

## MANAGEMENT OF SARS-COV-2 MEDICAL WASTE AGAINST A COVID19 PANDEMIC IN INDONESIA: A LITERATURE REVIEW

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### Abstract

**Introduction:** SARS-CoV-2 RNA transmission in wastewater has a risk of fecal transmission of SARS-CoV-2 to humans and the environment. Despite the increasing number of cases in almost all areas in Indonesia, the study to review and evaluate waste management resulted from medical facilities is still limited and less explored. This literature review aims to analyze the applicability of WHO guidelines on wastewater management to be implemented in Indonesia. Scientific papers were collected from several electronic databases such as PubMed, PLoS, Researchgate, WHO, Elsevier, Science, SARS-CoV-2, Covid19, and wastewater. The articles were selected based on the inclusion criteria that use SARS-CoV-2, Covid19, and wastewater as the main variables observed. The articles published before 2013 were excluded from this review. **Discussion:** Wastewater monitoring of SARS-CoV-2 within medical and health facilities is implemented to identify the virus's presence as the causative agent of Covid19 disease, which contaminated the environment and society. The results of the analysis in wastewater can be used to determine the infection control in health facilities while also beneficial in formulating the monitoring of environmental impacts caused by the waste. These efforts would support policies or interventions based on public health by applying social distances, locking, quarantine areas that aim to break the Covid19 transmission. **Conclusion:** Briefly, by considering the urgency of Covid19 pandemic containment and control measures of transmission in health facilities, population and environment. It is a waste management guideline that is highly required to be implemented based on public health aspects.

## INTRODUCTION

In December 2019, China, according to an endemic of respiratory disorder in Wuhan, Hubei Province in Central China. Based on the research results using molecular biology methods, this pneumonia outbreak has a relationship with the novel coronavirus (nCoV) with 75-80% nucleotide similarity with SARS-CoV (1-2). SARS-CoV-2 has a reasonably close relationship with classic CoV viruses that have infected humans, namely OC43, NL63, 229E, and HKU1, four CoVs belonging to the genus Alphacoronavirus and Betacoronavirus (1-3). Coronavirus infects both animals and humans and causes various diseases, including enteric, respiratory diseases and neurological. There are four different genera of the coronavirus: Alphacoronavirus, Betacoronavirus, Gammacoronavirus, and Deltacoronavirus. MERS-CoV, SARS-CoV and SARS-CoV-2 are three highly coronaviruses pathogenic capable of infecting humans, which appeared in 2002, 2012, and 2019.

Membrane fusion and virus entry into the host cell is mediated by coronavirus glycoproteins and is thus the primary target of several neutralizing antibodies. There are two domains for glycoproteins, S1 and S2, where S1 is responsible for binding virions on the host cell membrane to ACE-2. Some vaccine and antiviral drugs which target glycoproteins have been developed. Many of these antiviral therapies' efficacy is 22, including interfering with minor RNAs, protease inhibitors, neutralizing antibodies, glycoprotein inhibitors, and glycoprotein cleavage inhibitors in in-vitro studies. Many approaches have also been used to develop vaccines that use all or some of the glycoproteins as antigens. These involve domain proteins, viral vectors, complete S proteins, recombinant glycoproteins, and DNA vectors for recombinant receptor binding.

There are three subtypes of SARS-CoV-2 based on nucleotide variants that produce amino acid changes identified in S, G, and V24 (4). Viral mutation rates are much higher than that of most other microorganisms, including eukaryotes and prokaryotes. The particularly true for RNA-based viruses such as SARS-CoV-2, Ebola, and dengue serve as catalytic sites for mutations because of the hydroxyl groups in RNA. This advanced rate of mutation leads to increased virulence and higher adaptive evolution capacity. In the meantime, Tang et al. indicated that SARS-CoV-2 has a characteristically high SARS-CoV-2 RNA virus mutation rate, and due to their genome encoding exonuclease, other coronaviruses may be slightly lower than other RNA viruses. However, their high mutation rate increases the potential for this zoonotic virus pathogen to adapt to the successful transmission from human to human and potentially allow it to become

more virulent (4). The genomic characteristics of SARS-CoV-2 are significantly different from those of MERS-CoV or SARS-CoV. Previous studies have shown that SARS-CoV-2 was 96% homologous to the RaTG13 bat coronavirus isolate. Another study recorded that the pangolin coronavirus homology of SARS-CoV-2 was 99%. It can be inferred from these findings that pangolins serve as intermediate hosts between humans and bats. The SARS-CoV-2 outbreak has caused medical and economic emergencies worldwide.

Covid19 can rapidly progress to acute respiratory distress syndrome (ARDS) in elderly patients over sixty years of age, with high mortality, especially in individuals with comorbidities, such as diabetes, cancer, pulmonary disease, and hypertension. Moreover, the reported coronavirus using ADE as another strategy for infecting host cells has been linked by facilitating viral entry and replication in host cells. Neutralization of viruses by antibodies occurs when antibody molecules bind to the virus's surface epitope and block the viral binding process to the receptor cells so that the virus cannot enter the host cell. In the ADE phenomenon, antibodies that bind to viral particles fail to neutralize. ADE from infection is caused by virus-antibody immune complexes with Fcγ and complement receptors on host cells. They can cause viral fusion and entry into monocytes, B cells, and macrophages, increasing virus generation and reducing viral clearance.

Besides, internalized immune complexes regulate the host immune system to increase viral replication and provoke disease severity. The intrinsic and extrinsic mechanisms of ADE simultaneously assist in increased viral replication and higher viremia levels. In the case of SARS-CoV, infected macrophages displayed little to no induction of interferon-β, leading to the hypothesis that viral suppression of the immune response in respiratory epithelial cells resulted in unregulated viral replication. This can happen in a high viral load causing more tissue damage. ADE is associated with triggering cytokine storms, which has implications for forming potent inflammatory cytokines and other chemical mediators. According to a recent study, the D614G mutation is associated with viral virulence and increased viral load in Covid19 patients. Based on the currently available information, there are several ways that D614G mutation can influence mutation and increase fusion activation, receptor binding or increase in ADE. Another mechanism for a mutation to the next D614G form can only be antibody escape facilitated by antigenic drift. If the D614G mutation in SARS-CoV-2 neutralizes the impact of antibody sensitivity, or ADE activity was observed in the SARS-CoV study, D614G could also be

an intermediate antibody escape mechanism making the individual more susceptible to the second infection.

SARS-CoV-2 disease, better known as Covid19, has myalgia, fever, weakness and dry cough symptoms, and more than half of the patients have dyspnea (5–8). On March 11, 2020, the WHO declared a global pandemic based on the “rate of spread and death caused by Covid19 (9). WHO also declared Covid19 an International Public Health Emergency on January 31, 2020 (1). SARS-CoV-2 has spread to more than 150 countries and more than 3 million cases, and the case fatality rate ranges from 5.3% to 8.5% on April 26, 2020 (1,10).

RNA SARS-CoV-2 will be released into the environment through saliva, sputum and feces, found in wastewater. Based on the results of several studies showing the need for a better understanding of wastewater's role as a potential source of Covid19, including public health risk factors and epidemiological data. The presence of the SARS-COV-2 virus in a state that has not been treated with drinking water is possible but has not been detected in drinking water supplies. Meanwhile, another coronavirus has not been detected in surface water or groundwater sources, so the risk of exposure to coronavirus to water supplies is still low (11). SARS-COV-2 has an envelope and is less stable in the environment than viruses in human digestion, which do not have an enveloped envelope for which we know a water-borne transmission pattern such as adenovirus, norovirus, rotavirus and hepatitis A. One study found that another human coronavirus can survive as long as two days in hospital wastewater 20°C and dechlorinated tap water (12).

In contrast, high levels of influenza virus contamination (> 4 logs) in residual chlorine 0.3 mg/l were observed in drinking water after a contact time of just five minutes (13). Another study found similar contamination within days to weeks. Significant contamination of 99.9% of the coronavirus was observed for two days in the primary sewerage at 23°C, two weeks in pasteurized sewerage at 25°C and four weeks in reagent at 25°C (14–15). The observations show that higher temperatures, higher pH and sunlight can reduce the viruses.

Recent evidence shows that the survival rate of SARS-CoV-2 on the surface is the same as SARS-CoV causes acute respiratory syndrome (SARS) (16) with survival on the surface from 2 hours to 9 days (17); SARS-CoV survival time depends on many variables, including temperature, surface type, type of virus and relative humidity. The same study also showed that using a common disinfectant, such as 0.1 % sodium hypochlorite or 70% ethanol, and an efficient inactivation

process could be accomplished in 1 minute.

In Indonesia, facilities and knowledge about medical waste management, especially those related to SARS-CoV-2, are minimal, including management and management of waste management related to SARS-CoV-2. The purpose of this literature review is to identify the management of SARS-CoV-2 medical waste and the potential public health risks associated with SARS-CoV-2 in wastewater, solid medical waste and hazardous waste.

## DISCUSSION

Literature searching was carried out using keywords: SARS-CoV-2, Covid19, and Waste Water. The database is drawn from articles published in PubMed, PLoS, Researchgate, WHO, Elsevier, and Science. The criteria for selecting the material data sought were selected using inclusion criteria. The inclusion criteria used that the articles used SARS-CoV-2, Covid19, and Wastewater as the primary variables being observed. the exclusion criteria for articles published before 2013.

### Types of Waste Related to SARS-COV-2

Millions of contaminated PPE (for example, gloves and masks) will end up as waste, which is improperly managed, posing a threat to the environment and health; Kampf found that the coronavirus can survive on surface materials (for example, metal, glass and plastic) up to 9 days (17). In developing countries, where green and sustainable waste management methods can destroy Covid19, the threat can be remedied. In developed countries with low waste management policies, however, it is higher. In many developed countries, solid waste is discarded in open and poorly unmanaged landfills where scavengers operate with recycled material without wearing the proper PPE (18).

Some landfills often act as “food banks” for animals that can wander the developing world, such as dogs and goats. Also, acts like Covid19 could infect humans and livestock, which is worsening the spread of Covid19. The problem may be that plastic bottles used for packaging drinks and water sold in many developing countries are insufficiently disposed of or disinfected, including health facilities and isolation centers—another possible Covid19 dissemination source in these countries. Covid19 will contaminate used bottles, which will increase the spread of Covid19 by reusing contaminated plastic bottles. Governments in developing countries are taking aggressive measures to monitor and reduce the spread of Covid19, which still lacks strategies for the management of solid waste, like used PPE during and after the Covid19 pandemic. Improper management of

**Table 1. Selected Articles**

Author/s	Research Title	Population	Method	Result	Conclusion
Jribi S, Ben Ismail H, Doggui D, Debbabi H (41)	Covid19 virus outbreak lockdown: What impacts on household food wastage?	284 respondent	online survey	Food waste can bring Covid 19, people need information about Covid19 garbage management	As a basis for further promoting household food waste prevention behavior, living longer than the Covid19 crisis
Yu H, Sun X, Solvang WD, Zhao X (42)	Reverse Logistics Network Design for Effective Management of Medical Waste in Epidemic Outbreaks: Insights from the Coronavirus Disease 2019 (Covid19) Outbreak in Wuhan (China)	-	literature review	Covid19 waste management is urgently needed, especially related to incinerators	More information is needed to manage covid-19 waste management
Ilyas S, Srivastava RR, Kim H,2020 (43)	Disinfection technology and strategies for Covid9 hospital and bio-medical waste management	-	literature review	policy briefs on the global initiatives for Covid-waste management including the applications of different disinfection techniques have also been discussed with some potential examples effectively applied to reduce both health and environmental risks	This article can be of great significance to the strategy development for preventing/controlling the pandemic of similar episodes in the future.
Peng J, Wu X, Wang R, Li C, Zhang Q, Wei D (44)	Medical waste management practice during the 2019-2020 novel coronavirus pandemic: Experience in a general hospital	-	literature review	The SARS-CoV-2 is a newly discovered, highly pathogenic, and infectious virus, all aspects of prevention and control shall be highly valued. Standardization and strict implementation of the management of Covid9 related medical waste should be with careful consideration to reduce the risk of epidemic within hospitals.	This study illustrates the practice of medical waste disposal responding to the 2019-2020 novel coronavirus pandemic.
Singh N, Tang Y, Zhang Z, Zheng C (45)	Covid19 waste management: Effective and successful measures in Wuhan, China	-	literature review	Larger capacities of mobile facilities should be maintained, particularly during the pandemic, which can be very important for the developing countries where the medical waste disposal facilities are limited. The mobile facilities are not only convenient for the emergency situation but can also be used as a strategic backup capacity for a state in the future as well.	- Medical wastes will drastically increase due to Covid19-outbreak. -Safe and sustainable waste management is a major concern. -Experience and lessons can be learned for medical waste management in China.
Ramteke S, Sahu BL (46)	Novel coronavirus disease 2019 (Covid19) pandemic: considerations for the biomedical waste sector in India	-	literature review	In the condition of the Covid19 scourge, this article shows that huge research is expected to evaluate the business as usual for plague mindfulness and reaction in the biomedical squanders. We require exposing the discussion around potential changes to rehearse, for example, for the assortment and treatment of biomedical waste materials from emergency clinics and isolate offices with positive or suspected Covid19 patients.	This article discusses the potential consequences of the Covid19 pandemic on biomedical waste administrations, concentrating on basic focuses where option working methodology or extra moderation measures might be fitting.
Sangkham S (47)	Face mask and medical waste disposal during the novel Covid19 pandemic in Asia	- Data on the population and the total number of confirmed Covid19 cases were collected from 49 countries in Asia. This method was used to highlight the spatial variation of the pandemic, which not only exists between different countries but also, more importantly, exists within each country. These data are important to estimate Covid19 related face mask and medical waste generation in Asia.	Online survey	This is the first study to estimate the face mask and medical waste use in the context of the Covid19 pandemic in Asia. The finding shows that the number of face masks used and medical waste has increased with the steady increase in the number of confirmed SARS-CoV-2 cases. Covid19 is pathogenic virus, and the concerned authorities should pay significant attention to all aspects of prevention and control.	Standardisation, procedures, guidelines and strict implementation of medical waste management for the Covid19 pandemic should be carefully considered to reduce the risk of the pandemic spreading to the environment within hospitals, community residences and public areas.

Author/s	Research Title	Population	Method	Result	Conclusion
Rume T, Islam SMD (48)	Environmental effects of Covid19 pandemic and potential strategies of sustainability	-	literature review	This study indicates that, the pandemic situation significantly improves air quality in different cities across the world, reduces GHGs emission, lessens water pollution and noise, and reduces the pressure on the tourist destinations, which may assist with the restoration of the ecological system. In addition, there are also some negative consequences of Covid19, such as increase of medical waste, haphazard use and disposal of disinfectants, mask, and gloves; and burden of untreated wastes continuously endangering the environment	this study also outlines possible ways to achieve long-term environmental benefits. It is expected that the proper implementation of the proposed strategies might be helpful for the global environmental sustainability
Rahman MM, Bodrud-Doza M, Griffiths MD, Mamun MA (49)	Biomedical waste amid Covid19: perspectives from Bangladesh	-	literature review	In Bangladesh, hospital waste is mainly managed by city corporations, third-party organisations, and non-governmental organisations.	A policy-level paradigm shift into a strategic, state-of-the-art medical waste management system is required. Failing to tackle the huge surge in medical waste amid Covid19 is likely to put Bangladesh at further environmental and public health risk.
Sharma HB, Vanapalli KR, Cheela VS, Ranjan VP, Jaglan AK, Dubey B, et al (50)	Challenges, opportunities, and innovations for effective solid waste management during and post Covid19 pandemic	-	literature review	This paper highlighted the pressing issues and global challenges of solid waste management in the context of the current Covid19 crisis.	Building robust and localized supply chains to counter food shortage and wastage would help us fight similar possible future pandemics. Similarly, from an economic point of view, there is a need to build a resilient socio-economic-environmental pathway to avoid or successfully sail through similar future crises.
Das A, Garg R, Ojha B, Banerjee T (51)	Biomedical Waste Management: The Challenge amidst Covid19 Pandemic	-	literature review	As is evident from the current situation of the pandemic, basic infection control practices are the only measures for containment. Proper waste disposal is an integral part of these control measures.	Through this letter, the authors intend to draw the attention of the concerned authorities at the institutional and local administrative levels for thorough implementation of the prescribed policies with the scope of overall improvement in the BMW segregation and disposal in daily practice which will be of immense help even after the pandemic.

used PPE, on the other hand, can pose a significant risk of increased Covid19 transmission (17).

**Waste Water Played an Important Role in SARS-CoV-2**

Asymptomatic infections are caused by the SARS-CoV-2 virus (4,10,19-20), so that there are obstacles in determining the level of Covid19 transmission in communities and between countries. This is because each country has different abilities in diagnosing Covid19 both in terms of numbers and tools (21). A method that is quite effective in detecting Covid19 and analyzing the spread of Covid19 is through Covid19 surveillance in

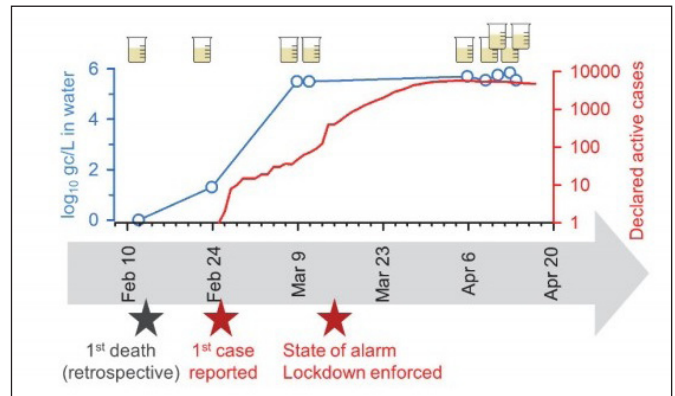
wastewater. This is because supervision or surveillance of Covid19 in wastewater provides unbiased results. Moreover, it can be used to evaluate the spread of infection in various regions. Supervision or surveillance on wastewater could be used to analyze circulating Covid19 variants, using phylogenetic analysis methods and comparing Covid19 variants between regions and the Covid19 genome evolution time (22–25) and most recently for SARS-CoV-2 (26). Based on the results of several studies that have been conducted, SARS-CoV-2 RNA was found in untreated wastewater with a concentration of 106 per liter and in treated wastewater of 105 per liter (26).

SARS-CoV-2 surveillance on wastewater can be used as an early warning system for Covid19 distribution. Wastewater monitoring of SARS-CoV-2 is a Covid19 identification system that has contaminated the environment and society; reducing SARS-CoV-2 in wastewater can also be used as a marker of reducing Covid19 cases in the community or region (31).

**Table 2. SARS-CoV-2 in Wastewater**

References	Location	Wastewater	Positive Rate
Wurtzer S, Marechal V, Mouchel J, Moulin L (26)	Australia	Wastewater is not processed	2/9 (22%)
Medema G, Heijnen L, Elsinga G, Italiaander R (29)	Belanda	Wastewater is not processed	14/24 (58%)
Wu F, Zhao S, Yu B, Chen Y-M, Wang W, Song Z-G, et al (30)	Amerika	Wastewater is not processed	10/14 (71 %)
Wurtzer S, Marechal V, Mouchel J, Moulin L (26)	Perancis	Wastewater is not processed	23/23 (100%)
		Wastewater processed	6/8 (75%)
Nemudraia A, Surya K, Wiegand T, Buyukyoruk M, Wilkinson R, et al (27)	Amerika	Wastewater is not processed	7/7 (100%)

The results of the SARS-CoV-2 analysis in wastewater can be used to determine policies or interventions based on public health through the application of social distancing, lockdowns and quarantine areas that aim to break the Covid19 transmission chain. Also, Covid19, which is identified in wastewater, can determine whether SARS-CoV-2 circulating in an area has mutated or not (32-33). Based on the results of recent research using modeling or simulation by Monte Carlo, that SARS-CoV-2 RNA in untreated wastewater can determine the number of people infected with Covid19. The results of the modeling conducted by Monte Carlo show that 171 to 1090 people were infected with Covid19 from the wastewater samples taken (28). One of the most recent studies conducted in the United States adopted a wastewater control approach that was able to be used to reveal the phylogeny of the SARS-CoV-2 strain in circulation, determine the heredity of the virus, and be able to evaluate the efficacy of public health interventions to overcome outbreaks (social isolation) (27).



Source : Randazzo W, Cuevas-Perrando E, Sanjuan R, Domingo-Calap P, Sanchez G (34)

**Figure 1. The SARS-CoV-2 Relationship in Wastewater and Human Cases**

**Management of Medical Waste Management during the Covid19 Pandemic**

Medical waste increased by 600% during the Covid19 outbreak in Hubei Province, People’s Republic of China (PRC), from 40 tons per day to 240 tons per day. The new patient transport and waste disposal system around the hospital has been overwhelmed by this. Similar challenges will also face other nations. To further minimize the spread of Covid19 and the development of other pathogens, additional waste management systems must be placed in the place.

**Table 3. Amount of Medical Waste in 5 Major Cities in Asia**

City	Population	Medical waste	Total production in 60 day
Manila	14 mil	280 ton/day	16.800 ton
Jakarta	10.6 mil	212 ton/ day	12.750 ton
Kuala Lumpur	7.7 mil	154 ton/ day	9.240 ton
Bangkok	10.5 mil	210 ton/ day	12.600 ton
Hanoi	8 mil	160 ton/ day	9.600 ton

Source : Jiangtao S, William Z.(35)

Management of used PPE, such as masks and protective garments, is critical for protecting against indirect Covid19 infection. PPE is classified as medical waste, such as face masks, protective gear, and public hospital emergency teams and segregated Covid19 hospitals. PPE has the power to carry Covid19, and both, directly and indirectly, distribute it. The most important principle is safety for people in hospitals and healthcare centers, people who work in places related to Covid19, effectively managing medical waste to avoid Covid19 (17,36).

The isolation medical waste management flow should follow these steps: “Dispose to the container for medical waste,”; “Storage in designated facilities,”;

“Transport by vehicle for medical waste”, and “Incineration destruction.” The medical waste container must consist of an outer plastic box and an inner plastic bag in the ‘Dispose to Container for Medical Waste’ stage and a red sign of infection must be displayed on the side of the plastic box. In the inner plastic container, individual safety or PPE that is used should be thrown away. After sealing the plastic bag with tape, cover the closed plastic box to ensure that the medical waste container is sealed properly, and then the container is disinfected by spraying it with a disinfectant. The designated facility must consist of a closed and guarded system at the “Storage in designated facility” level, isolating medical waste bins for up to seven days.

Insulation from hospitals and medical waste vehicle maintenance centers must be equipped with closed loading boxes when transporting medical waste and maintained at 4°C during transportation. Also, medical waste vehicles must be white, and both sides of the loading box must be marked with a red sign of infection.

It is necessary to treat isolated medical waste by incineration. Used household masks may be disposed of in garbage bags and burned or stored without recycling. Due to the spread of the Covid19 global pandemic, lifestyles have changed absolutely. Nearly everybody wears masks outside the house, sometimes washing their hands and, if possible, operating remotely. Most schools and universities are moving to online classes, household goods online shopping and increasing food delivery services. Packaging waste and single-use waste in households and isolated medical waste in hospitals have also risen substantially. In particular, the life cycles of packaging materials and single-use products are significantly shortened by express distribution systems. As the demand for recycled products has been reduced due to lifestyle changes by reducing use, wastewater treatment plants’ capacity should be increased.

To solve the emergency of waste due to Covid19, all stakeholders must cooperate. Waste related to Covid19, such as used PPE, masks, gloves and protective clothing in hospitals and healthcare centers, must be disposed of separately from other waste using special containers with a red biohazard symbol. Monitoring systems for collection, transportation and maintenance should be intensified using trace systems based on information and communication technology. All PPE, including used gloves and masks, used personal clothing associated with Covid19 infection in the household, must be separated for safe transport to incineration facilities.

SARS-CoV-2 infected patients with clinical signs of fever and cough are significant sources of infection,

with some reports indicating that asymptomatic carriers may transmit Covid19 through respiratory droplets from person to person, and close contact, aerosols, are possible transmission channels. Research has shown that SARS-CoV-2 can live up to 2-3 days on plastic and metal objects. It can contaminate the environment and infecting people; medical waste management can be an important way to control the source of infection. As some hospitals separate the area from storage rooms for general medical waste and medical waste related to Covid19, there is a potential risk for waste mixing due to the very close intervals and relatively longer transportation distances. Some hospitals have built waste disposal equipment on site for the quick and convenient disposal of medical waste related to Covid19. However, the expenditure is very high, and, if not collected in time, the residue will contaminate the surrounding area. It does not extend in low risk and medium regions or less developed countries to hospitals and organizations.

Medical waste management involves many departments and a large number of individuals requiring collaboration between departments. This framework brings together and coordinates training on Covid19, surveillance, material supply, safety management and disposal of medical waste. Management practices are adapted in time to epidemic outbreaks, and the critical point is to differentiate waste and reduce storage times. Thus, a separate temporary storage area for medical waste related to Covid19 is expected to be collected directly from the temporary storage area by medical waste disposal companies without unnecessary contact. To minimize the risk of leakage and harm during the hospital transfer process and increase transfer quality, the timing and route of collection and transportation of Covid19 related medical waste vary from general waste. The sanitary landfill, which is a means of disposing of hospital medical waste, is replaced by high-temperature incineration to monitor the outbreak better and reduce the risk of virus transmission. The hospital’s storage time has been changed from no more than 48 hours to no more than 24 hours. Nevertheless, more attention should be paid to managing medical waste in high-risk disease areas, such as the city of Wuhan in Hubei Province, and all household waste and medical waste in hospitals must be burned. With discharge times of less than 24 hours and, where possible, a frequency of twice daily (37).

### **Packaging and Classified Pretreatment**

The risk of carrying pathogens has been significantly enhanced by waste from face masks. Therefore, to collect the discarded masks, several buckets of medical waste with various markings were

placed in the hospital's general area. They are packaged in double-layered medical waste bags and disposed of as general medical waste by some workers.

Medical and household healthcare waste, examination room accommodation, ward observations, isolation wards and medical laboratories, in particular laboratory nucleic acid testing, should be treated as medical waste related to Covid19 and a label printed with 'infectious Covid19' should be placed. To prevent damage to the wrapping, wound waste is packaged into alert boxes. After being filled with another double-layered medical waste container, the chlorine-containing disinfectant is sprayed once again for disinfection. Then, in the medical waste bucket, the injured waste is put in. Specimens or preservative solutions containing laboratory pathogens must be sealed and pre-packed. They must then undergo high-pressure steam sterilization at 121°C for 110 minutes before putting them in the medical waste bucket.

### Temporary Storage

For medical waste relevant to Covid19, a separate temporary storage area with a significant warning sign has been created. Medical waste buckets from fever clinics, observation wards, isolation wards, and nucleic acid testing laboratories are brought into this area to avoid mixing them with other waste from the general ward. The temporary storage period for medical waste associated with Covid19 does not exceed 24 hours in the hospital.

### Collection and Transportation

Specially qualified personnel and select vehicles must prepare for medical waste disposal related to Covid19, which must be distinguished from general medical waste. To keep accurate records of time and quantity between external and internal carriers, separate hand over books are used. Transport roads should avoid crowds as much as possible and rush hours in the morning and at night should be avoided. Immediately after loading and unloading, storage spaces and vehicles must be disinfected.

### Centralized Disposal

By high-temperature incineration, Covid19-related medical waste is ideally treated. While air pollution may be caused by the gases exhausted during the combustion process, previous research has shown that combustion is the most common and successful way to kill infectious diseases and be applied to a range of infectious medical waste. Processed after high temperature steaming and boiling, with sanitary landfill.

### Disposal Practices

The estimated daily production of medical waste is 2.1 tons, and there is about 150 kg of associated Covid19 medical waste. Under general management, the disposal time for Covid19 related medical waste was reduced by almost 2 hours and the transport distance was reduced by approximately 1,000 meters compared to the normal situation (38–40).

### CONCLUSION

Covid19 waste management according to WHO standards can be applied in Indonesia and it is highly needed to break the Covid19 transmission chain in society.

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