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RESEARCH ARTICLE

DISPOSAL AND MANAGEMENT TECHNIQUES OF BIOMEDICAL WASTE: PERSPECTIVE AND CHALLENGES FACED DURING THE COVID PANDEMIC IN INDIA

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ABSTRACT

Biomedical waste (BMW) is the waste which is generated during Diagnosis, treatment, immunization and biomedical research, according to the World Health Organization (WHO, 2018), approximately 85% biomedical waste is non-hazardous and 15% is hazardous waste to humans, animals and environment (1). Every year, it is estimated that at least 5·2 million people, including 4 million children, die each year because of diseases related to unmanaged medical waste (2). India is one of the largest population countries; the biomedical waste management is one of the toughest challenge and COVID19 pandemic increases the problem even more. The number of persons infected with the COVID 19 is continuously raising throughout the world, to diagnosis and management of the infection, usage of the personal protective equipments like PPE kits, masks, gloves, shoe covers, face shields are increased in the hospitals and discarding of waste generated in home quarantines was also increased. This mini- review, we highlighted the challenges to disposal of biomedical waste during COVID 19 pandemic in India.

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INTRODUCTION

Severe acute respiratory syndrome coronavirus -2 (Sars-Cov-2) respiratory viral infections was first identified in Wuhan, China in December 2019, the infection was spread through contaminated aerosols and droplets unlike other respiratory viruses, and this virus spreads rapidly, within a short period the virus spread throughout the world. On February 11, 2020, the World Health Organization (WHO) suggested the name of the disease Coronavirus disease 2019 (COVID-19). On March 11, 2020, WHO declared the novel coronavirus (COVID-19) outbreak was a global pandemic. By April 2022,493 million cases and about 6.1 million deaths had been reported worldwide (1,2,8). In India first COVID-19 was reported in Kerala from three students returning from Wuhan, Chinain February 2020 and by April 2022 43 million cases and 5.2 lakhs of deaths reported. World was not ready to tackle the pandemic, before pandemic health care workers who are working in Viral research labs are used to wear the personal protective equipments (PPEs). During COVID 19 pandemic health care worker all the strata wearing the PPEs and common people also started wearing gloves, masks and other protective gears

METHODS

In order to fulfill the objective of this review, we searched the literatures in the scholar sites including Pubmed, Scopus and Google scholar. The search keywords are 'Biomedical waste', 'COVID-19 Biomedical waste management', 'pandemic', 'and SARS-CoV-2''Types of healthcare waste' 'Disposal of Biomedical waste. Only articles written in English language were selected for this review.

Biomedical waste situation in India

In India BMW rules were introduced in 1998 by ministry of environment and forests (3). The rules were modified 5 times(2000,2003,2011,2016 and 2018). Important modification in 2016 and 2018 BMW rules (10)

The major changes in 2016 BMW

- Included vaccination camps, blood donation camps, surgical camps or any other healthcare activity.
- Pre-treatment of the laboratory waste, microbiological waste, blood samples and blood bags through disinfection sterilization on-site in the manner as prescribed by WHO or NACO.
- Provide training to all its health care workers and immunize all health workers regularly against diseases like tetanus and Hepatitis B.
- Establish a Bar-Code System for bags or containers containing biomedical waste for disposal within one year of notification of rules i.e. 27th March, 2017. But as per the Bio-Medical Waste Management (Amendment) Rules, 2018, bar-code System has to be established in accordance with the guidelines issued by the Central Pollution Control Board by 27thMarch, 2019.

- Report major accidents like needle stick injuries, broken mercury thermometer, accidents caused by fire, blasts during handling of biomedical waste and the remedial action taken and record
- Procedure to get authorization is simplified.
- No hospital/ healthcare facility (occupier) shall establish on-site treatment and disposal facility, if a service of "common bio-medical waste treatment facility'' (CBMWTF) is available at seventy-five kilometers.
- Operator of a common bio-medical waste treatment and disposal facility to ensure the timely collection of bio-medical waste from the healthcare facility and assist the healthcare facility in conducting training.
- Bio-medical waste has been classified into 4 categories instead of 10 categories as per Biomedical Waste (Management & Handling) Rules, 1998 to improve the segregation of waste at source.

Source: *Bio-Medical Waste Management Rules.* 2016 Published in the Gazette of India

Importance of proper disposal of biomedical waste

Environment effect: Improper segregation and disposal of BMW can trigger the contamination of air, ground water and dangers to people, animals, or soil and water sources. It has the potential to contaminate groundwater sources, which in turn may infect humans and animals. Biomedical waste needs to be properly contained to keep it away from birds, rodents, and stray animals. This enhances packaging and labeling of contaminants and helps prevent the spread of illness through human and animal populations – by air, land, or water (4)

Illegal trading of medical waste: BMW waste such as syringes, needles and PPE Kits even masks were not disposed properly it may be collected by unauthorized persons and recycled illegally, sale in gray market this leads to spread infections such as HIV, HBV and COVID-19. According to a recent study, 70% of BMW generated in India gets treated in incinerators and 30% is either illegally dumped or found as common garbage on the roads (Singh and Saha, 2020). In addition, small towns and villages do not have the proper facilities to treat the COVID-19 waste; they are either depending on neighboring cities for BMW treatment or using a deep burial system (4).

Challenge of BMW during COVID-19: Biomedical waste defined as any waste which is generated during diagnosis, treatment and immunization of humans and animals by WHO. During this pandemic, this definition was revised as waste generated during isolation, diagnosis, treatment, quarantine, and home care of COVID-19 patients (5).

Table 1. COVID 19 related waste from January- 2021 to December- 2021

SN	Month &Year	COVID 19 BMW (Tons/day)
1	Jan-21	74
2	Feb-21	53
3	Mar-21	75
4	Apr-21	139
5	May-21	203
6	Jun-21	164
7	Jul-21	72.8
8	Aug-21	55.5
9	Sep-21	49.1
10	Oct-21	32.3
11	Nov-21	24.6
12	Dec-21	23
	Average	80.4

In these pandemic asymptomatic and mild symptomatic individuals are high, only 15% of the patients showed marked symptoms and are hospitalized. Diagnosis and treatment of the huge number of patients was a big challenge for developed and developing countries.

On the other hand biomedical waste generated in this period was also high, before pandemic in India 550 tons per day(TPDs) BMW was generated, during pandemic it is increased to 656 tons per day in 2020 (5). The Average COVID 19 related waste was 80.4 TPD in 2021 (Table.1). In April, May and June the generation of biomedical waste was very high due to surge of COVID 19 cases. Month wise proportion of COVID 19 related waste stated on table 1, Fig 1 (6,7). By April 2022 India tested 790.4 million COVID 19 tests and 1.85 billion vaccine doses were given, this made huge quantity of BMW additionally.Pre-COVID-19 total health-care waste production ranged from 1 kg/day/bed to 10–11 kgs/day/bed (2 kgs/bed/day infectious waste) depending on the average income of a country. During COVID-19 pandemic, health-care facilities around the world reported nearly five times increase in the volume of waste produced (6,7).

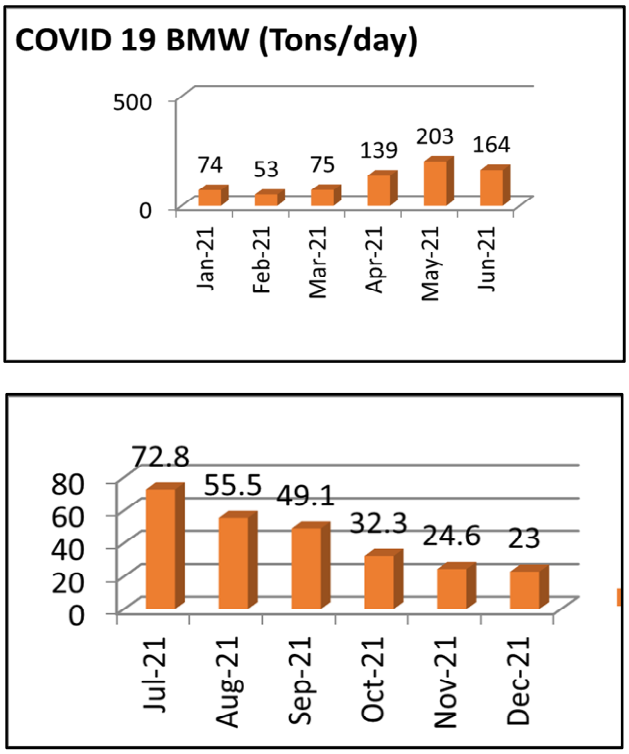

Fig. 1. Month wise proportion of COVID 19 related wastes in 2021

Challenges due solid waste: Mostly the solid waste generated during the pandemic includes personal protective equipments (PPEs) like disposable gowns, gloves, facemasks, and shielding goggles in huge quantity because these are used and discarded daily, Laboratory COVID-19 waste material including plastic wastes, such as pipettes, Eppendorf tubes, reagents, small polymerase chain reaction (PCR) tubes, and enzyme-mixed liquid. For this, all laboratories must be equipped with one dedicated autoclave for treatment of the waste (8).Pharmaceutical trash has also increased rapidly due to their usage during the COVID-19.Disposing of this infectious solid waste should be done after disinfection treatment as per the recommendations and guidelines given by WHO. Without treatment/decontamination, disposal of such waste would raise several problems. Around 100 TPD of biomedical waste was generated additionally per day during COVID 19. Ccountry does not have sufficient infrastructure and human resources to handle this huge amount of BMW. The present 198 Common biomedical waste facilities (CBMWFs) and 225 captive incinerators was insufficient to dispose this huge amount of waste (10). WHO recommends that utility gloves and heavy-duty, reusable plastic aprons are cleaned with soap and water, and then decontaminated with 0.5% sodium hypochlorite solution each time they are used. Single-use gloves and gowns should be discarded as infectious waste after each use and not reused; hand hygiene should be performed after PPE is removed.

COVID 19 survival period on articles: It is important to know the survival period of the virus in surfaces and solid waste. According to study conduct by*Van doremalen et al., 2020.* The survival periods of the COVID-19 virus following aerosolization on copper, cardboard, plastic, and stainless steel are 3 h,4 h, 24 h, and 2–3 days respectively (11). *Kampf et al., 2020* have reported that the virus can also survive on inanimate surfaces, i.e. metal, glass, or plastic, for a period of 9 days (13). *Kasloff, S.B et al*. reported the Viable SARS-CoV-2on various articles they reported surveillance of COVID 19 on plastic 21 days 14 days on stainless steel, 7 days on nitrile gloves and 4 days on chemical resistant gloves, N-95 and N-100 masks at 14 days. When dried onto PPE kits(Tyvek), infectious SARS-CoV-2 persisted up to 14 days, cotton provided the lowest survival rate on few hours (14)

Challenges due to liquid waste: Liquid waste that contains chemical and human samples (blood, urine, sputum and body fluids) COVID 19 survive in sputum and BAL fluids quite long period, this sample should be treated with 1% hypochlorite before discarding chemical substances, i.e. laboratory reagents, film developing reagents, expired/unused disinfectants, solvents, and waste containing heavy metals (batteries, broken thermometers, blood-pressure gauges, etc.) is considered chemical healthcare waste, about 3% liquid waste was generated in health care as per 2016 BMW. As COVID 19 surge the liquid waste is also increased (15,16)

Pathological waste: Pathological waste includes tissues, organs and **cadaver**. It can spread infection in a similar fashion to infectious waste because of the presence of infective viral particles in the tissue samples. The transmission of infection from cadavers is low but standard precaution should be taken. Health care workers or mortuary staff preparing the body should wear: scrub suit, impermeable disposable gown (or disposable gown with impermeable apron), gloves, mask, face shield (preferably) or goggles, and boots. After use, PPE should be carefully removed and decontaminated or disposed of as infectious waste as soon as possible and hand hygiene should be performed (17,18).

Guideline to proper disposal of biomedical waste in India: Central Pollution Control Board (CPCB) of India brought out specific guidelines for the handling, treatment, and disposal of waste generated during treatment, diagnosis, and quarantine of COVID-19 patients on March 18, 2020. These guidelines were revised on March 25, 2020 (revision 1), followed by revisions on April 18, 2020 (revision 2), June 10, 2020(revision 3), and July 17, 2020 (revision 4)(18). In this revision-4 of 2016 BMW waste rules to provide revised guidance on segregation of general solid waste and biomedical waste from quarantine centers/home-care/healthcare facilities treating COVID-19 patients and to recommend on disposal of PPEs

Quarantine center

- Use separate biomedical waste bins for proper segregation of COVID 19 related waste
- Double layered cover bags should be used for collections and each bag should be labeled as “COVID 19 waste”
- The bins are cleaned with 1% sodium hypochlorite
- Register in CPCB mobile application namely ‘COVID19BWM’ to update the details of COVID-19 biomedical waste generation.

Sample collection centers and laboratories

Pre-treat viral transport media, plastic vials, vacationers, eppendorf tubes, plastic cryovials, pipette tips as per BMWM Rules, 2016 and collect in Red bags

Home Quarantine

- Any general waste should be collection in leak proof bags and tie hand over to municipality personals
- Biomedical waste such as masks, gloves should be discarded in yellow bag and hand over to door step biomedical waste collector

CONCLUSION

COVID-19 effects all sectors in community especially hospital sector was drastically effected. Biomedical waste management in this pandemic also a huge challenge. Increased home care of COVID-19 patients or increased chronically ill patients in the general population has increased the total volume of potentially infected biomedical and general waste. There are various harmful impacts on air, water and soil with untreated biomedical waste. Compare to developed countries in India facilities for biomedical waste management’s lower. Although good BMW waste rules (2016 BMW rules) are available but following and implementation is big task due to Lake of CBMWFs and trained personal

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