

Management of Bio-Medical Waste during the COVID-19 Pandemic in Raipur City

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ABSTRACT

The COVID-19 pandemic had led to a significant surge in bio-medical waste (BMW). Due to the contagious nature of diseases, the safe treatment and disposal of BMW became a significant challenge during the pandemic. The study entirely relies on secondary data and primarily focuses on the generation and management of BMW in Raipur city in the recent past. The study suggests that due to the countrywide lockdown, the amount of BMW initially decreased; however, it increased significantly when the COVID-19 cases increased in the city. The management of BMW has been outsourced to the SMS-Water Grace Enviroprotect Pvt. Ltd., which is responsible for the collection, transportation and safe disposal of BMW generated in the city. This public-private partnership (PPP) model has ensured the effective management of solid waste in the city.

Keywords: Bio-medical Waste, Solid Waste, Bio-medical Waste Management, COVID-19, Raipur City, Sustainable Development Goals.

INTRODUCTION

Municipal Solid Waste (MSW) refers to a heterogeneous collection of waste material produced in urban areas, increasing daily due to the ever-increasing population and rapid shift in lifestyle and food habits (Amasuomo & Baird, 2016; Kumar & Agrawal, 2020). Solid waste can create significant health problems and a very unpleasant living environment (WHO, 2005). If not correctly disposed off, waste

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may increase the likelihood of disease transmission. Poor sanitation and Solid Waste Management (SWM) are linked to the transmission of diseases and a resultant reduction in human well-being. Sustainable Development Goal target 6.2 calls for adequate and equitable sanitation for all (WHO, 2019).

Clinical waste or bio-medical waste is used for wastes produced on healthcare premises. BMW comprises of the waste generated during the diagnosis and treatment of patients, excluding the general waste (Dehal et al., 2022). It is generated by operations in healthcare, research, and diagnostic institutes, which include one or more of the following: diagnosis, treatment, immunisation of humans and animals, and the synthesis or testing of biological materials (WHO, 2017).

BMW differs from general municipal waste and poses various health hazards. BMW management rules 2016 and the Amendment Rules 2018 are the latest guidelines from the Ministry of Environment, Forest & Climate Change to regulate the handling of BMW activities in the country (MoEFCC, 2016). India is the second-most populous country after China and the second worst-hit nation by COVID-19 after the United States of America. According to the WHO dashboard on COVID-19 trends, worldwide, 514 million cases have been registered until May 8, 2022, while 43.1 million cases were recorded in India. Urban centres, particularly metropolitan cities, have faced higher cases of COVID-19 (Pethe & Sharma, 2020). Due to the flawed bio-medical waste management system and lack of resources, India faces severe consequences during COVID-19. Untreated and improperly managed BMW is a potential source of infection (Ramteke & Sahu, 2020). The diligent handling and management of BMW can prevent hospital-acquired infection and lower the rates of disease transmission (Chand et al.). The COVID-19 pandemic has resulted in the massive generation of BMW, and this sudden spike in BMW has created challenges to the existing waste management infrastructure (Dehal et al., 2022).

Compared to other municipal solid wastes, BMW has acute management and risk concerns. The management of BMW is not up to the mark, particularly in many developing countries (Shammi et al., 2021). The improper disposal and management system leads to significant environmental and health-associated risks to humankind. The COVID-19 pandemic has worsened the situation far ahead. The generation of BMWs has increased manifold across the globe. According to the World Health Organization, 85 per cent of the total healthcare waste is non-toxic, and only 15 per cent is toxic (WHO, 2018), but the present pandemic has changed the scenario completely. Highly

populated countries exhibited more strenuous situations. India had a 46 per cent gross increase in BMWs in April and May 2021 (CSE, 2021).

In line with the United Nations Environment Program to ensure sustainable waste management, guidelines for curbing the spread of COVID-19 through waste management include the treatment of residual waste (Patnaik & Jena, 2021). Sound planning and management reduce waste generation and manage overall waste management spending. The scientific disposal of bio-medical waste requires the continued involvement of long chains of people such as doctors, nurses, ward boys and cleaning staff. Therefore, all staff need to know what they are expected to do and why. It is essential to act according to the instructions given. The experience of BMW management in this global crisis could be a lesson for authorities to develop a well-equipped system for safe disposal in Post-COVID 19 scenarios (Vanapalli et al., 2021).

While urban solid waste has attracted the attention of town planners, environmental activists and civic administrators, there is a lack of concern towards any special sources of waste and its management. One such waste is bio-medical waste generated primarily from health care establishments (Babu et al., 2009). Biomedical Wastes Management and Handling Rules, 1998 categorizes BMW into ten categories and issues a guideline for its proper treatment and disposal (Table 1). Ministry of Environment, Forest and Climate Change amended the existing rules in March 2016. In new rules, colour codes have been declared for the classification of BMW for its management. Earlier categories described in Table 1 have been merged into four colour categories for disposal and treatment. These new rules have simplified and improved segregation, transportation and disposal methods for the management of BMW. These four colour categories are also presented in Table 1. The category-wise identification and segregation of BMW at source is the most significant task that needs to be performed sincerely for the sustainable management of BMW.

The recent guideline (5th revision) of CPCB for 'Handling, Treatment and Disposal of Waste Generated during Treatment/ Diagnosis/ Quarantine of CoviD-19 Patient' thoroughly discussed the measures need to follow for the management of BMW at the institutional level as well as at household level by ULBs. The CPCB guideline emphasises creating awareness among citizens regarding the segregation of COVID-19 BMW and treating it differently than general MSW. The guideline indicates that the rapid antigen test kits used to detect COVID-19 should be classified as red waste and deposited through common bio-medical waste treatment facilities (CBWTFs) or manufacturers attached. Along with this, the guideline instructed the

TABLE 1: BMW CATEGORIES AND COLOUR CODES FOR
 TREATMENT AND DISPOSAL

<i>Category</i>	<i>Description of Waste category</i>	<i>Treatment and Disposal</i>	<i>Colour Codes for Treatment and Disposal</i>
1	Human Anatomical Waste: (human tissues, organs, body parts)	Incineration/ deep burial	Yellow
2	Animal Waste: (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals colleges, discharge from hospitals, animal houses).	Incineration/ deep burial	Yellow
3	Microbiology and Biotechnology Waste: (wastes from laboratory cultures, stocks of specimens of microorganism live or attenuated vaccines, human and animals cell culture used in research, infectious agents from research and industrial laboratories, wastes from the production of biological, toxins, dishes and devices used for transfer of cultures)	Autoclaving/ microwaving/ incineration	Yellow, Red
4	Waste Sharps: (needles, syringes, scalpel, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	Disinfection (chemical treatment/ autoclaving/ microwaving) and mutilation/ shredding	Yellow, Blue
5	Discarded Medicines and Cytotoxic Drugs: (wastes comprising outdated contaminated and discarded medicines)	Incineration/ destruction of drugs disposal in secured landfills	Yellow, Black
6	Solid Wastes: (items contaminated with blood and body fluids, including cotton, dressings, soiled plaster casts, linens, beddings, and other materials contaminated with blood)	Incineration/ autoclaving/ microwaving	Yellow, Red

(contd.)

(Table 1 contd.)

7	Solid waste: (wastes generated from disposable items other than the waste sharps such as tubes, catheters, intravenous sets etc.)	Disinfection/ autoclaving/ microwaving and mutilation/ shredding	Red, Blue
8	Liquid Waste: (waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities)	Disinfection/ Discharge into drains	Black
9	Incineration Ash: (ash from incineration of any bio-medical waste)	Disposal secured landfill	Black
10	Chemical Waste: (the chemical used in the production of biologicals, chemicals used in disinfection, as insecticides, etc.)	Chemical treatments and discharge into the drain for liquids and secured landfill for solids.	Black

Source: Biomedical Wastes Management and Handling Rules, 1998 and 2016.

manufacturer of the COVID-19 antigen kit that the instruction concerned with the deposition of the antigen kit must be written on it.¹

In this study, the trends and patterns of bio-medical waste generation in Raipur city have been analysed. The study also describes bio-medical waste management, including collection, treatment, and disposal of BMW in Raipur city. The study relied on secondary data from Chhattisgarh Pollution Control Board, Chhattisgarh Environment Conservation Board, Raipur Municipal Corporation, and SMS Water Grace Enviroprotect Pvt. Ltd. The study has few limitations concerned with the nature of the data. For instance, the BMW data of 2021 also included the waste from food items provided to the COVID-19 patients. Similarly, the BMW generated from homes during the quarantine period is not included in the BMW. The management of MSW and BMW is conducted by two different agencies that have created the problem of data synchronisation and compatibility.

COVID-19 BMW GENERATION IN INDIA

According to the data published by the Central Pollution Control Board (CPCB) in the year 2018, the total amount of BMW generated in India was 517/day in the year 2016 and around 501/day in the year 2015, out of which about 4-5 per cent remains untreated. The annual report 2018/2019 released by CPCB showed the generation of 557/day BMW in 2017, out of which 517/day was treated. However, the

situation drastically changed in India after the spread of COVID-19 as a different type of BMW emerged, which is more infectious. Tones of COVID-19 contaminated wastes are generated worldwide, and its sound management became essential to break the disease transmission.

The safe and sustainable management of COVID-19 contaminated biomedical waste (BMW) is a social and legal responsibility. Unsound management of this waste could cause unforeseen “knock-on” effects on human health and the environment (Behera, 2021). During COVID-19 crisis, the approach of CPCB had also changed, and they published separate data of BMW generated from the COVID-19. The average daily amount of COVID-19 BMW generated since June 2020 is presented in Table 2.

On December 31, 2019, China informed the World Health Organization (WHO) about cases of pneumonia of unknown aetiology detected in Wuhan city, Hubei province of China, while on January 27, 2020, (confirmed later on January 30, 2020), the first suspicious case of COVID-19 was diagnosed in Thrissur, Kerala in India (Andrews et al.). After that, COVID-19 increased manifolds; however, the record of COVID-19-related BMW was unavailable for a few initial months. The NCRB has published COVID-19 BMW data from June 2020 onwards. The COVID-19 biomedical waste consists of PPE kits, masks, shoe coverings, gloves, human tissues, blood-contaminated objects, bodily fluids such as dressings, plaster casts, cotton swabs, blood-contaminated bedding, needles and syringes. Since then, the number of COVID-19 patients has fluctuated during the first, second, and third pandemic waves. With the increase in cases, COVID-19 BMW has also increased. The correlation between the monthly average confirmed cases and the monthly average of COVID-19 BMW is +0.49. The correlation value (+0.49) indicates a definite increase in the amount of COVID-19 BMW with the growth in confirmed cases. However, the growth of COVID-19 BMW is not proportionate to the rise in confirmed cases.

CPCB has also reported the same fact. According to CPCB, “as per the information submitted by State Pollution Control Boards/Pollution Control Committees and daily data received from the COVID-19 BWM Tracking App, the average quantity of COVID-19 related bio-medical waste generation during May 2021 is about 203 tonnes per day (TPD). Peak generation of BMW (about 250 TPD) was reported on May 10 2021. The earlier peak generation in 2020 was in the range of 180 - 220 TPD. Despite an additional number of COVID-19 patients, there is no proportional growth in the quantity of COVID-19 bio-medical waste generated, mainly due to proper waste segregation”.²

TABLE 2: AMOUNT OF COVID-19 BMW AND CONFIRMED CASES OF COVID-19 IN INDIA (JUNE 2020 TO MARCH 2022)

Year	Month	Amount of BMW* (TPD)	No of Covid Cases**
2020	June	91.67	384697
	July	132.92	1072030
	August	154.07	1982375
	September	156.85	2604518
	October	159	1911356
	November	138	1294572
	December	129.35	834983
2021	Jan-2021	75	466457
	February	53	363600
	March	75	1052604
	April	139	6613641
	May	203	9284558
	June	164	2315314
	July	72.8	1251145
	August	55.56	1154887
	September	49.1	971100
	October	32.3	533320
	November	24.67	314522
	December	23.02	250982
2022	January 2022	38.41	6463636
	February	33.11	1621690
	March	9.87	100310

Source: *<https://cpcb.nic.in/covid-waste-management/>

** <https://covid19.who.int/region/searo/country/in>

The generated amount of COVID-19 BMW is unevenly distributed among the states. From June 2020 to December 2020, Maharashtra produced the highest COVID-19 BMW (5,367 tonnes), followed by Kerala (3,300 tonnes), Gujarat (3,086 tonnes), Tamil Nadu (2,806 tonnes), Uttar Pradesh (2,502 tonnes), Delhi (2,471 tonnes), West Bengal (2,095 tonnes), and Karnataka (2,095 tonnes). State-level data indicates that different states have recorded the peak of COVID-19 cases at different months. It is also found that they have generated the highest waste in the same month.

GENERATION OF BIO-MEDICAL WASTE IN RAIPUR CITY

The CPCB has systematically published the data on biomedical waste generated due to COVID-19 (Table 1). However, comprehensive data on biomedical waste (non-covid BMW) has not been published by CPCB for the post-COVID-19 period. Contrary to it, Raipur Municipal Corporation and SMS Watergrace Enviroprotect Pvt. Ltd have provided separate

data for both COVID-19-related waste as well as general BMW. Table 3 depicts the pre and post-COVID-19 situation of bio-medical waste in the city from 2019 to 2021.

The first confirmed corona virus case in Chhattisgarh was reported on March 19, 2020, in Raipur, where a woman returning from London tested positive (*Hindustan Times*, 2020). Later the city turned into the epicentre of the COVID-19 pandemic in Chhattisgarh. Despite the lack of synchronised and systematic data, it is widely recognised that the city has carried a disproportionate burden of diseases. It has taken the burden of the local patients and non-residents of the city. The availability of quality healthcare infrastructure has become the prime concern for everyone. In the first wave of the pandemic, the All India Institute of Medical Sciences, Raipur, had become one of the country's most crowded hospitals. In the initial stage of the pandemic, AIIMS, Raipur was the only hospital taking care of COVID-19 patients. Even later, during the subsequent waves of COVID-19, the AIIMS, Raipur has provided excellent quality services and worked as a nodal agency to decide COVID-19 treatment protocol in the state. Raipur city has taken the disproportionate burden of COVID-19 BMW. Table 3 depicts the overall BMW generated in the city from 2019 to 2021 and COVID-19 BMW generation is discussed subsequently.

TABLE 3: TREND OF BIO-MEDICAL WASTE GENERATION
IN RAIPUR (2019 TO 2022)

Month	2019		2020		2021	
	Daily Average (Kg)	Total (tonnes)	Daily Average (Kg)	Total (tonnes)	Daily Average (Kg)	Total (tonnes)
January	3413	106	2551	79	6229	193
February	3809	107	2586	75	5463	153
March	3817	118	2358	73	5611	174
April	3803	114	1805	54	6925	208
May	3898	117	2042	61	6176	191
June	3689	111	2762	83	5286	159
July	4388	136	3221	100	5457	169
August	4665	140	3655	110	5192	161
September	4651	140	4283	128	4968	149
October	4551	137	4410	137	4851	150
November	5390	162	3600	108	4801	144
December	5390	162	3774	117	5261	163
Total	4457	1548	3256	1125	5687	2015

Source: Unpublished data of RMC and website of SMS Watergrace Enviroprotect Pvt. Ltd.

Table 3 indicates that in 2019, 1548 tons of BMW were generated in Raipur city, having an annual average of 4457 kg per day. The total amount of BMW declined to 1125 tons and an annual daily average of 3256 kg per day in 2020. The decline of more than 25 per cent in a year is phenomenal and ensued primarily due to the prolonged nationwide lockdown declared from March 25, 2020, as a preventative measure against the COVID-19 pandemic in India when the numbers of recorded cases were only 519, with nine reported deaths (Raman et al., 2021). Given that 70 per cent of the healthcare in India is provided by the private sector and most only provided minimal services during the lockdown, the immediate consequences of lockdown was on healthcare provisions and a negative impact on the general health of the population (Verma & Mishra, 2020). Reduced capacity due to social distancing and other restrictions after relaxation also caused interruptions to healthcare provision. The combined effect of these things came in the form of a substantial decline in biomedical waste in Raipur city in 2020 (Table 3).

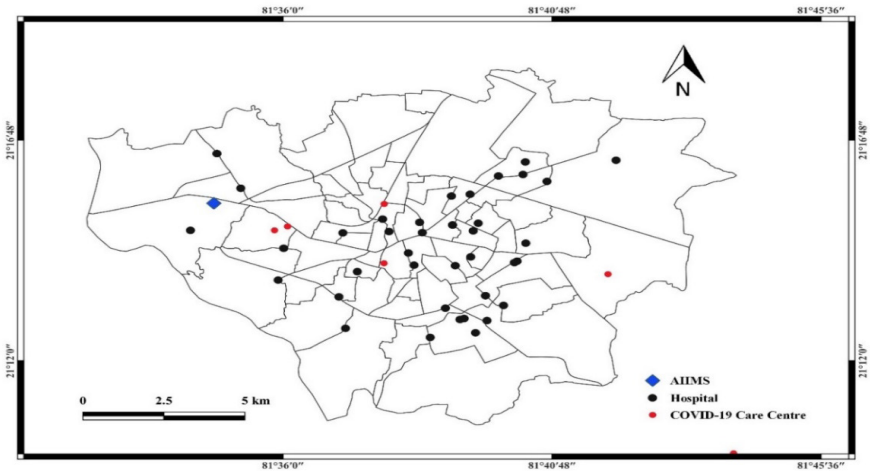
Compared to 2020, in 2021, the amount of biomedical waste in the city increased drastically. Table 3 indicates that in comparison to 2020, about 80 per cent growth in BMW statistics was registered in 2021 mainly due to two reasons. First, the restrictions imposed due to the COVID-19 lockdown were relaxed phase-wise, and regular healthcare services were restored in 2021. Second, the peak of COVID-19 cases in the city were also observed in 2021. These two combined effects led to a drastic increase in the BMW generation in the city.

HOTSPOTS OF COVID-19 BIO-MEDICAL WASTE GENERATION IN THE CITY

In the year 2021, from March onwards, the country has witnessed a massive rise in the cases of COVID-19 and the resultant breakdown of the healthcare system. The government has opted for many emergency measures to control the situation. An immediate extension in the existing healthcare facilities was made by converting non-Covid healthcare centres/hospitals into Covid Care Centres and opening up the Covid Care Centres in non-medical premises such as schools and colleges. The higher number of such centres indicates the severity of the situation in a particular place.

Figure 1 presents the location of COVID-19 Care Centres and hospitals engaged in treating COVID-19 patients in the city from May 2021 to December 2021. The densely populated central part of the city is dotted with many such centres. It indicates the severity of the COVID-19 in the city's core. These hospitals and COVID-19 Care Centres have become the city's primary source (hotspots) of BMW generation.

Figure 1: Centre of Bio-medical Waste Generation in Raipur City (March to December 2021)



Source: Based on SMS-Watergrace Enviroprotect Pvt. Ltd. Data, 2021

Table 4 indicates that until February 2021, only one hospital (AIIMS, Raipur) was engaged in treating COVID-19 patients, but by March, 2021, number was increased to 18. By April 2021, total of 53 hospitals were involved in treating COVID-19 patients. In April and May 2021, almost every eligible hospital was engaged in treating COVID-19 patients. As the situation improved, the number of hospitals treating COVID-19 patients decreased and was reduced to only five at the end of the year. During emergency, a few COVID-19 Care Centres were also installed in April and May 2021 to avoid additional pressure on hospitals. These Covid Care Centres were primarily used as quarantine centres, and primary healthcare facilities were installed there during the emergency that started from March onwards (Table 4).

The generation of BMW increased considerably during the peak situation of COVID-19 centres. In April 2021, the amount of COVID-19 BMW was about 55 tonnes which significantly increased to 84 tonnes in May 2021. The share of COVID-19 BMW was about 28 per cent at the beginning of the year, reaching its peak (50%) in May. Since then, it has again declined considerably. In 2021 from September onwards, the amount and total share of COVID-19 BMW declined sharply. This sharp decline is partially due to a decrease in COVID-19 cases and mainly due to a change in methodology (Table 3). Earlier all kinds of waste, including food wastage and clothes generated by COVID-19 patients, have been treated as COVID-19 waste. However, the classification scheme has changed considerably from August onwards. Change in the

TABLE 4: MONTH-WISE CHANGE IN HEALTHCARE INSTITUTIONS AND BMW IN RAIPUR CITY (2021)

<i>Month</i>	<i>No. of Active Hospitals</i>	<i>Active COVID-19 Care Centres</i>	<i>COVID-19 BMW (in Tonnes)</i>	<i>Total BMW (in Tonnes)</i>	<i>Share of COVID-19 BMW (%)</i>
January	1	-	54.0	193	27.97
February	1	-	44.2	153	28.89
March	18	1	55.5	174	31.92
April	53	7	84.3	208	40.51
May	52	8	96.0	191	50.28
June	29	3	68.3	159	42.98
July	8	1	39.0	169	23.06
August	6	-	16.1	161	10.03
September	5	-	10.3	149	6.93
October	5	-	8.6	150	5.72
November	4	-	8.1	144	5.61
December	5	-	5.8	163	3.55
Total			490.2	2015	24.33

Source: Compiled from unpublished data of Raipur Municipal Corporation (RMC).

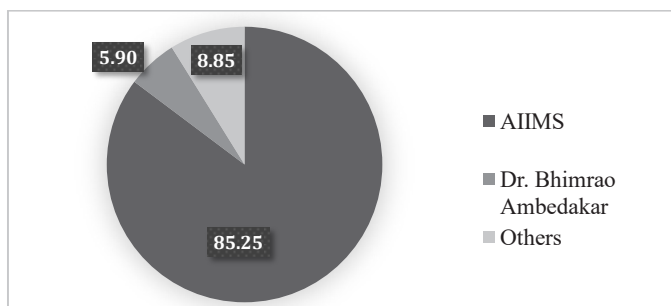
classification scheme led to a considerable decline in COVID-19 BMW. Because of the mid-year change in the classification scheme, these data are very general and may not reveal the actual state of COVID-19 BMW generated in the city.

BIO-MEDICAL WASTE MANAGEMENT IN THE RAIPUR CITY

Generation of COVID-19 BMW in the city was unevenly distributed as different centres (hotspots) have a differential share of COVID-19 BMW. AIIMS, Raipur has treated the highest number of patients and generated the highest amount of BMW. In 2021, 85 per cent of COVID-19 BMW in the city was generated from the AIIMS, while Dr Bhim Rao Ambedkar Memorial Hospital generated another six per cent waste. All other hospitals and COVID-19 Care Centres in the city shown in Fig. 2 have generated a mere nine per cent of the total COVID-19 BMW.

Before discussing the core issue in the management of BMW, it is worth mentioning that at the household level, the management of BMW is performed by the different agencies and RMC. They segregate the solid waste into organic, recyclable, and inert waste and generally do not separate the BMW from MSW. It was reported in the field visit that during the peak of the COVID-19 crisis in the city, general sanitation workers collected the household waste separately for those households affected by the COVID-19. However, no systematic data on generated

Figure 2: Contribution of Hospitals and COVID-19 Care Centres in COVID-19 BMW Generation



Source: Based on SMS-Watergrace Enviroprotect Pvt. Ltd. data, 2021

amount and management of BMW at households is available. Henceforth, this discussion on the management of BMW is confined only to the management of BMW at the healthcare institutions. This discussion does not consider the generation and management of BMW at the household level.

As mentioned earlier, the categorisation and segregation of BMW at source is the most significant task in the management of BMW. Table 5 represents the category-wise generation of BMW from 2019 to 2021. The concerned agency does not provide category-wise data for 2021; subsequently, extrapolated data for the different categories are used for 2021. Table 5 evinces that the collective share of yellow and red waste is about 90 per cent of the total BMW. However, the proportion of yellow waste in the total BMW has drastically increased after the COVID-19 pandemic in 2020.

TABLE 5: CATEGORY-WISE GENERATION OF BMW (2019-21)

Category of BMW	2019		2020		2021 (Estimated)	
	Amount (Tonnes)	Share (%)	Amount (Tonnes)	Share (%)	Amount (Tonnes)	Share (%)
Yellow	920.1	59.44	852.5	75.78	1527.0	75.78
Red	485.8	31.38	174.0	15.46	311.5	15.46
Blue	126.4	8.16	89.8	7.99	161.0	7.99
White	15.7	1.01	8.7	0.78	15.7	0.78
Total	1,548	100	1125	100	2015	100

Source: Unpublished data of RMC and website of SMS Watergrace Enviroprotect Pvt. Ltd.

The majority of healthcare establishments in Raipur city are located in the densely populated central part of the city (Fig. 1). Therefore, the proper management of infectious biomedical waste needs immediate

attention. The waste management system of these healthcare institutions involved the management of general solid waste generated during the day-to-day functioning and the management of BMW generated during the treatment of patients. The general solid waste generated from these healthcare institutions is managed by the RMC, while the management of BMW has been outsourced to SMS-Watergrace Enviroprotect Pvt. Ltd. Henceforth the BMW management of Raipur city is conducted through the Public-Private Partnership (PPP) model.

The SMS-Watergrace Enviroprotect Pvt. Ltd. uses GPS-enabled vehicles to collect and transport already segregated BMW. A total of nine such vehicles are engaged in the transportation of BMW. They transport the collected BMW from the institution to the specially designed treatment plant. The general solid waste management facility of Raipur city is located in Sakri and Saron. The BMW disposal plant in the city was developed by the SMS-Watergrace Enviroprotect Pvt. Ltd. and is located in Siltara village, located about 18 km away from the city. This incinerator plant is compatible with the Biomedical Waste Rules 2016 and has an online monitoring system. The BMW disposal plant has been extended to an area of about 1.5 acres. This treatment features a 250 kg/hr incineration capacity, a 1000 lit/batch autoclaving capacity, a 100 kg/hour shredding capacity, and a 5 KLD Effluent Treatment Plant (ETP) with zero discharge.

CONCLUSION

The ongoing COVID-19 pandemic has led to a significant surge in bio-medical waste. The highly infectious nature of diseases created a panic situation where the management of COVID-19 BMW became a significant challenge. Initially, the BMW in the city decreased due to the lockdown imposed by the government. During the subsequent waves of COVID-19, the amount of BMW generated in the city has also increased significantly. The BMW had mainly generated from healthcare institutions and COVID-19 care centres. Apart from it, the households with COVID-19 patients also contributed to the generation of BMW. The BMW waste is collected and segregated separately by general workers engaged in SWM at the household level. It is observed that the CPCB guidelines regarding the segregation and disposal of COVID-19 BMW at the household level need more effective implementation by the concerned stockholders. At the institutional level (from hospitals and clinics), the SMS-Watergrace Enviroprotect Pvt. Ltd performs the task of BMW management. The company performed the task of transportation through GPS-enabled vehicles and an incinerator plant. The transported BMW is treated scientifically in the incinerator plant located in Siltara Village.

The pandemic turned into havoc during its peak, and posed myriad challenges to every institution working in our society. Similar challenges arrived in the form of effective management of BMW. The city has accepted the challenges and reformed the BMW collection and management system. Now, after two years of the onset of the COVID-19 pandemic, Raipur city has become more efficient in SWM and management of BMW.

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Footnotes

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2. https://cpcb.nic.in/uploads/Projects/Bio-Medical-Waste/COVID19_Waste_Management_status_June_2021.pdf

APPENDIX-I

List of Abbreviations

AIIMS	All India Institute of Medical Science
APP	Application
BMW	Biomedical Waste
CBWTF	Common Biomedical Waste Treatment and Disposal Facility
CPCB	Central Pollution Control Board
ETP	Effluent Treatment Plant
GPS	Global Positioning System
KLD	Kilo Litre Per Day
MOEFCC	Ministry of Environment, Forest and Climate Change
PPE	Personal protective equipment
PPP	Public-Private Partnership
RMC	Raipur Municipal Corporation
SWM	Solid Waste Management
TPD	Tonnes Per Day
UNEP	United Nations Environment Programme
WHO	World Health Organization