to WHO. The spread of COVID-19 is increasing, one of the causes is inadequate medical waste management. The increase in the number of confirmed cases of COVID-19 has an impact on a significant increase in the volume of medical waste, so management of this waste is required. Here are some reasons why COVID-19 medical waste must be managed according to standard procedures that refer to the world health organization (WHO): 1) The Covid-19 virus can live for several days on inanimate objects, so the medical waste has the potential to spread to other people; 2) Hospitals in Indonesia, which are equipped with adequate facilities to manage hazardous and toxic waste (B3), are still very minimal; 3) During normal conditions before the pandemic, Indonesia produced 296 tons of medical waste per day; 4) There are still many third parties involved with health facilities to manage B3 waste whose permits are in doubt; 5) No sorting medical waste in Indonesian households, masks, medicine bottles, and tissues are mixed with ordinary household waste when disposed of; 6) Cleaners and scavengers are the most vulnerable to infection due to not implementing proper segregation and management of B3 waste; and 7) The COVID-19 virus is thought to spread primarily from person to person through respiratory droplets and close contact, as well as aerosols as a potential means of transmission.

Medical waste management is carried out by several management techniques. Methods or ways to minimize the risk of harm resulting from medical waste include:

- **Separation:** Separation is useful as the prevention of contamination of non-B3 waste with B3 waste. In addition, the separation makes it easier to transport. waste is sorted by amount, composition, and method of disposal.
- **Grouping:** Separate various categories of medical waste in health facilities, infectious and pathological waste, and sharp objects placed in different containers. Containers are labeled as biohazardous, closed, watertight, and uniform in color for each type of medical waste in all health facilities. The size of the container depends on the volume of waste generated and the container used is easy to handle and transport. For used

needles, a specially designed container is used, usually a box made of metal. Systems for separation, packaging, labeling and marking involve separating the medical waste into categories, as previously described. The packaging is done in colored bags, for example, yellow plastic bags are used for infectious medical waste that aims to be treated immediately by burning or buried deep in the final disposal site. However, if it is going to be burned, it is placed in a red plastic bag or container. This method does not apply to wastes originating from pathology, chemotherapy, and radioactivity. B3 waste is packaged in blue or white transparent bags, usually incinerated, chemically used and destroyed, or by landfill. As for labeling and marking, medical waste is known to have a bio-hazard symbol. Both packaging and labeling are adopted worldwide. The difference lies in the method of treatment.

- **Use of Disinfectants:** Disinfectants are used to reduce the toxic effects of some medical wastes. Chemical-based disinfectants (such as chlorine dioxide, sodium hypochlorite, or peracetic acid) are sometimes used by health facilities to ensure that the toxic effects are reduced. For solid waste, the disinfectant is effective on the waste material that has been crushed. In some cases, the disinfectant itself is hazardous, so it is not recommended for the treatment of pharmaceutical, chemical, and certain types of infectious waste.
- **Incineration or Burning:** Incineration is the process of destroying waste by burning it at a high temperature in a furnace, generally over 800 degrees Celsius.
- **Disinfection by Plasma:** In this process, the low-temperature plasma produced by the plasma generator using air as the working fluid regulates the combustion process.

Fig 3. COVID-19 Medical Waste Management

B. Condition of COVID-19 Medical Waste Generation in Indonesia

The Director of the Environment of the Ministry of National Development Planning/Bappenas said that one of the challenges due to the prolonged COVID-19 pandemic is the accumulation of medical waste which is categorized as Hazardous and Toxic Materials (B3). Medical waste which is categorized as dangerous reaches 20 thousand tons during the COVID-19 pandemic in Indonesia. This shows a significant increase in the amount of medical waste compared to before the pandemic. Data from the Ministry of Environment and Forestry (KLHK) shows that from March 2020 to August 2021 the figure has reached 20,110 tons of medical waste. This number will continue to

increase in line with the current government's intensified vaccination implementation, it is estimated that medical waste from vaccines can reach 7,500 tons.

Health facilities, in this case, hospitals that have licensed medical waste management units in the form of initiators and auto clips, have not increased much compared to before the pandemic. This has become a special difficulty for the government in its efforts to reduce the generation of COVID-19 medical waste.

Fig 4. Medical Waste Collection by Officers

2.7 COVID-19 Medical Waste Management Solution

Due to the COVID-19 pandemic, there has been a spike in the generation of medical waste in almost every country. In Hubei Province, China, there was a six times increase in the amount of generation from 40 tons per day, up drastically to 240 tons per day (Shi and Zheng, 2020). In Indonesia, medical waste generation has increased by more than 30% per day during the COVID-19 pandemic, from 296 tonnes per day to 382 tonnes per day, while the number of medical waste treatment facilities is very limited.

The reality on the ground shows that of the 132 hospitals referred to by the government to treat COVID-19 patients, only 20 hospitals have licensed incinerators and throughout Indonesia, out of nearly three thousand hospitals only 96 have licensed incinerator facilities, the rest the hospital handed over its medical waste management to a third party.
Seriousness is needed in handling COVID-19 medical waste, several studies have shown that the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) as the cause of COVID-19 can survive for several days at a certain temperature and humidity conditions (Chin et al, 2020). Careless handling, such as what happened in Jagakarsa, South Jakarta (Health, detik.com. 8 April 2020) and Timika, Papua (radartimikaonline.com. 27 April 2020), where COVID-19 medical waste is scattered without being properly managed, of course causing problems. which is quite serious amid the government's efforts to break the chain of transmission of COVID-19.

2.8 Medical Waste Management Capacity in Indonesia

The capacity of medical waste management in Indonesia carried out by health facilities has only reached 53.2 tons per day, plus the capacity of third-party management services is around 187.9 tons per day, while medical waste generated during the COVID-19 pandemic is estimated to reach 382 tons per day. days (Kemenkes.2020), there is a deficit of almost 141 tons of medical waste per day. This fact needs to be responded to well by the government to immediately increase the capacity for medical waste management by a significant amount from the current capacity.

The government's response related to the increasing number of COVID-19 medical waste generation is evidenced by issuing circulars to related parties; 1) Letter of the Ministry of Environment and Forestry Number 167 of 2020 concerning Management of Medical B3 Waste at the COVID-19 Emergency Health Facility; 2) Circular Letter of the Ministry of Environment and Forestry Number 02 of 2020 concerning Management of Infectious Waste (B3 Waste) and Household Waste from Handling COVID-19; and 3) Letter of the Director-General of Waste, Waste, and B3 Management No. 156/2020 Regarding Hazardous Waste Management for the Emergency Period for Handling COVID-19. In essence, the circular letter above is a quick response from the government as an effort to optimize medical waste management in Indonesia. One of the relaxations issued by the government is as shown in the Circular Letter of the Ministry of Environment and Forestry No. 02/2020 which allows health facilities that already have B3 waste management facilities to process their waste even though they have not yet obtained the required permits.

The B3 waste management capacity owned by third parties to deal with COVID-19 medical waste can be increased to 679 tons per day (Ministry of Environment and Forestry, 2020). If this is done, the generation of COVID-19 medical waste can immediately be reduced so that we can focus more on tackling the spread of the COVID-19 pandemic. In addition, the government plans to increase the capacity of B3 waste management by health facilities by creating a national priority waste management program in 32 locations in the period 2020-2024. Circular Letter of the Ministry of Environment and Forestry No. 02/2020 was followed up in several areas such as the DKI Jakarta provincial government through the Environmental Service which implemented the management of COVID-19 B3 medical waste. Through collection at the household level, sub-district depot, city depot, and transported by a third party to the extermination facility at the BantarGebang Waste Power Plant (PLTSa) (Warih, 2020).

2.9 The COVID-19 Pandemic as Momentum for Improving Medical Waste Management

The COVID-19 pandemic has shocked all parties, no country is ready to face this pandemic. The steps that have been taken by the government, although a bit late, need to be appreciated. However, several things need to be considered, including;

- **First**, medical waste treatment technology is still dependent on incinerators, and this technology is starting to be abandoned in some developed countries. It is suspected that the incinerator has the potential to produce exhaust emissions in the form of mercury and dioxins (Damanhuri, 2020). In addition, several cases show that handling medical

waste using incinerators is considered excessive and wasteful so that it is prone to misuse. Almost all incinerators owned by hospitals in Indonesia are not equipped with adequate air pollution controllers, instead of reducing the medical waste they produce other pollution in the form of mercury and dioxin emissions.

- **Second**, the current distribution of medical waste management, both owned by health facilities or third parties, is not evenly distributed throughout Indonesia. Of the existing capacity, 85% are on the island of Java, the rest are scattered in Sumatra, Kalimantan, and Sulawesi, even for the Maluku and Papua regions, there is not a single health facility and the private sector has medical waste management facilities. This shows that the principles of B3 waste management are not being met, namely as soon as possible and as close as possible (precautionary and proximity principles), and is exacerbated by the limited number of licensed B3 waste transporter services providers throughout Indonesia, which are only 140 companies. As a short-term solution to immediately reduce the amount of COVID-19 medical waste generation, the use of incinerators owned by industry (eg).
- **Third**, the government is expected to immediately create a healthy investment climate for medical waste processing and transportation services. Complex licensing is considered as one of the obstacles so that it does not attract investment in this service sector. However, the government is expected to remain present by encouraging State-Owned Enterprises and Regional-Owned Enterprises to immediately start engaging in the field of medical waste management services.
- **Fourth**, to support and increase the amount of medical waste treatment owned by health facilities by developing a lightening financing scheme. The All-Indonesian Hospital Association (PERSI) revealed that the financial condition of hospitals during the COVID-19 pandemic was very concerning and there was concern about the decline in the quality of health facilities services (Partakusuma, 2020). The potential for leakage of medical waste into the environment will increase and be dangerous for the community if the health facilities (RS) ignore medical waste management due to budget constraints.

CONCLUSION

From the end of 2019 until now, it has been almost two years since the coronavirus pandemic or COVID-19 is a deadly virus, spreading throughout the world, including Indonesia. On the other hand, the COVID-19 pandemic has had a positive impact on the environment such as reduced use of fuel for transportation, reduced resource consumption, and waste disposal, reduced industrial activity, reduced pressure on tourism. However, the increase in the amount of medical waste generation increased significantly, reaching more than 30% compared to before the pandemic. The occurrence of the COVID-19 pandemic that spreads to almost all countries, including Indonesia requires special handling by the government and the parties involved, both in terms of providing medicines, various kinds of medical equipment, and so on, including related to the management of medical waste due to the pandemic so that it does not damage human health and environmental quality. Based on PP No. 101/2014 in conjunction with PP No. 22/2021, medical waste is categorized as B3, and its management is carried out with the principle of vigilance and

using safe and environmentally friendly management methods, integrated from upstream when it is produced to downstream when it is destroyed. The increase in medical waste during the COVID-19 pandemic caused its environmental problems, due to the lack of public awareness of the dangers of medical waste, such as masks being found carelessly discarded and the generation of medical waste mixed with waste in landfills. Besides that, there is still an imbalance between the medical waste processing facilities owned by the hospital and the increase in the amount of medical waste generated during the pandemic. Various efforts to reduce medical waste generated during the COVID-19 pandemic have been carried out by the government together with hospitals that have processing facilities in the form of incinerators and auto clips, but the numbers are not sufficient so that a more radical way is needed to immediately reduce the gap between medical waste generated and processing facilities owned. The ease of licensing which has been an obstacle for investors to participate in managing medical waste needs to be parsed and resolved by involving various related parties. The COVID-19 pandemic is expected to be a momentum for Indonesia to improve the B3 waste management system, especially medical waste and in the end, the spread of the virus that causes COVID-19 will soon be cut off to lead to a healthier Indonesia, both for its people and the environment.

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