

The management of healthcare waste during the (COVID-19) pandemic: Experiences of (India, Japan, Malaysia, Indonesia, China, & Thailand)

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Abstract: This study is an attempt to reveal the effect of the Corona pandemic on the quantity of healthcare wastes in six countries, mainly India, Japan, Malaysia, Indonesia, China, and Thailand. These countries have witnessed an incredible increase in the amount of healthcare waste by more than 30% during the pandemic. Moreover, this work evinces the methods and practices that have been taken in these countries to safely dispose of the healthcare waste that was related to COVID-19 patients. In a conclusion, this study shows the necessity of reviewing and updating laws, re-adapting the health system, management systems, and healthcare waste management to face the current and other possible health crises, and setting urgent protocols for healthcare waste management to be used during future health crises.

Keywords: Coronavirus; (COVID-19); waste; Healthcare waste; Healthcare waste management; pandemic

Jel Classification Codes : Q50; Q53

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Introduction:

By the end of 2019, the world has witnessed the emergence of a new Coronavirus disease (COVID-19) or what has also known as (SARS-Cov-2) in the Chinese city, Wuhan. In the middle of 2020, this virus has already spread to many countries around the world where millions of cases were confirmed and hundreds of deaths were recorded according to the World Health Organization (WHO).

Due to the rapid rise in the number of coronavirus cases, the healthcare waste (HCW) of COVID-19 patients has also witnessed a large and noticeable increase in its quantity. These HCWs are considered toxic substances as well as a risk of contamination. In addition, the HCW that are generated by health care institutions during the performance of their diagnostic and therapeutic services carry a large number of viruses, chemical germs, and even radioactive materials. As a result, the poor and unsafe disposal of these wastes will cause again the spread of the COVID-19 virus and, thus, the inability to control it. For this reason, it has become crucial to manage and dispose of the HCW in a safe, efficient, and orderly manner to face this pandemic.

Through the above, the study problem appears to be formulated in the following basic question:

What is the impact of the COVID-19 pandemic on the quantity of healthcare waste? In addition, what are the measures that should be taken in order to manage the healthcare waste that are related to COVID-19 infected patients?

To answer the above-mentioned research question respectively, we hypothesize that, first, the amount of HCW is directly affected by the number of infections with the SARS-Cov-2 virus, and second, a set of urgent measures are taken to manage HCW related to COVID-19 patients for the sake of controlling the spread of the virus during this health crisis .

This study, then, follows a descriptive and analytical method to review and understand the literature that is relevant to the study. Furthermore, it is important to analyze the collected data and discuss its main findings to either validate or deny the hypotheses of the

study. The data of our study is collected from six countries, namely: Thailand, Japan, China, Indonesia, India, and Malaysia during 2020 and the first trio of 2021.

This work is divided into two main parts: a theoretical part that is devoted to exploring the concepts that are relevant to this study, and a practical part that is devoted to collect, analyze and discuss the collected data. The latter consists of the volume of HCW in the selected countries during the pandemic, and the measures that are taken to manage HCW, which are related to COVID-19 patients.

I- Theoretical Framework:

I.1. Health-care waste definition:

- The term health-care waste (HCW) includes all the waste generated within health-care facilities, research centers, and laboratories related to medical procedures. It also includes the same types of waste originating from minor and scattered sources, including waste produced in the course of health care undertaken in the home (e.g. home dialysis, self-administration of insulin, recuperative care) (WHO, 2014, p. 03).
- Healthcare waste includes all the waste generated by hospitals (HCEs), research centers, and laboratories that are associated with health procedures. The waste produced by HCEs is comparable to domestic waste and usually regarded as general HCW or as non-hazardous waste. In addition, hazardous waste includes sharp, infectious waste, pharmaceutical waste, pathological and genotoxic waste, pressurized containers and high heavy metal and radioactive waste has the potential to pose a variety of environmental and health risks (Nuralam, Xiao-lan, Dubey, & Wen-Chuan, 2017, p. 524).

Based on the previous definitions, we can define health care waste as that waste generated from various facilities that provide health care services: research centers, production of medicines and vaccines, veterinary treatment centers, medical analysis laboratories, and from treatment and nursing at homes. The latter consists of non-hazardous waste such as household waste and hazardous wastes,

which are harmful to health and the environment (sharps and infectious wastes among others).

I. 2. Categories of health-care waste:

Healthcare wastes are usually classified before disinfection. The typical composition of healthcare waste is approximately 85% general non-infectious, 10% infectious/ hazardous, and 5% chemical/radioactive (Jiao , Jin , Dan , & al, 2020, p. 4).

According to the World Health Organization, HCW is classified into:

Table (1) : Categories of health-care waste

The category of waste	Description and examples
Hazardous health-care waste (15%)	
Infectious waste	Waste known or suspected to contain pathogens and pose a risk of disease transmission, e.g. solid waste and wastewater contaminated with blood and other body fluids, including highly infectious waste such as laboratory cultures and microbiological stocks.
Sharps waste	Used or unused sharps, e.g. hypodermic, intravenous or other needles; auto-disable syringes;
Pathological waste	Human tissues, organs or fluids; body parts; fetuses; unused blood products
Pharmaceutical waste, cytotoxic waste	Pharmaceuticals that are expired or no longer needed; items contaminated by, or containing, pharmaceuticals. Cytotoxic waste containing substances with genotoxic properties e.g. waste containing cytostatic drugs.
Chemical waste	Waste containing chemical substances, e.g. laboratory reagents; film developer;
Radioactive waste	Waste containing radioactive substances, e.g. unused liquids from radiotherapy or laboratory research;
Non-hazardous or general health-care waste (85%)	
Waste that does not pose any specific biological, chemical, radioactive or physical hazard.	

The source: (WHO, 2017, p. 04)

I. 3. Current practices of COVID-19 waste management:

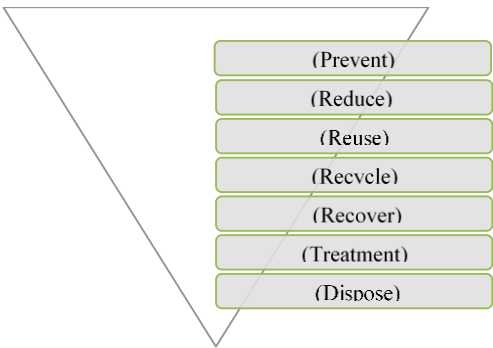
I.3.1. Segregation, storage, and transportation of COVID-19 waste:

The proper segregation of healthcare waste at source, storage, and transportation are required not only to stop negative health and environmental impacts, but also to take care of resource efficiency and material recovery. Besides, existing operational protocols for healthcare waste management HCWM and municipal solid waste management (MSWM) should be continued for COVID-19 waste with specific precautionary measures, adjustments, and arrangements. They should be applied to mitigate any potential risks of COVID-19 infection within the waste management process. The subsequent key findings that are collected in regard of handling healthcare waste from healthcare facilities are identified through a desk study and a questionnaire survey (UNEP, 2020, p. 31).

I.3.1.1. Waste minimization:

According to the waste management hierarchy shown in (Figure 01), based on the concept of the 03Rs (reduce, reuse and recycle), the best practice of healthcare waste management is not to produce waste in the first place by avoiding wasteful ways of working. In the second place, recycling the maximum amount of waste should be conducted rather than disposing of by burning or burial. Healthcare managers can also take measures to reduce waste production by adapting purchasing and inventory control strategies.

The Figure (1): Hierarchy of waste management



The source: (WHO, 2014, p. 67)

I.3.1.2. Waste segregation at source:

Colour coding makes it easier for the staff, who handles waste, to put the items into the correct container and to maintain segregation of the wastes during transport, storage, treatment and disposal. Colour coding also provides a visual indication of the potential risk posed by the waste in a particular container.

Each country has issued some specific regulations, operations and recommendations for proper waste segregation and handling at the source that includes COVID-19 waste generated by healthcare facilities, as shown below (UNEP, 2020, p. 31):

- Segregate waste that is close to the source as soon as possible (proximity principle).
- Place segregated waste in identifiable, color-coded, labelled containers or bags, which are leak-proof and puncture resistant (particularly for sharps).
- Place instructions for proper waste segregation close to the container.
- Use double-layer bags. Waste is to be placed in a special bag or container, sealed, and then placed in the second bag or container.

I.3.1.3. On-site transport and storage of waste:

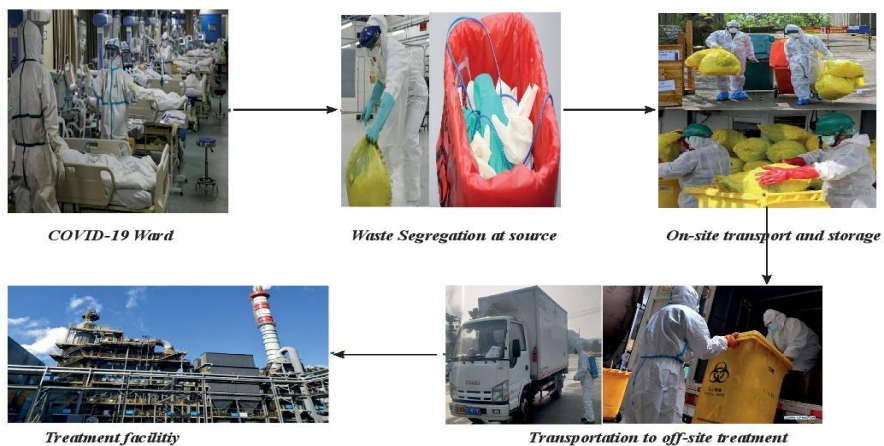
On-site transport should take place during less busy times whenever possible. Set routes should be used to prevent exposure to staff and patients and to minimize the passage of loaded carts through patient care and other clean areas. Depending on the design of the health-care facility, the internal transport of waste should use separate floors, stairways, or elevators as far as possible. Regular transport routes and collection times should be fixed and reliable. Transport staff should wear adequate personal protective equipment, gloves, strong and closed shoes, overalls, and masks (WHO, 2014, p. 87).

I.3.1.4. Transportation to off-site treatment:

Off-site transport includes activities related to carrying healthcare waste on public roads from the respective healthcare facilities to the treatment facilities. It is important to offer regular and

increased waste collection services for identifying COVID-19 healthcare facilities. When possible, we should use specialized, licensed healthcare waste service providers for transporting healthcare waste. Some countries have introduced a manifest system or waste-tracking note before sending hazardous healthcare waste offsite, which includes the following information: (i) waste type, (ii) waste sources, (iii) pick-up date, (iv) destination, (v) driver's name, (vi) the number of containers or volume, (vii) the receipt of the load received from the responsible person at the pick-up area (UNEP, 2020, p. 33).

Figure (2): Schematic of the HCW: From generation to disinfection and disposal practices



1.3.2. Treatment and disposal methods of COVID-19 waste:

1.3.2.1. Incineration:

Incineration is based on a high-temperature combustion range between 800 °C to 1200 °C that completely kills the pathogen and potentially burns up to 90% organic matters. The most of the COVID-waste are sent to incinerate at a temperature > 1100 °C. Sometimes, the residual mass is re-incinerated with fresh charge depending upon the volume reduction of COVID-waste. There are a number of toxins that are produced in-situ like furan and dioxins. They have a high tendency to accumulate in fatty tissues and cause damage to the immune and endocrine system. Therefore, the flue-gas treatment facility is also required with the incineration facility that costs

additional burden to the operator (Sadia , Rajiv , & Hyunjung , 2020, p. 03).

I.3.2.2. High-temperature steam disinfection (Autoclave):

High temperature steam disinfection refers to the wet heat treatment process that uses high-temperature steam (saturated water vapor with a temperature higher than 100 °C) to kill microorganisms on the transmission medium. Hospital wastes are exposed in an environment with a certain temperature of water vapor for a certain period of time. Due to the latent heat released by the water vapor, pathogenic microorganisms undergo protein denaturation and coagulation, which leads to the death of microorganisms (Jiao , Jin , Dan , & al, 2020, p. 06).

I.3.2.3. Medium temperature microwave technique:

This technique operates under the temperature range between 177 °C and 540 °C. It includes reverse polymerization by applying the high-energy microwaves under an inert atmosphere for breaking down the organic matters. The absorption of electromagnetic waves (with a wavelength of 1 mm to 1 m in the frequency of hundreds of megahertz to 3000 MHz) increases the internal energy as the resultant vibration and rubbing of molecules. However, an inert environment created by nitrogen prohibits the combustion with oxygen to exhibit high-temperature disinfection. Relatively lower energy and action temperature, limited heat loss, and less environmental burden with no toxic residue after the disinfection process are the main advantages of the microwave technique. The specially designed microwave devices under strictly controlled process can prominently inactivate SARS-CoV-2 (Sadia , Rajiv , & Hyunjung , 2020, p. 04).

I.3.2.4. Chemical disinfection technique:

The chemical disinfection technique is widely applied to pre-treat COVID-waste in combination with prior mechanical shredding (Sadia & Al, 2020, p. 05). Generally, the crushed hospital wastes are mixed with chemical disinfectants (such as sodium hypochlorite, calcium hypochlorite, chlorine dioxide, etc.) and remained for a sufficient time. During the disinfection process, organic substances are decomposed and infectious microorganisms are killed or inactivated.

Chemical disinfectants are featured with low effective concentration, rapid action, stable performance and broad sterilization spectrum. Not only do they kill microorganisms, but also bacteria (Jiao , Jin , Dan , & al, 2020, p. 06).

II- Methods and Materials:

This article presents a comprehensive source of information data on healthcare waste management under the COVID-19 pandemic in (India, Japan, Malaysia, Indonesia, China, Thailand), which can be further utilized for the development of strategic plans, or contingency plans in order to protect people and the environment, towards achieving sustainable healthcare waste management in developing countries .The relevant data and information were collected by applying desk review.

A desk review of articles, reports and guidelines related to healthcare waste management under the COVID-19 pandemic in (India, Japan, Malaysia, Indonesia, China, Thailand), was carried out using Google Search, Google Scholar and the scientific articles from SNDL (Algerian National Online Documentation System).

III- Results and discussion:

III.1. Results

III.1.1. The volume of (HCW) generated from various health care activities:

The table below shows the medium production rates of HCW according to the type of health care facility under normal circumstances.

Table (2): Average Waste Generation Rates by Type of Facility

Facility	Total Healthcare Waste Generation	Infectious Healthcare Waste
Hospital	2 kg/bed-day	0.5 kg/bed-day
Clinic	0.02 kg/patient-day	0.007 kg/patient-day
Maternity	5 kg/patient-day	3 kg/patient-day
Clinical Laboratory	0.06 kg/test-day	0.02 kg/test-day
Basic Health Unit	0.04 kg/patient-day	0.01 kg/patient-day

The source: (UNEP-IETC, 2012, p. 27)

According to the table above, maternity clinics and hospitals are the largest producers of HCW compared to other medical facilities. This is due to the nature of the maternity clinics specialized in obstetric operations, which generate large quantities of HCW (placenta, bandages, sharp tools, ...) To add more, the nature of hospitals that are of large sizes (a large number of beds) and a large number of patients are also considered to be a source of a high daily rate of HCW.

After the spread of the Coronavirus, the number of infections and deaths has increased to the point that many hospitals across the world were saturated and lost their ability to receive more patients. This fact resulted in a large increase in the volume of infectious HCW that are engendered by the health care facilities. To reduce the rapid spread of Covid-19 infections, it is important to rely on personal protective equipment (PPEs) (protective masks, gloves, protective glasses, protective clothing, among others). Indeed, healthcare workers must protect themselves and patients from the virus and its transmission to others. Many countries have set strict laws and imposed penalties on those who do not wear a protective mask in public spaces. This resulted in a noticeable increase in personal protective equipment, especially protective masks, which were classified as a dangerous and contagious waste during the Corona pandemic.

Table (3) : Estimated daily facemask use, and HCW generated

	daily facemask use (pieces)	Discarded facemask (tons/day)	Healthcare waste (tons/day)
Asia	3,769,305,693	11,308	55,630
Africa	951,832,679	2,855	8,367
Europ	891,476,038	2,674	70,338

The source: (Dwi , et al., 2021, p. 02)

According to (Dwi, et al., 2021), the global needs of protective masks were estimated at 129 billion masks/month, and 56 billion gloves/month. Furthermore, China is the first global supplier of personal protective equipment (PPEs), where 17.9 billion protective masks, 1.73 billion protective clothing, and 0.54 billion Covid-19 detectors were exported to 150 countries and 07 global organizations

until 20 October 2020. Unfortunately, China was not able to cover the massive demand of the worldwide needs of personal protective equipment.

According to the same study, the number of protective masks needed according to the number of confirmed cases: In Asia, it is estimated at 3.77 billion masks/day with a weight of 11308 tons/day while the amount of the HCW is about 55630 tons/day. In Africa, it is estimated at 952 million masks/day weighing 2855 tons/day, while the amount of HCW produced in Africa was estimated at 8367 tons/day. As for Europe, the number of masks was said to be 891 million masks/day, with a weight of 2674 tons/day. As for the amount of HCW produced in Europe, it was estimated at 70388 tons/day.

Table (4) : Estimated daily facemask use, and HCW generated in the countries under-study

Country	daily facemask use (pieces)	Healthcare waste (tons/day)
India	381,179,657	6,491.49
Japan	92,758,754	130.54
Malaysia	7,049,901	35.41
Thailand	10,220,851	13.07
Indonesia	159,214,791	420.03
China	989,103,299	332.95

The source: (Sarawut , 2020, p. 03)

The findings from (Sarawut , 2020) study reveal that, during this pandemic, about 381,179,657 masks are used in India per day, and the volume of HCW is estimated at 6,491.49 tons/day. In fact, (Mrinalini , Pranjali J, Sunil , & Satya , 2021) claims that the amount of HCW in India has doubled by 15 times and this is due to the rapid spread of the Covid-19, from (0.3-01 kg/bed/day to 4.5-15 kg/bed/day). In Japan, the estimates of the daily use of masks are about 92,758,754 masks/day, while the amount of HCW produced is estimated at 130.54 tons/day, while Malaysia uses about 7,049,901 masks/day and the amount of HCW produced is estimated at 35.41 tons/day. Again, (Dwi , et al., 2021) evinces that the amount of HCW in Malaysia has increased by 30% in March 2020. In Thailand, the daily use of masks is estimated at 10,220,851 masks/day, and the sum

of HCW produced during this pandemic is estimated at 13.07 tons/day. As for Indonesia, 159,214,791 masks are used/day, and the amount of HCW produced is estimated at 420.03 tons/day. In China, about 989,103,299 masks are used per day, and the waste produced there is estimated at 332.95 tons/day (Sarawut , 2020).

Based on the records from the hospital institutions in Wuhan-China, the amount of HCW produced during the pandemic was estimated at 240 tons/day compared to the previous year that was estimated at 50 tons/day. An increase of 600% has been recorded during the two excessive years. Moreover, many countries have witnessed an increase in the volume of the HCW, more specifically, the personal protection waste (PPE) such as masks, gloves, and others (Manuel A, María Alejandra Ruano, & Luis Sanchez-Alcalde, 2020).

III.1.2.Existing practices for COVID-19 infectious waste: separation, storage, and transportation in the countries under-study:

Through the following table, we will review the procedures used in sorting out, storing and transporting Covid-19 medical waste in some countries during the Corona pandemic.

Table (5) : Existing practices for COVID-19 infectious waste separation, storage, transportation in the countries under-study

Country	Practices for COVID-19 Waste Generated from Healthcare
India	- Use dedicated trolleys and collection bins in COVID-19 isolation wards, laboratories and test centers. Used masks are discarded and collected in separate 'yellow colour-coded plastic bags' (suitable for biomedical waste collection) labelled 'COVID-19 waste.' - Disinfect inner and outer surfaces of containers, trolleys and bins with 1% NaClO solution daily. - Depute dedicated sanitation workers for biomedical and general solid waste collection and timely transfer to temporary storage. - Use vehicles with GPS and barcoding systems for containers containing HCW for waste tracking. Label vehicles with the 'Biohazard' sign
China	- Wuhan improved the process by closing the municipal solid waste disposal site and enhancing disinfection and the sterilization of waste-related facilities. - Medical waste collection is performed with strict technical guidelines to avoid virus transmission. - Medical waste is collected from individual containers placed at medical institutions and public areas. - Medical waste is transported and disposed through specially designed registered vehicles operated by professional workers at scheduled times. - Healthcare workers are equipped with protective equipment, including masks, gloves, goggles, protective clothing and disinfectants.
Indonesia	- Identify the classification and communication (labels, symbols) means. - Designate COVID-19 infectious waste bins. - Conduct internal sterilization and disinfection before bags are tied. - Label bags 'Danger, do not open.' Disinfect bags before collection and schedule regular waste transportation by cleaning services on weekdays
Japan	- Separate and store infectious, non-infectious and general wastes and sharp objects from other infectious wastes with proper containers. - Seal easy-to-use and durable containers. - Transport by a designated cart to avoid scattering and spilling wastes within facilities and the use of short storage periods. - Access storage rooms, if you are an authorized person. - Apply clear labelling on infectious waste containers at storage rooms.

Malaysia	- Do not separate COVID-19 waste from other infectious waste. - Equip cold rooms in bigger healthcare facilities. Collect daily or three times a week depending on the quantity and transport only by a special lorry licensed to transport hazardous waste.
Thailand	- Separate into sharp and non-sharp COVID-19 waste. - Disinfect and use double bags. Moreover, designate specific storage areas. - Send waste from community healthcare facilities to district healthcare facilities once a week. - Temperature-controlled storage is available at the district level. - Transport by licensed hazardous waste transporters (requires temperature controlled vehicles). - Treat within 48 h after transportation. Disinfect vehicles and bin daily with NaClO.

The source: Collected by the author based on: : (Sarawut , 2020); (Jie , Xunlian , & al, 2020)

III.1.3.Existing practices for COVID-19 wastes treatment and disposal in the countries under-study:

The next table reviews the methods used in some countries to manage and dispose of Covid-19 HCW during the excessive increase of this type of waste.

Table (6): Existing practices for COVID-19 wastes treatment and disposal in the countries under-study

Country	COVID-19 Waste Treatment and Disposal
India	- Common biomedical waste treatment facility (CBWTF). - Disposal permitted by deep burial only in rural or remote areas without CBTWF facilities. Large volume of yellow colour-coded (incinerable) COVID-19 waste beyond the capacity of existing CBWTFs and BMW incinerators, necessitates permitting HW incinerators' usage at existing treatment, storage and disposal facilities (TSDFs) or captive industrial incinerators if any exist in the state/union territory. In such cases, ensure separate arrangement for handling and waste feeding.
China	- Temporary incinerator installation suggested for waste management. - Municipal solid waste incinerators to co-process medical waste in a rotary kiln. Hazardous waste is thoroughly incinerated in high-temperature flue gas and slag residue after 60 min of high-temperature (850 C) incineration.

Indonesia	Mostly incineration, disinfecting at source and transporting to the disposal site, open burning (if no incinerator) or hazardous waste landfill.
Japan	Incineration, melting, steam sterilization (autoclave), dry sterilization and disinfection followed by shredding and disposal to sanitary landfills.
Malaysia	Mostly incineration.
Thailand	Incineration, autoclave, sanitary landfill.

The source: Collected by the author based on: (Sarawut , 2020); (Jie , Xunlian , & al, 2020)

III.2. Discussion

The large increase in the number of infected patients with Coronavirus (Sars-cov 2) around the world has directly affected the quantity of HCW, which has also increased significantly causing pressure on health systems, health care waste management (HCWM), and treatment systems in many countries. According to this study, the percentage of increase in the volume of HCW as a result of Covid-19 was estimated to (30%), and the percentage has varied from one country to another according to the number of infections and the statistical capabilities of each country. For example, in Wuhan-china the percentage of increase is (600%).

The inappropriate handling of HCW resulting from Corona patients will inevitably lead to a fast spread of infection and the inability to control it, so the number of infections and deaths will inevitably increase. To face this threat, many countries and international organizations such as the World Health Organization (WHO) have issued urgent decisions and protocols to manage HCW during the Covid-19 pandemic. These protocols rely upon safe and appropriate management of these wastes and limiting the spread of Coronavirus disease.

According to this study, the most effective way of managing HCW is good segregation and an attempt to reduce it. The waste of Covid-19 patients is approached on the basis that it is highly contagious and is separated from other wastes to avoid virus transmission during the process of collection or transportation. (Covid-19) HCW is placed in two-layer (thick) bags to avoid leakage

with a "(Covid-19) waste" stamp on it. It should be sterilized with chlorine or sodium hypochlorite solution after filling (3/4) three-quarters of its volume. Then, it should be placed in the container for the HCW.

In addition, the study shows that most countries have established temporary storage rooms for (Covid-19) waste that are separated from other storage rooms. The storage period, which ranges between (24h-72 h) at the maximum, has been reduced according to the pressure of the generated wastes and to the capabilities of each country. Firstly, it is to avoid the risk of mixing covid-19 medical waste with other waste. Secondly, it is to reduce the fast spread of the Sars-cov 2 virus.

The HCW of Covid-19 patients is collected and transported by accredited and licensed institutions for the collection of infectious waste. They contain qualified and well-trained personnel to deal with this type of waste. Moreover, the latter is collected and transported at different times compared to other types of waste. Traffic is avoided during the transportation process to avoid the spread of the virus.

The study showed that the most used method in treating Covid-19 waste is thermal incineration due to its ability to eliminate (Sars-cov2) virus and reduce the volume of waste by 80%.

To face the increasing pressure of HCW, many countries have used mobile incinerators at the hospital level to treat HCW waste. In some countries where medical waste causes terrible pressure, the incinerators of major industrial establishments such as cement factories have been used as support to relieve pressure on medical waste treatment institutions.

Conclusion:

Through the obtained results, the hypothesis was confirmed. An increase of more than 30% in the quantity of HCW was recorded during the Covid-19 pandemic as compared to previous years. This continuous increase of medical waste related to Covid-19 patients has

imposed a great challenge on the states and governments at the level of health care waste management systems.

To face this health crisis, a set of measures have been taken to readapt health care system, management systems, and health care waste management. Measures should conform to the following features: coping with the characteristics of the emerging coronavirus, following the recommendations of the World Health Organization, and keeping pace with the increasing demand of citizens for health care services during the current health crisis or another future health crisis.

To reduce the health and environmental risks of HCW in the future, decision-makers should:

- Establish urgent protocols for HCWM to have resorted during health crises with responsibilities and tasks assigned according to a pre-studied plan.
- Increase the number of health care waste treatment facilities (HCWTF) according to the population of each region and providing hospital institutions with mobile health care treatment devices.
- Increase hospitals' capacity for patients during health crises by increasing the number of beds and providing mobile hospitals to be ready for use during health crises.
- Training medical staff such as the doctors, nurses, and employees of HCW treatment institutions to know how to deal with infectious HCW and providing them with an adequate stock of Personal Protection Equipment (PPE) during health crises.
- Pay more attention to research on HCWM as well as the health and environmental impacts of HCW. Furthermore, benefit from the experiences of East Asian countries in the field of HCWM in health crises, especially China because of its experience in facing epidemics and pandemics.

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