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Review Article

Challenges of COVID-19 Related Biomedical Waste Management

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Abstract

The pandemic of COVID-19 has resulted in huge amounts of biological waste (BMW) and plastic waste (PW) [54]. The Covid-19 epidemic has had an impact on waste management, particularly medical waste management [32]. As a result, proper management is required to handle the various types of solid waste, particularly Biomedical waste (BMW), which is emerging in large quantities every day from various health care facilities, quarantine homes, and centers, and the possible challenges we are facing while confronting the problem of this waste, which could be a source of this contagious virus if not properly managed [6]. This research reviewed biomedical waste generated in underdeveloped, developed, and developed countries. I also discussed the problems and possible solutions for dealing with this waste.

Keywords: *Challenges of COVID-19 Related; Biomedical Waste Management*

Introduction

Biomedical waste

Biomedical waste is described as any waste generated during the diagnosis, treatment, of humans or animals, during related research, or in the manufacturing or testing of biologicals. The cradle to grave strategy is used to characterize, quantify, segregate, store, transport, and treat BMW [8]. The current Coronavirus Disease (COVID-19) pandemic outbreak has put tremendous strain on the BMWM system around the world. Because the COVID-19 virus is a contagious disease, adequate waste disposal is also required to restrict its spread. The waste generated during treatment and laboratory tests is highly contagious and hazardous [30]. About 85% of the waste created by healthcare activities is normal, non-hazardous waste. The remaining 15% is classified as hazardous waste, which could be infectious, poisonous, or radioactive [17].

Infectious waste

Waste that has the potential to harm both humans and the environment. Lab cultures, tissues, and swabs are examples of this type of trash. Garbage tainted with blood and its byproducts, waste from patients in isolation worlds, abandoned diagnostic tests including blood and body fluids, and disposable medical devices are just a few examples (urine, feces, vomit, swab) [33].

Pathological waste

Human bodily waste created during diagnosis and treatment and animal corpses from medical researchis referred to as pathological waste. Human tissue and organs discarded after surgery, diagnosis, or therapy, animal tissue and corpses from medical trials, and human tissue and pathological wax blocks abandoned after pathological sections are all examples of discarded human tissue and organs [39].

Sharp waste Sharp items include those that can pierce the skin, such as infected syringes, discarded needles, knives, blades, scalpels, and syringes with fixed needles, as described by OSHA's blood-borne pathogens regulation [36]. Sharp waste created in the hospital should be adequately managed to prevent the spread of COVID-19. Before discarding contaminated needles into a sharp disposal container, do not recap, break, bend, or detach them from syringes, as this increases the risk of needle stick injuries and the transmission of blood-related infections.A white trash bin/dropbox should be used to collect all sharp trash [2].

Cytotoxic waste

Cytotoxic medications used in cancer treatment and their metabolites, as well as waste containing compounds with genotoxic qualities (i.e., very dangerous compounds that are mutagenic, teratogenic, or carcinogenic) [5].

Pharmaceutical waste

Pharmaceutical waste consists of medical medications and vaccines that are either outdated, unused, contaminated or no longer required. The volume of pharmaceutical waste has increased steadily as a result of the increased number of hospital admissions during the COVID-19 outbreak [49].

Chemical waste

Chemicals used in biomedical production, disinfection, pesticides, and other applications (Categories of Bio-Medical waste).

Radioactive waste

Materials contaminated with radionuclides as a result of their use in medicine or research are classified as radioactive wastes [5]. It contains abandoned sealed radiation sources, radionuclide-contaminated liquid and gaseous material, excreta from patients who had radioactive diagnostic and therapeutic procedures, paper cups, straws, needles, syringes, test tubes, and tap water washing [47].

Non-hazardous or general waste

Waste that is not biologically, chemically, radiologically, or physically hazardous is considered Non-hazardous or General waste [35]. During their daily actions at healthcare institutions, both asymptomatic and symptomatic COVID-19 patients are likely to generate a large volume of nonhazardous SARS-CoV-2 contaminated healthcare waste, posing a substantial danger to the community transmission.

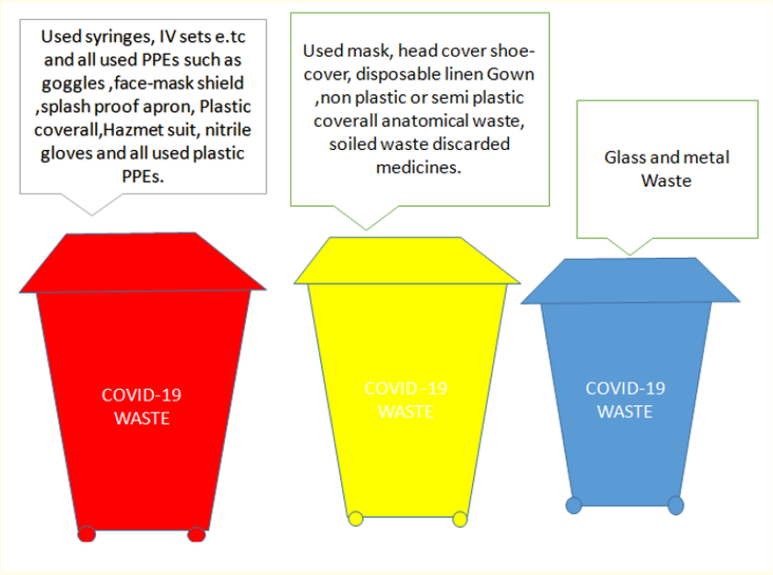

Figure 1

Current waste management processes

Collection of waste products

This is the beginning of the biomedical waste disposal process. During the handling process, the biomedical waste must be gathered in containersthat are both quiet and sturdy [21]. Sharp garbage is collected in sharp-safe boxes and all infectious garbage is collected in leveled lined containers. Even non-hazardous trash from a healthcare facility should be collected and disposed of in sturdy bags (ideally red biohazard bags) that are completely closed before being collected and disposed of by municipal rubbish [18]. To provide appropriate strength and no leaks, double-layered bags (using two bags) should be used to collect waste from COVID-19 isolation wards [16].

Segregation of waste product

The separation of trash into appropriate containers is referred to as segregation. Biomedical waste should never be mixed with other types of waste [48]. The color-coded segregation system should be installed at the site of generation, and BMWshould be separated there as well. It is very necessary to reduce the volume of infectious waste; otherwise, the volume of general trash will eventually exceed the control of disposal [37].

Storage of waste product

Following the segregation of healthcare waste, containers or bags are moved to temporary storage. Sanitation of storage facilities should be done regularly, and a constant temperature should be maintained [46]. Waste should not be kept for longer than 48 hours. Bins can be made of metal or plastic; if re-usable, make sure they are cleaned and disinfected regularly. Overly large containers may be difficult to lift and spill [44].

Waste transportation

Sanitized vehicles, trained waste pickers and drivers, specific routes, and waste tracking systems are all required for safe transportation [1]. Employees who will be exposed to COVID-19 wastes must receive specialized training. Overcrowding and rush hour should be avoided by the route and time of transit.After loading and unloading, disinfect the storage area and vehicles quickly [40].

Waste treatment

When infectious waste arrives at the disposal facility, it is treated. The competent treatment is chosen based on the type of trash.The treatment could be carried out in several ways [15]

Incinerator

Incineration is a high-temperature combustion process that transforms organic and combustible trash into inorganic, non-combustible solid wastes and gaseous combustion by-products [49]. All hazardous waste is contained in the ash at the bottom of the incinerator, which can subsequently be disposed of in either sanitary or hazardous landfills. To safeguard personnel from the heat of the incineration unit, good operating procedures are essential, just as they are for any other process [23].

Steam based method

Autoclaving

COVID-19 wastes are treated in an autoclave. Autoclaving is a steam-based sterilizing method that runs from 121°C to 135°C for 30 minutes [19]. Instead of expensive incineration, autoclaving merely introduces very hot steam for a set length of time. Microorganisms

are fully eradicated at the end of the procedure. This procedure is particularly effective because it is far less expensive than other options and poses no personal health hazards (BWS, 2018).

Microwaving

It's a technique for heating garbage by exposing it to microwave-frequency electromagnetic radiation. This causes the food's polar molecules to rotate and produce thermal energy in the process. Dielectric heating is the term used to describe this process. This allows for the production of thermal energy by polar molecules. Microwaves usually run for 30 minutes at (97-100) degrees Celsius [19].

Chemical method

Chemical disinfection is best for treating liquid waste like blood, urine, feces, or sewage from hospitals. Solid trash must be shredded before or during disinfection to enable effective contact between the disinfectant and waste surfaces; however, this must be done in a closed system to prevent pathogens from being released into the air. For efficiency and environmental reasons, thermal disinfection (such as autoclaving) should be preferred over chemical disinfection [48].

Ultra violet irradiation (UVI)

UVI is a highly effective disinfectant for microorganisms (viruses and bacteria) and is increasingly being utilized as a substitute for CHL [50]. Disinfection with harsh ultraviolet C (UVC) light is rarely effective because of insufficient penetration depth and occupational medicine risks [51].

Disposal

The waste products are ready to be disposed of once they have been collected, segregated, stored, transported, and treated. Municipal landfills and sanitary sewage systems are the most convenient locations for garbage disposal [13]. At the time of packaging, hospital staff usually separates infectious medical waste. Before being temporarily stored onsite, the double-bagged products are treated with a 0.5 percent chlorine solution. The manner of disposal thereafter differs depending on the hospital.

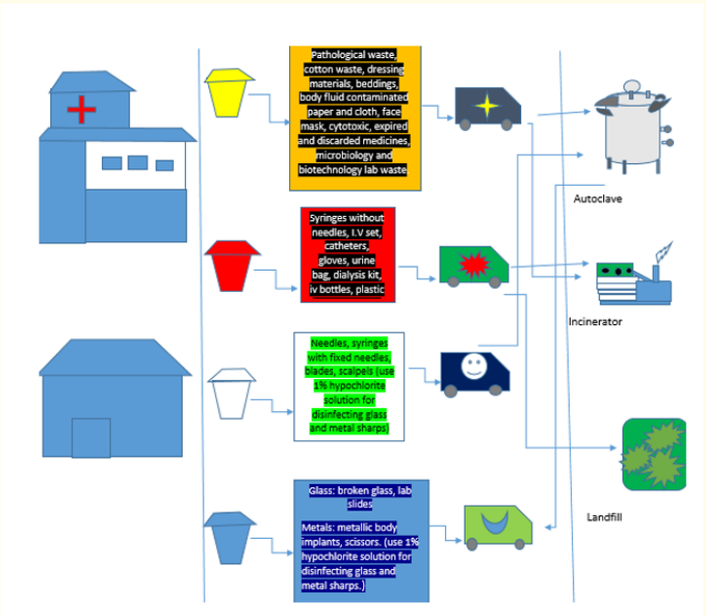

Figure 2

COVID-19 waste generation in

Developing countries

The situation of waste management in such nations differs from that in developed nations, and it is difficult to adopt established country recommendations since developing countries, in particular, lack financial, technological, social, and institutional capabilities. In low-income countries, around 90% of waste is dumped at dumpsites or burned in the open [52]. According to estimates, developed countries and cooperative economic organizations are responsible for half of all MSW produced globally. The overall organic content of MSW is 46%, but it jumps to 64% in developing nations [3]. The amount of waste produced in developing countries is increasing every day as a result of poor waste management, according to the findings of 2.85 kg/bed/day in Thailand, 2.23 kg/bed/day in Indonesia, and 2.0 - 2.2 kg/bed/day in Mexico, around 2.5 kg/bed/day of COVID-19 healthcare waste is generated in developing countries [5]. According to the Indian Medical Association (IMA), the amount of bio-medical waste generated each day in the country has virtually doubled from 7.22 lakh kg before COVID to nearly 14 lakh kg currently [38].

Developed countries

Even though most modern countries use advanced techniques to properly manage COVID-19 waste, it still has a significant influence on specific sections of the country. According to the findings, 45 - 48 percent of respondents noticed an increase in the use of packaged foods, fresh foods, and meal delivery. The fact that people spent more time at home during the lockdown was one of the key causes of the increased waste creation. In addition, food waste and plastic packaging increased by 43 percent and 53 percent, respectively [27]. In April 2020, compared to the same period in 2019, the City of Melbourne recorded a 70% increase in legally deposited rubbish during the first lockdown. According to the current study, approximately 104 and 160 tons of used face masks were manufactured every day in Victoria during the first and second waves of the pandemic [26]. In Italy, stringent lockdown resulted in a 27.5 percent reduction in total trash generation, with a 24.4 percent reduction in residual trash, 20 percent reduction in paper and cardboard trash, 16.7% reduction in glass trash, 16.3% reduction in plastic and metal waste, 14.4% reduction in domestic food waste, and 80.5 percent reduction in commercial food waste. When compared to other cities, the reduction can be due to lower garbage output. However, compared to the same period in 2019, waste recycling grew by 1%, while street bins decreased by 38.2 percent [4]. During the circuit breaker period, Singapore homes produced an additional 1334 t of plastic garbage (e.g., disposable forks, containers, and spoons), according to an estimate based on an online poll of 1110 respondents. During the eight weeks, dinner delivery was predicted to have increased by 73 percent [28]. As a result of the circuit breaker pause on non-essential economic activity, the overall volume of waste generated in Singapore decreased by 19% in 2020 compared to 2019. Waste from industry, construction, and commerce, among others, fell in tandem with the circuit breaker pause on non-essential economic activity. Despite the popularity of food takeaways during the circuit breaker last year, plastic trash created in Singapore decreased by 7% from the previous year [29].

Underdeveloped countries

Biomedical waste is a common thread in worldwide public health, particularly in underdeveloped countries. Before the COVID-19 epidemic, developing countries were already grappling with poor medical waste management, and they are now being impacted hard by an unexpected surge in the volume of medical waste [20]. This badly handled trash provides a significant environmental risk, as well as posing a long-term and unwelcome public health risk and posing a risk of re-infection. In Dhaka, Bangladesh's capital, medical waste is generated at a rate of 163–199 kg per bed every day. COVID-19 generated at least 14 500 tons of trash from health care across the country in April 2020, a figure that has surely escalated due to the rising infection rate [7]. In Nigeria, nearly two-thirds of households (60.8 percent) claimed that their wastage increased when the COVID-19 epidemic began, whereas over one-third (39.2 percent) claimed that their waste did not increase as a result of the pandemic. Similarly, two-thirds (63.4 percent) of respondents in Guyana agreed that the pandemic had increased the amount of waste generated [25].

Major regulatory authorities and its policies COVID-19 related BMW challenges during Handling, Treatment, and Disposal

Handling of infectious medical waste in the home

- Household infectious waste can be classified as hazardous and citizens might be warned not to combine it with regular solid waste.
- The waste can be separated and kept in double-layered, color-coded plastic bags. This garbage can be moved from a secondary storage station to a management station for disinfection and burning [14].
- All PUI/PUM trash should be double bagged, "swan neck" tied, and sprayed with a 0.5 percent chlorine disinfecting solution on the outside (1 percent household bleach solution).
- If there is a special medical waste collection service, the double-bagged garbage should be disposed of as soon as possible.
- If there isn't a special medical waste collection service, the double-bagged waste should be held for 72 hours before being disposed of with regular trash [1].
- (b)Handling of infectious medical waste in Quarantine centers/Camps
- General solid waste should include leftover food, disposable utensils, water bottles, used by suspected quarantined persons, as well as garbage created from the kitchen, packaging material, waste food material, waste papers, waste plastics, floor cleaning dust, and so on.
- All garbage created at the quarantine facility was classified as isolation waste, and the disinfection and management of the waste were closely supervised by health officials.
- The site where biomedical waste is collected should be disinfected regularly using a 1 percent hypochlorite solution that has been newly prepared [31].
- Biomedical waste if any generated from quarantine centers/camps should be collected separately in yellow bags (suitable for biomedical waste collection) provided by ULBs. These bags can be placed in separate and dedicated dust bins of appropriate size. General waste should not be stored in yellow bags [10].

Handling of infectious medical waste in the hospital

- Maintain correct waste segregation inwards by using separate color-coded bins (with foot-operated lids)/bags/containers, as per BMWM Rules, 2016 as amended, and CPCB instructions for BMW Management Rules implementation.
- To provide appropriate strength and no leaks, double-layered bags (using two bags) should be used to collect waste from COVID-19 isolation wards [11].
- Bags/containers used for collecting biological waste from COVID-19 wards should be labeled as "COVID-19 Waste" in addition to the necessary labeling. This label would allow CBWTFs to quickly identify the trash for priority treatment and disposal upon receipt.
- Daily disinfection of the (inner and outer) surfaces of containers/bins/trolleys used for COVID-19 waste storage should be done using a 1% sodium hypochlorite solution [12].

- COVID-19 verified patients' feces must be treated as biomedical waste and stored in a yellow bag/container if they are unable to use bathrooms and their excreta is collected in diapers. If a bedpan is used, feces should be rinsed into the toilet and cleansed with a neutral detergent.
- Put used PPEs in the Red bag, including goggles, face shields, splash-proof aprons, Plastic Coveralls, Hazmat suits, and nitrile gloves [2].

Treatment

- To the degree possible, the waste should be treated before final disposal using non-combustion or steam-based treatment technologies such as autoclaves and microwaves, etc.
- Chemical disinfection could also be a possibility, depending on the local situation and available resources [41].
- The event that a state does not have a CBWTF, or if a rural or remote location does not have access to one, existing captive facilities of any hospital may be identified for the disposal of COVID-19 waste by the terms of the BMWM Rules, 2016 and these instructions. This could include allowing the use of deep burial trenches for the disposal of yellow category waste by the standards outlined in Schedule II of the 2016 Bio-medical Waste Management Rules (BMWM, 2016).
- Transport biological waste and regular solid waste separately using specific carts, trolleys, or trucks. After each trip, ensure that the cars are sanitized with 1% sodium hypochlorite [1].
- Bags carrying ordinary solid waste, waste collectors arriving at quarantine centers/Home centers may be sprayed with disinfection solution (1% sodium hypochlorite solution) before disposal as a precaution [41].

Disposal

- To avoid reuse, garbage masks and gloves in normal households should be kept in a paper bag for at least 72 hours before being disposed of as dry general solid waste after cutting.
- Discarded PPEs from the general public should be stored in a separate bin for three days before being disposed of as dry general solid trash after cutting/shredding [43].
- To avoid water contamination, the disposal location should be a certain distance away from the water source.

Unauthorized people should not be allowed near the disposal site, which should be tented.

Conclusion

Thus, COVID-19 waste management is critical because if it is not effectively managed, it not only has a bad influence on hospital environments but also has a significant influence on the health of the general population, community, and nation. Supporting nations who do not have the fiscal capacity to fund social policy, particularly universal social security programs, would require a coordinated global effort. In this endeavor, the long-term viability of debt should be a top priority.

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Conflict in Interest

The author has no conflict of interest.

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