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A Scenario from India Relating To Various Aspects of Biomedical Waste Management in the Wake of Covid-19

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ABSTRACT

India, with the second-largest population globally after China, and one of the worst-hit countries by the COVID-19 pandemic, is facing significant challenges due to its poorly managed biomedical waste system. The lack of public awareness and resources is exacerbating the problem, putting hospital personnel, physicians, nurses, patients, and visitors at risk of exposure to biomedical waste. Proper training for those handling and managing biomedical waste is critical in preventing further virus transmission. Inadequate treatment and management of BMW can result in contamination of soil, air, and water, which can lead to the transmission of diseases and various health issues. India has seen a 25% increase in daily biomedical waste generation in 2020 as a result of COVID-19. As a result, new guidelines and strategies are being implemented by various countries to safely manage the increased amounts of biomedical waste, including COVID-19 waste. A step towards regulating and controlling BMW activities in the nation was taken with the implementation of the BMW management rules 2016 and the amendment Rules 2019. To stop the COVID-19 pandemic from spreading and to safeguard the security of medical staff, patients, and the general public, efficient biomedical waste management is essential.

Keywords: Biomedical waste, COVID-19 Waste, CPCB (The Central Pollution Control Board), SPCBs (State Pollution Control Boards), PCCs (Pollution Control Committees), ULBs (Urban Local Bodies), CBWTF (Common Bio-medical Waste Treatment Facility), HCFs (Health Care Facilities), BMWM (Bio-medical Waste Management).

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INTRODUCTION

Definition of bio-medical waste:

According to the Bio-Medical Waste (Management & Handling) Rules 2016, Bio-Medical Waste is defined as "any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps, including categories mentioned in Schedule – I appended to these rules".[1]

MATERIALS AND METHOD

The purpose of this literature review is to identify potential issues with the handling and disposal of COVID-19 waste, as well as to suggest remedies. The authors searched the PubmedCentral (PMC) database using keywords like "biomedical waste management in COVID-19," "healthcare waste," "COVID-19," "novel corona," "SARS-CoV-2," "types of healthcare waste," "healthcare waste management," "COVID-19 waste," hazards, disposal, and management," and they found recent pertinent studies on particular issues relating to COVID-19 waste. Out of the more than 70,000 articles that were accessible in PMC up until the last week of May 2023, only those articles that dealt with the management of biomedical waste during COVID-19 were included.

The Central Pollution Control Board (CPCB) from March 2020 to April 2022 and the Government of Rajasthan (17.11.2020-13.02.2022) both released COVID-19 waste management recommendations, and the authors included these rules as well as implementation issues. The World Health Organization (WHO), the United States Occupational Safety and Health Administration (OSHA), and the European Union guidelines for COVID-19 waste management and infection control practices published from March 2020 to April 2022 were also taken into consideration by the authors.

This review of the literature offers a thorough overview of waste management, especially in light of the COVID-19 epidemic. It is important to comprehend the difficulties and problems that develop while handling waste during a pandemic, as well as the rules and recommended methods for doing so. The study can provide decision-makers and waste management specialists with information on how to efficiently handle this sort of waste by emphasizing viable strategies to reduce the dangers connected with COVID-19 waste. Overall, it seems that this literature analysis offers insightful and informative data on a significant and timely topic.

Transmission of Covid-19

SARS-CoV-2 can spread via contact, droplet, aerosol, fomite, fecal-oral, blood-borne, mother-to-child, and animal-to-human transmission. SARS-CoV-2 infection primarily results in respiratory

sickness, which can range in severity from mild illness to severe illness and death. However, some infected individuals never experience any symptoms.[2, 3] According to the available data, the natural reservoir host of SARS-CoV-2 is a species of horseshoe bat called *Rhinolophus affinis*.[4]

Persistence of Covid-19 Virus Sars-Cov-2 on Different Surfaces

The COVID-19 virus can remain suspended in aerosol for more than 3 hours. Persistence of COVID-19 Virus SARS-CoV-2 on different surfaces are as follows [5]:

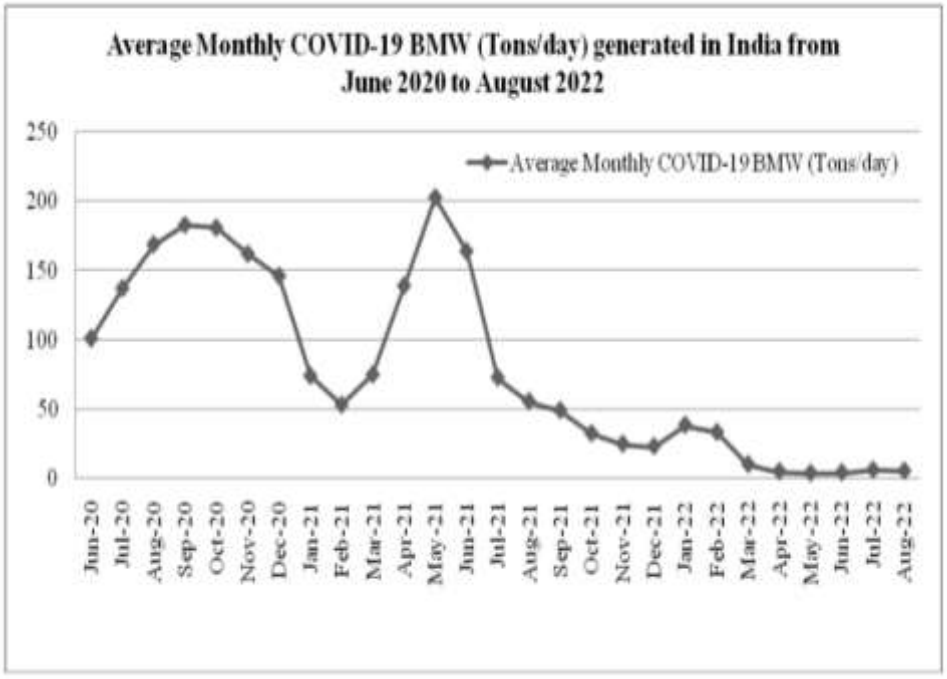
Surface	In hours	Surface	In hours
Plastics & Stainless Steel	72	Printing and Tissue Paper	3
Copper	4	Wood and Cloth	48
Cardboard	24	Glass and Banknote	96

Human coronaviruses can remain infectious on inanimate surfaces at room temperature for upto 9 days. At a temperature of 30°C or more, the duration of persistence is reduced.[6]

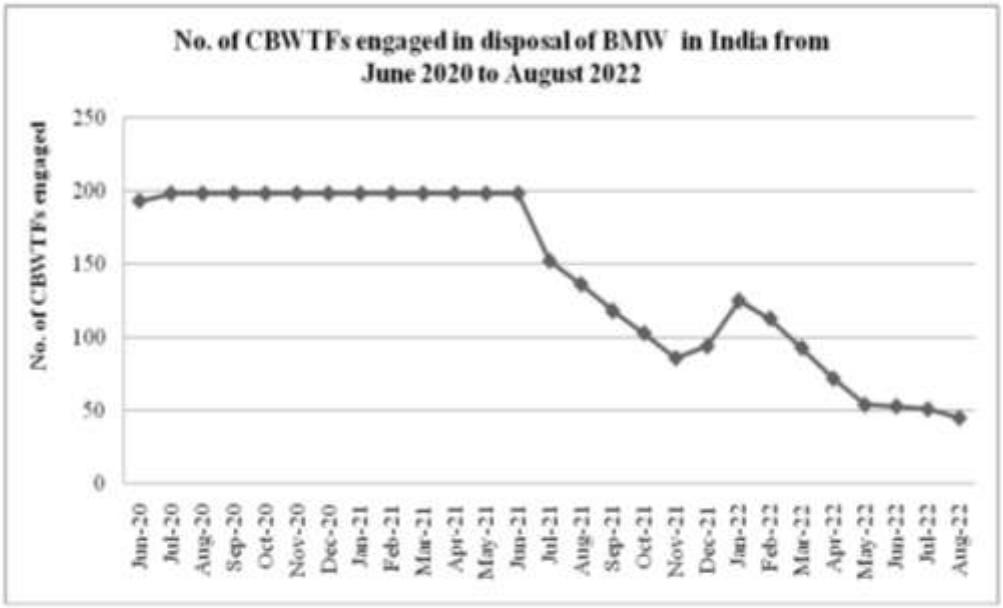
COVID-19 BIOMEDICAL WASTE MANAGEMENT STATUS IN INDIA

Average Monthly COVID-19 BMW (Tons/day) generated and No. of CBWTFs engaged in the disposal of BMW in India from June 2020 to August 2022 [7-18]

Month	Average Monthly COVID-19 BMW (Tons/day)	No. of CBWTFs engaged	Month	Average Monthly COVID-19 BMW (Tons/day)	No. of CBWTFs engaged
Jun-20	101	193	Aug-21	55.56	136
Jul-20	137	198	Sep-21	49.1	118
Aug-20	169	198	Oct-21	32.3	103
Sep-20	183	198	Nov-21	24.67	86
Oct-20	181	198	Dec-21	23.02	94
Nov-20	162	198	Jan-22	38.41	125
Dec-20	146	198	Feb-22	33.11	113
Jan-21	74	198	Mar-22	9.87	93
Feb-21	53	198	Apr-22	4.67	72
Mar-21	75	198	May-22	3.54	54
Apr-21	139	198	Jun-22	3.97	53
May-21	203	198	Jul-22	5.81	51
Jun-21	164	198	Aug-22	5.08	45
Jul-21	72.8	152			



Average Monthly COVID-19 BMW (Tons/day) generated in India from June 2020 to August 2022



No. of CBWTFs engaged in disposal of BMW in India from June 2020 to August 2022

GAPS IN THE TREATMENT AND DISPOSAL OF BIOMEDICAL WASTE

According to the Central Pollution Control Board (Ministry of Environment Forest & Climate Change) Delhi as reported by SPCBs/PCCs [19-20]:

Year	No. of HCFs	Quantity of BMW generated (tonnes/day)			Total Quantity of BMW Treated and Disposed (tonnes/day)			Gap in treatment and disposal of BMW (tonnes/day)		
		non-COVID	COVID	Total	non-COVID	COVID	Total	non-COVID	COVID	Total
2020	3,52,014	656	118	774	590	118	**708**	66	0	**66**
2021	3,75,256	684	80	764	641	80	**721**	43	0	**43**

According to information from the annual report for 2021, there is a lag between the production of BMWs and their treatment and disposal. The states of Assam, Bihar, Himachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Nagaland, and Tripura have gaps in generation, treatment, and disposal. There should be no lag between the production of biomedical waste and its treatment and disposal for environmentally friendly disposal of BMW.[20]

COVID-19: GUIDELINES ON DISINFECTION OF COMMON PUBLIC PLACES INCLUDING OFFICES

According to the Guidelines for disinfection of quarantine facilities (for COVID-19) issued by The National Centre for Disease Control [21]:

Areas	Agents	Procedure
All indoor areas such as entrance lobbies, corridors, and staircases, escalators, elevators, security guard booths, office rooms, meeting rooms, cafeteria	1% sodium hypochlorite or phenolic disinfectants	mopped with a disinfectant with 1% sodium hypochlorite or phenolic disinfectants
High-contact surfaces such as elevator buttons, handrails/handles and call buttons, escalator handrails, public counters, intercom systems, equipment like telephones, printers/scanners, and other office machines	1% sodium hypochlorite	cleaned twice daily by mopping with a linen/absorbable cloth soaked in 1% sodium hypochlorite
Metallic surfaces like door handles, security locks, keys, etc.	70% alcohol	70% alcohol can be used to wipe down surfaces where the use of bleach is not suitable.

Hand sanitizing stations ought to be set up in office premises (particularly at the entrance) and near the high contact areas. When someone coughs in a meeting, conference, or workplace setting without using a mask or respiratory etiquette, the space around their seat should be vacated and cleansed with 1% sodium hypochlorite.[21]

WHO recommends alcohol-based hand rub products (between 60% and 80% of alcohol), 70% ethyl alcohol to disinfect small surface areas and equipment between uses, such as reusable dedicated equipment (for example, thermometers); sodium hypochlorite at 0.1% (1000 ppm) for

disinfecting surfaces and 0.5% (5000 ppm) for disinfection of blood or bodily fluids spills in health-care facilities.[22]

Environmental and Health Impacts Of Spraying Covid-19 Disinfectants with Associated Challenges

Individuals who are exposed to sodium hypochlorite may have severe coughing and throat pain. A reaction between chlorine byproducts and other naturally occurring compounds could lead to the development of secondary products. These secondary products/byproducts have harmful health impacts like cancer, a higher risk of miscarriage, and birth defects. Marine flora and animals are harmed by chlorine disinfectants. Nitrogen, chloramine-forming, or N-nitroso-dimethylamine-forming disinfectants may be mixed, all of which have been recognized as carcinogens.

Due to the severity of the COVID outbreak, the use of these disinfectants can be somewhat justified, but caution must be exercised when using them because of their potential long-term consequences on people and the environment.

At the regional, national, and international levels, clear and comprehensive disinfectant application rules are also necessary to reduce the harmful impacts on people and the environment. [23]

Biomedical Waste Management Rules: An Indian Perspective

The Ministry of Environment, Forest & Climate Change's BMW management rules 2016 and the amendment rules 2019 are the most recent regulations in India for handling and managing biomedical waste. They cover the segregation, storage, collection, transportation, treatment, and disposal of waste as well as the duties of waste generators, waste treatment facilities, and state pollution control boards. The regulations also place a strong emphasis on the need to reduce waste and utilize eco-friendly substitutes. [1]

Biomedical Wastes Categories, and Their Segregation, Collection, Treatment, Processing and Disposal Options [1]

Category	**Type of Waste**	**Type of Bag or Container to be used**	**Treatment and Disposal options**
Yellow	Human Anatomical Waste, Used mask (triple layer mask, N95 mask, etc.), Head cover/cap, Shoe-cover, Disposable linen gown, Non-plastic or semi-plastic coverall, Gloves, etc., Tissues and toiletries of covid-19 patients, Swabs contaminated with blood/body fluids of covid-19 patients, Covid-19 patients used syringes, medicines	Yellow colorednon-chlorinated plastic bags/ containers	Incineration/Plasma Pyrolysis/deep burial
Red	Disposable tubing, Disposable Bottles, Disposable Intravenous tubes and sets, Catheters, urine bags, Used PPEs (goggles, face shield, splashproof apron, plastic coverall, Hazmat suit, nitrile gloves), Used Rapid COVID-19 Antigen test kits, Cartridges of gene expert, chips and microtubes of CBNAAT, Refractable syringes used in the immunization program, Syringes (without needles and fixed needle syringes), Viral transport media, Plastic vials, Vacutainers, Eppendorf tubes, Plastic cryovials, Pipette tips	Red colored non-chlorinatedplastic bags/ containers	Autoclaving/micro-waving/hydroclaving then shredding/ mutilation/ combination ofsterilization & shredding. Treated waste to be sent to registered/ authorized recyclers/ for energy recovery/ plastics to diesel/fuel oil/ for road making.
White (Translucent)	Waste sharps including Metals, Needles, syringes with fixed needles, needles from needle tip cutters or burners, scalpels, blades, etc.	Puncture-proof, Leak-proof, tamper-proof containers	Autoclaving/Dry Heat Sterilization then shredding/ mutilation/ encapsulation in a metal container/ cement concrete; Then sent for final disposal to iron foundries/sanitary landfill/designated concrete waste sharp pit.
Blue	Broken or discarded and contaminated Glass vialsand ampoules except those contaminated with cytotoxic wastes, Metallic Body Implants	Puncture-proof and leak-proof boxes or containers with blue-colored markings.	Disinfection (by soaking the washedglass waste after cleaning withdetergent and Sodium Hypochlorite treatment) Autoclaving/microwaving/ Hydro claving, then sent for recycling.

Use of the Bar-Code System

By 27.03.2019, every Health Care Facility (HCF) must implement a bar code system for bags or containers containing BMW that are being sent out of the premises or place for any reason, according to Rule 4 (i) of the BMWM Rules, 2016. Additionally, every CBWTF Operator is required by Rule 5(c) of the BMWM Rules 2016 to set up a barcode system for handling BMW. The CPCB has created guidelines for the "Barcode System for Effective Management of BMW" to make it easier for operators of CBWTFs and hospitals at the state level to install the barcode system. [20]

CPCB GUIDELINES FOR HANDLING, TREATMENT, AND DISPOSAL OF WASTE GENERATED DURING TREATMENT/DIAGNOSIS/ QUARANTINE OF COVID-19 PATIENTS [24]

CPCB Guidelines 2020 (on 18th March 2020):

The COVID-19 epidemic has led to an increase in the output of biomedical waste. In the year 2020, "Guidelines for handling, treatment, and disposal of waste generated during treatment, diagnosis, and quarantine of COVID-19 Patients" have been prepared by CPCB to ensure the safe collection, transport, treatment, and disposal of COVID-19 biomedical waste. These guidelines must be followed in addition to the methods currently used to manage general solid waste and biomedical waste under the BMW Management Rules, 2016, and SWM Management Rules, 2016 accordingly. These guidelines have also undergone the following 5 revisions:

1st Revision (on 25th March 2020):

This first revision of the guidelines is primarily done to include specific requirements and responsibilities for people operating quarantine camps or caretakers of quarantine homes/home-care units, the responsibilities of Urban Local Bodies (ULBs), specific provisions for States not having common CBWTFs, and for allowing hazardous waste incinerators to dispose of COVID-19 waste.

2nd Revision (on 18th April 2020):

This second revision of the recommendations is primarily intended to explain the management of general waste from quarantine homes and masks/gloves from other households as well as to integrate specific duties and obligations of individuals running sewage treatment plants at healthcare facilities.

3rd Revision (on 10th June 2020):

This third revision of the guidelines was released to include guidance on the segregation of general solid waste and biomedical waste, the safety of waste handlers and sanitation workers employed by

healthcare facilities, and local bodies (ULBs) and CBWTFs handling biomedical waste and solid waste produced by quarantine centers, home-care providers, and healthcare facilities caring for COVID-19 patients.

4th Revision (on 17th July 2020):

This fourth revision of the guidelines was released to offer updated guidance on the segregation of general solid waste and biomedical waste from quarantine centers, home care facilities, and healthcare facilities caring for COVID-19 patients, as well as disposal recommendations for PPEs.

5th Revision (on 26th April 2022):

This fifth revision of the guidelines was released to offer instructions on how used Rapid COVID-19 Antigen self-test kits should be disposed-off at the household level. As COVID-19 is not a category-A virus according to the CDC, these recommendations also state that COVID-19 biomedical waste should be treated like any other biomedical waste and governed as such under the Biomedical Waste Management Rules, 2016. In general, the management of COVID-19 biomedical waste should adhere to the provisions as outlined in the BMWM Rules, 2016, as well as these recommendations. [24]

Collection of Waste

For the collection of BMW, double-layered bags (using 2 bags) should be utilized. Healthcare establishments with isolation wards should maintain separate color-coded bins with foot-operated lids/Bags/Containers.

Healthcare facilities with isolation wards, sample collection centers & laboratories for COVID-19 suspect patients should delegate specialized sanitation workers for biomedical waste and general solid waste separately for prompt collection and transfer of the waste to temporary waste storage areas.

COVID-19 waste can be collected by CBWTF collection van either directly from the COVID-19 isolation wards or temporary storage room.

Before collection from a quarantine center or home care, solid waste bags and the bin used for yellow bags should be treated with 1% sodium hypochlorite solution by waste collectors.

Note: At Quarantine centers/camps, biomedical waste should be collected in yellow bags. The BMW produced by suspected or confirmed COVID-19 patients receiving care at a quarantine home/home-care facility should be collected in yellow bags and given to authorized waste collectors contracted by local bodies/ CBWTF operators at the door or deposited in yellow bags at designated deposition centers. [24]

Disposal of Feces of COVID-19 confirmed patients

Feces of COVID-19 confirmed patients collected in the diaper is treated as BMW and should be placed in a yellow bag/container. If feces of COVID-19-confirmed patients are collected in a bed pan, then feces are to be flushed into the toilet and pan to be cleaned with neutral detergent and water, disinfected with a 0.5% chlorine solution, then rinsed with clean water. [24]

Disposal of used PPEs

Waste masks and gloves in general households (other than COVID-19 patients) should be kept in paper bags for a minimum of 72 hours before disposal of the same as dry general solid waste after cutting the same to prevent reuse. Discarded personal protective equipment (PPE) from the general public at commercial establishments, shopping malls, institutions, offices, etc. should be stored in a separate bin for 3 days before being disposed-off as dry general solid waste after cutting/shredding. PPEs worn by medical personnel accompanying a COVID-19 patient's diseased body to a crematorium or graveyard shall be handled as biomedical waste and disposed-off as per SWM Rules, 2016, and BMW Management Rules, 2016. Used masks from crematorium/graveyards visitors, as well as from crematorium employees, should be collected in separate bins and kept for 72 hours before being disposed of as dry general solid waste by local authorities. [24]

Disposal of sued Rapid COVID-19 Antigen self-test kits at household level

The COVID-19 antigen home self-test kit results, whether positive or negative, can both be disposed-off in the same way.

Used test kits may be collected separately as domestic hazardous waste at common waste deposition centers established by local bodies as per Solid Waste Management Rules 2016.

Users may deposit in nearby PHCs, CHCs, GMCs, hospitals, and 24 hours pharmacies for subsequent disposal through CBWTFs or manufacturers attached to them.

Disposal as per the manufacturer's recommendations may include (i) keeping the used test kits apart for at least 72 hours before disposing of them as dry solid waste, (ii) using the disinfectant provided with the kit by the manufacturer, or (iii) using any other disinfectant to disinfect the used kit before disposal with general solid waste as dry waste to ensure the 10 log 4 reduction required by the BMWM Rules, 2016. [24]

Sanitization of vehicles

Labels reading "COVID-19 WASTE" should be placed on every dedicated cart, collecting bin, or container used to collect or store COVID-19 waste. Healthcare facilities with isolation wards, Common Biomedical Waste Treatment Facilities, and Urban Local Bodies are responsible for making sure that vehicles are cleaned with 1% sodium hypochlorite or another suitable chemical disinfectant following each trip. [24]

Duties of Urban Local Bodies (ULBs)

ULBs are in charge of assuring the secure collection and disposal of BMW produced by COVID-19 suspects receiving care at home, in quarantine homes, or camps.

ULBs should provide information on each Quarantine camp/ Quarantine home/Home care to SPCBs/PCCs from time to time, and provide contact details of the CBWTF operator at Quarantine camps, so that whenever BMW is generated, it can be lifted by CBWTF on a call basis, provide necessary support, security & authorization to staff of CBWTFs and make agreement with CBWTF for ultimate disposal of BMW collected from Quarantine homes/Home care/waste deposition centers/from door-step.

ULBs should establish common waste deposition centers to receive and collect BMW and aware the public about the need for segregation of municipal solid waste & BMW including used Rapid Self-test antigen kits for COVID-19. [24]

"COVID19BWM": The CPCB app for Managing Biomedical Waste

The designated nodal person at healthcare facilities with COVID ICUs, quarantine centers/camps, home isolation/home care, etc., and Common Biomedical Waste Treatment Facilities, SPCBs, PCCs, and ULBs should maintain the separate record of COVID-19 biomedical waste.

In May 2020, the CPCB created the app "COVID19BWM". The COVID-19 biomedical waste was tracked using this application from the waste generator to the common treatment facility. Every COVID-19 biomedical waste generator (healthcare facilities with COVID ICUs, quarantine camps/centers, homes isolation/home care, etc.) and the Common Biomedical Waste Treatment Facility, SPCBs, PCCs, and ULBs, are required to use this application.

State Pollution Control Boards (SPCBs)/Pollution Control Committees (PCCs) should coordinate with CBWTF and ULBs for the collection and disposal of BMW and should keep track of all COVID-19 treatment wards/quarantine centers/quarantine homes in their respective states. [24]

Training for Waste Collectors

Healthcare facilities with COVID ICUs, CBWTF operators, and ULBs are responsible for educating waste handlers about infection prevention practices like hand hygiene, respiratory etiquette, social distancing, use of the proper PPE, and its disposal, etc. through videos and demonstrations in the local language. PPEs (three-layer masks, splash-proof apron/gowns, heavy-duty gloves, gum boots, and safety goggles) should be provided to staff involved in handling and collection of general solid waste and BMW. [24]

Management of waste-water from HCFs/Isolation wards

According to the CDC, there is little chance that the COVID-19 virus might spread through a sewerage system. Operators of ETPs/STPs attached with discharge from healthcare facilities and isolation wards should continue to ensure disinfection of treated waste water as per standard operational practices to inactivate the corona-virus, practice basic hygiene precautions, and wear PPEs (goggles, face mask, liquid repellant coveralls, waterproof gloves, and rubber boots). Utilizing treated wastewater in utilities within HCFs may be avoided during the COVID-19 pandemic. [24]

DEAD BODY DISPOSAL OF COVID-19 PATIENTS IN UNKNOWN/SUSPECTED/CONFIRMED CASES: A SAFETY IMPLICATION

Only the lungs of dead COVID patients, if handled during an autopsy, can be infectious.

The deceased body should be placed in a leak-proof plastic body bag with a decontaminated exterior treated with 1% Sodium Hypochlorite so that the staff transporting the body is not at further risk.

The vehicle, after hand-over the dead body to cremation/burial staff, should be decontaminated with 1% Sodium Hypochlorite. [25]

Anyone handling the body must follow infection prevention and control (IPC) standard precautions which include washing their hands before & after handling the body and wearing the proper PPE (eye protection, such as a face shield or goggles, as well as medical mask, gown, and gloves) and closed-toed shoes or footwear protection depending on the level of contact with the body.

Family and friends may view the body after it has been prepared for cremation/burial. They should not touch or kiss the body and should perform hand hygiene after the viewing. The ash is safe to handle and can be gathered for final rituals. [26]

REGULATORY CHANGES IN RAJASTHAN DUE TO COVID 19

17.11.2020: In Light of the COVID-19 Pandemic, Schools, Colleges, and Educational and Coaching Institutions in Rajasthan Will Remain Closed Until November 30, 2020.

28.11.2020: The Rajasthan Government Sets a Price of Rs. 800 For Rt-Pcr Diagnostic Tests For Covid-19 In Private Laboratories.

29.11.2020: The Rajasthan Government announced guidelines for surveillance, containment, and caution for the period of December 1st to December 31, 2020, as well as a nighttime curfew in 13 districts of the state from 8 p.m. to 6 a.m.

23.12.2020: The Rajasthan Government orders a nighttime curfew on New Year's Eve from 8 p.m. on December 31, 2020, till 6 a.m. on January 1, 2021, in cities with more than 1 lakh residents.

31.12.2020: The Rajasthan Government issues guidelines for the implementation of surveillance, containment, and caution measures; a night curfew is imposed between the hours of 8 p.m. and 6 a.m. inside the urban limits of the 13 district headquarters towns.

19.08.2021: The Dholpur District Magistrate issued a prohibitory order under Section 144 of the Criminal Procedure Code, banning all gatherings/processions until further notice.

07.09.2021: Rajasthan Government issues advisory to prevent the spread of COVID-19 in light of upcoming festivals in the State.

17.09.2021: Rajasthan Government announces the three-tier Public Discipline Guidelines 6.0, allowing private offices to operate with 100% staff and maintaining the State's night curfew from 11:00 p.m. to 5:00 a.m.

08.10.2021: The Rajasthan Government announces new Public Discipline Guidelines because of the declining Covid-19 cases in the State.

29.10.2021: The Rajasthan Government permits operating auditoriums with 100% capacity between 6:00 am and 10:00 pm.

11.11.2021: Rajasthan Government notifies further amendments to the Rajasthan Epidemic Diseases Act; social events are permitted subject to compliance with Covid appropriate behavior.

26.11.2021: Rajasthan Government issues guidelines for educational institutes in the State intending to curb the spread of COVID-19.

13.02.2022: Rajasthan Government issues latest Public Discipline Guidelines; directs all commercial establishments to conspicuously display information related to the administration of both doses of COVID-19 vaccine to staff. **[**27, 28]

COVID-19 WASTE GUIDELINES BY DIFFERENT COUNTRIES AND AGENCIES

WHO: On March 3, 2020, the WASH (Water, Sanitation, and Health) division of the World Health Organization (WHO) published guidelines for the safe handling and management of COVID-19 waste. These guidelines were revised on March 19, 2020, and April 23, 2020, with the most recent update on July 29, 2020. The guidelines provide information on infection control and prevention strategies for COVID-19 patient care and waste management. The guidelines place a strong emphasis on the need to separate various waste types, use the right personal protective equipment (PPE), and use safe disposal techniques, offer advice on how to safely handle medical waste produced by households and communities as well as how to properly disinfect and discard reusable PPE.

The World Health Organization (WHO) suggests the "My 5 moments for hand hygiene" as a technique to encourage effective hand hygiene in hospital settings. The five moments are "before

touching a patient," "before clean/aseptic procedures," "after body fluid exposure/risk," "after touching a patient," and "after touching patient surroundings" respectively.

Using an alcohol-based hand rub is preferred method of hand hygiene in healthcare settings when hands are not visibly dirty, as it is a quick and effective way to kill most types of microorganisms. It is important to use the appropriate technique, including rubbing the hands together for 20-30 seconds until the hands are dry, to ensure maximum effectiveness. [29, 30]

The recommended PPE for handling health-care waste (long-sleeved gown, heavy-duty gloves, boots, mask, and goggles or a face shield) helps to minimize the risk of exposure to infectious materials and prevent the spread of infection. It is also important to perform proper hand hygiene after removing PPE to further reduce the risk of contamination. [21]

EUROPEAN UNION:

According to EU guidelines/recommendations on domestic waste management, Paper tissues, and face masks used by patients should be immediately put in the waste bag that was placed in their room specifically for this purpose exclusively. Additionally, a second bag should also be kept separately for storing gloves and facemasks used by the caretaker and by the cleaner. The collected bag should always be kept closed and should not be emptied into another bag. All such bags should be collected and placed in a clean general garbage bag (doing so makes the waste to be collected in a double-layered bag). However, if the aforementioned procedures are rigorously followed, these bags can simply be put into the general trash without being sorted, without the need for any special collection measures or additional disposal techniques. [31]

ITALY:

An Italian agency has made an effort to distinguish between the two primary types of municipal waste streams generated by households.

1. T1 type waste: Municipal waste produced by households *with* COVID-19-positive individuals under required quarantine or isolation.
2. T2 type waste: Municipal waste produced by households *without* COVID-19-positive individuals under required quarantine or isolation.

T1 type should be categorized as infectious medical waste and handled as such according to the appropriate legal requirements. Very few companies typically deal with this kind of waste, which is often collected using standardized bags and then sterilized. The guidelines for such waste emphasize collecting waste in a double-layer bag and require no source-separated collection as they are collected as residual waste.

On the other hand, T2-type waste is collected as per the established separate collection system. Tissues, masks, and single-use gloves should be included in the residual waste stream which has to be delivered through 2 sealed bags. Employees handling such waste should be outfitted with PPE. The regulations clearly say that elderly persons should not handle T1 waste type, but with the right safeguards, they can handle T2 type waste. [32]

UNITED STATES:

According to the U.S. Occupational Safety and Health Administration (OSHA), waste that is suspected, known to contain, or known to be contaminated with COVID-19 does not require additional safety measures above and beyond those already taken to safeguard employees from risks they may encounter while performing their regular job duties in the solid waste and wastewater management. OSHA also stated that municipal solid waste that may or may not be contaminated with SARSCoV-2 should be managed similarly to other municipal waste that is not contaminated, but strictly using engineering and administrative controls, safe work practices, and PPE such as puncture-resistant gloves and face & eye protection, to prevent worker exposure to recyclable materials they manage, including any contaminants in the materials. [33]

CHINA:

According to the "COVID-19 Infected Pneumonia Medical Waste Emergency Disposal Management and Technical Guide (Trial)" published by the People's Republic of China's Ministry of Ecology and Environment, infectious medical waste produced during the prevention and treatment of pneumonia epidemics should be packaged strictly as per the standards for Special packaging bags, containers, and warning signs for medical waste. Medical waste disposal units shall give priority to the collection and disposal of infectious medical waste generated during the prevention and treatment of epidemics. Hazardous waste incineration facilities, domestic waste incineration facilities, industrial furnaces, and other emergency disposal activities for medical wastes with epidemics shall be conducted as per the requirements of the competent health authorities. The medical waste collection, storage, transfer, and disposal processes should strengthen personnel hygiene protection. [34]

CONCLUSION

District level information on BMWM is not available in every State/UT which is required as per the BMWM Rules, 2016 as well as CPCB guidelines. Even seven years after the notification of BMWM Rules, 2016, authorization by every HCF, even non-bedded, has not been obtained. Domestic BMW is not collected separately from the households by the Urban Local Bodies as required under BMWM Rules, 2016. Liquid waste treatment facility i.e. ETP/STP is not installed

by all bedded HCFs in the States. Gap analysis is not carried out as per the CPCB guidelines to determine the need for an additional treatment facility to treat and dispose-off biomedical waste.

There are reasonably robust data on COVID-19 deaths in hospitals because most people who die in hospitals are tested. Deaths outside hospitals are likely underestimated as people are dying in care homes where mortality approaches ~40% and may die without being tested and diagnosed. It is difficult to determine prevalence as testing practices vary so much from country to country. Seroprevalence studies will help to collect these data.

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