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Mini Review

Biomedical Waste and COVID-19 in India and the World: Are We Ready?

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Abstract

Biomedical Waste (BMW) is any waste produced during the diagnosis, treatment, or immunization of human or animal research activities pertaining thereto or in the production or testing of biologics or health camps. Biomedical Waste Management (BMWM) is done in three stages – 1) Collection and separation, 2) Transportation to respective facilities 3) Proper treatment and disposal. Actually, BMWM has always been an issue in India. With the world in global crisis due to the recent outbreak of the Coronavirus Disease (COVID-19) pandemic, it has put great pressure on the BMWM system in India and around the world. To control the spread of the COVID-19 virus proper disposal of the waste is also necessary as it is a contagious disease and the waste generated during the treatment and laboratory tests are highly contagious and hazardous. This article investigates the situation of BMWM in India and studies whether the Indian BMWM system will be able to handle this increased amount of generated waste. The Indian government has given various guidelines to manage this increased biomedical waste overload. Data was gathered from literature search engines such as PubMed and Google Scholar, from verified newspapers and online news articles as well as from verified government websites.

Keywords: Biomedical Waste, Biomedical Waste Management, COVID-19, Coronavirus, Pandemic

Introduction

The influence and amount of global mayhems have increased in the last century. Various kinds of disasters like an epidemic outbreak have threatened Mankind in more than one way (Figure 1). In agreement with the World Health Organisation (WHO), an epidemic outbreak is "The occurrence of disease cases above normal expectancy",[1] which is usually caused by an infectious disease through human-to-human transmission and animal-to-human transmission or by exposure to the radioactive and hazardous chemical source.[1] Epidemic, if is ineffectually controlled, can become a pandemic and may lead to a global crisis. During the last century, India has also been harmed by various epidemic outbreaks (Figure 2).[2] The world is currently facing the biggest crisis of the century. In the near-term, a virus is more likely to be the catastrophe we need to worry about rather than a war.[3]

The number of infections may rise exponentially during an epidemic outbreak which also increases the demand of various resources like healthcare workers, facilities, supplies etc. in order to control the disease spread. Another challenge is efficient waste management as the medical waste generation also increases which can as a result accelerate the spread of the disease if not treated properly. Biomedical waste (BMW) is any waste produced during the diagnosis, treatment, or immunization of human or animal research activities pertaining thereto or within the production or testing of biologics or health camps.[4] It follows the trundle to a sepulchre advent which is characterization, quantification, segregation, storage, transport, and treatment of BMW.[4]

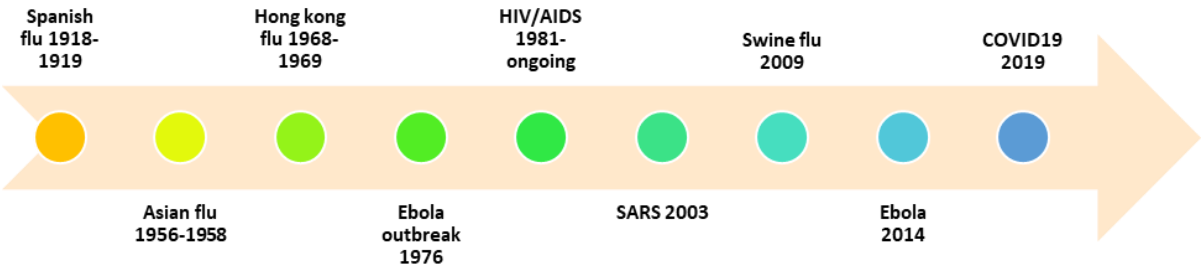

Figure 1. Various epidemic outbreaks around the globe.

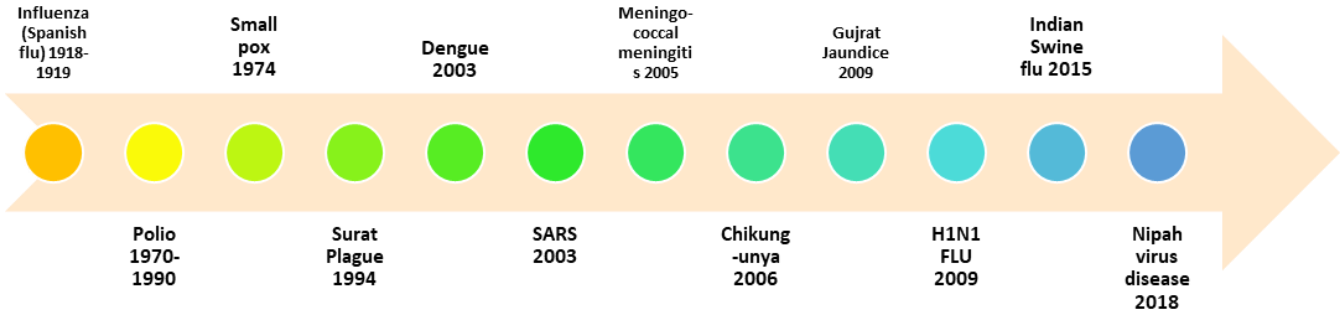

Figure 2. Various epidemic outbreak in India in the last century

To carry out this study, data was collected using literature search engines such as PubMed and Google Scholar, verified newspapers and online news articles as well as from verified government websites. The collected data was synthesised using Microsoft office word software.

In 2015, in one of his TEDx talks[3] Bill Gates mentioned that "The world isn't ready for the next epidemic". This statement proves more accurate now than at any other time. The globe was not ready for what came through. Later, in December 2019, the Novel Coronavirus disease 2019 (COVID-19) reported several cases of atypical pneumonia in Wuhan, China,[5,6] which was later confirmed to flow from to human-to-human transmission.[7] Since January 2020, the number of COVID-19 infections has increased significantly. On January 31st, 2020, a worldwide emergency was declared by the WHO.[8] On 11th February 2020, the official name of the virus guilty for COVID-19 clothed to be Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2).[9]

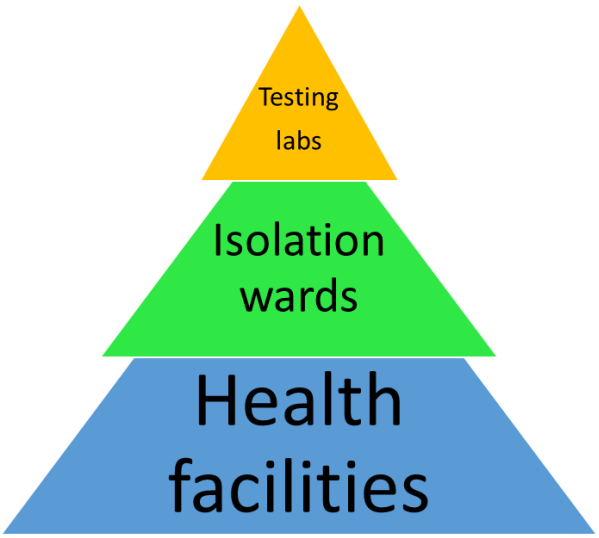

Figure 3. Source of COVID-19 Waste

Statistics of COVID-19 around the world and in India

Globally, as of 6:42 pm CEST, 17 May 2020, there have been 4,534,731 confirmed cases of COVID-19, including 307,537 deaths, reported to WHO,[10] which has surpassed the overall number of deaths during the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003.[11] In India alone, the total number of cases had reached 96,168 including the number of deaths which was 3029 on 08 May 2020, 18 May 2020, 08:00 IST (GMT+5:30).[12] The total number of samples tested was 2302792 till (18/05/2020 9:00 AM IST) 13. To manage the rapid spread of COVID-19, a nationwide lockdown was declared on 24th March 2020,[14] as a component of which all public places were closed, gatherings and events cancelled and everyone was encouraged to remain reception and work from home. Every educational institute suspended their activities in addition to which online platforms became the new classrooms. The implementation of lockdown also restricted movement, both domestic and international.

In India, a total of 304 Government[15] and 105 private laboratories[16] were permitted to do COVID-19 testing as of May 1st, 2020. India has converted 586 hospitals dedicated to COVID-19 patients, with a capacity of one lakh isolation beds and 11,500 ICU beds reserved for COVID-19 patients as of Apr 11, 2020 (06.02 PM IST)[17] with the numbers increasing daily. For the isolation of suspected cases of COVID-19, the government has made provision of 12,000 beds at central government facilities and 26,000 beds at state government facilities as of March 18, 2020 (11.57 PM IST)[18] with the number increasing daily.

The number of patients and the caretaking facilities for these patients is increasing day by day. As these locations increase, the number of BMW also increases with them. In India, the typical BMW generation ranges from 0.5 kg to 2.0 kg per bed per day among various hospitals.[19] Medical waste comprises infectious waste, sharp objects, chemical substances, pathological waste, radioactive waste, etc. which may contain highly hazardous substances and will impose potential risks to the healthcare workers, patients, and the

general public. Almost 75-90% of the wastes generated by the healthcare providers is non-toxic and falls into the general waste category,[19] which is successively managed by local civic authorities. Therefore, the remaining 10-25% falls into the hazardous category and poses significant public health risks if not properly managed.[19] During an outbreak, general waste generated by health care facilities shall be treated as infectious wastes. On average, a COVID-19 patient takes 2-8 weeks to recover.[20] Considering the above figures, it takes five weeks for a patient to recover.

Table 1.

Total number of COVID-19 cases in health facilities	Amount of waste generated per day per bed	Total waste generated per bed per 35 days
1	2kg	70 kg
96,168	192336 kg	6731760 kg

Table 2. Considering a maximum of 0.5 kg of waste generated per test.

The total number of COVID-19 test done.	Amount of wastes generated per test.
1	0.5kg
2302792	1151396 kg

Table 3.

Total waste generated per bed per 35 days (in tonnes)	The total amount of waste generated per test. (in tonnes)	Total waste generated (in tonnes)
6731.76	1151.396	7883.156

The Spread of COVID-19

According to WHO, coronavirus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes[21]. These droplets later land and get settled on various surfaces or objects around the person. Other people can get infected after they touch their eyes, nose or mouth after touching these contaminated objects or surfaces[22]. As reported by WHO, people also can get infected by COVID-19 if they inhale droplets from an individual with COVID-19 who coughs out or exhales droplets which is why it's important to remain more than one meter away from a person who is infected. Coronavirus can live to tell the tale on any surface for hours to days conditionally on the material it is made of. Table 4 gives an inventory of surface material together with the period which coronavirus stays alive on different materials[23].

Many of the materials mentioned above also are a part of BMW in various forms like needles, test-tubes, NS bottles. Hence proper disposal of BMW is crucial as it can be highly contagious.

Biomedical waste

The BMWM is done in three stages[24] (Figure 4). At the source site, BMW is typically collected and placed in various colour coded containers according to the nature of the waste. At first, the BMWM guidelines were given in 1998 in India, which was later modified in the year 2016.[3] The classification and disposing of the method of BMWM are presented in Table 5.[3] It is believed that BMW could be stored in one place before transferring to the respective facility. The requirement of maximum storage time is different in regions. For example, the storage time for BMW (including radioactive and infectious waste) in India mustn't be beyond 48 hours at source.[3] The transportation of medical waste is usually done in two steps: Find the primary location to move the infectious medical waste from hospitals to treatment centres and to send the residue to landfill.[25] The Hazardous nature of medical wastes makes it necessary to treat it before the ultimate disposal in order to avoid environmental impacts (e.g. contamination of surface and underground waters). Medical waste is treated in many ways such as thermal process, chemical action, etc. out of which incineration is the most widely used method.[25]

However, the amount of BMW during an epidemic is far higher because the number of patients rise. The waste generated during any epidemic is extremely contagious and hazardous. This increase puts plenty of pressure on the BMWM systems of any country. In India, as access is limited to only 198 Common Bio-Medical Waste Treatment Facilities (CBMWTFs) and 225 captive incinerators,[26] it's going to be challenging to manage the high amount of waste generated during the widespread. As of 2017, about only 78% of India's total 200,000 tonnes of BMW was treated by CBWTFs.[26] The rest was treated and disposed of either by isolated treatment facilities or deep burial. The waste generated during any pandemic is an addition to the average BMW. This certainly creates a burden on the BMWM system of India.

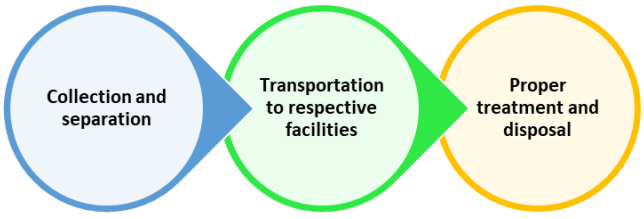

Figure 4. Biomedical Waste Management (BMWM) Process

Table 4.

Different kinds of materials	Time by which coronavirus stays on the surface.	Examples of surface made out of that material.
Metal	5 days	Doorknobs, jewellery, silverware etc.
Wood	4 days	Furniture etc.
Plastics	2 to 3 days	Milk containers and detergent bottles, train and bus seats, backpacks, elevator buttons etc.
Stainless steel	2 to 3 days	Refrigerators, pots and pans, sinks, some water bottles etc.
Cardboard	24 hours	Shipping boxes
Copper	4 hours	Pennies, teakettles, cookware, coins
Aluminium	2 to 8 hours	Soda cans, tin foil, water bottles
Glass	Up to 5 days	Drinking glasses, measuring cups, mirrors, windows
Ceramics	5 days	Dishes, pottery, mugs
Paper	The length of time varies. Some strains of coronavirus live for only a few minutes on paper, while others live for up to 5 days.	Mail, newspaper
Food	Coronavirus doesn't seem to spread through food.	Takeout, produce

Table 5.[3]

Category	Type of waste	Color and type of bag to be used	Treatment and disposal options
Yellow	Human anatomical waste Animal anatomical waste	Yellow-colored nonchlorinated plastic bags	Incineration or plasma pyrolysis or deep burial
	Soiled waste	Yellow-colored nonchlorinated plastic bags	Incineration or plasma pyrolysis or deep burial. In the absence of above facilities, autoclaving or microwave/hydroclaving followed by shredding/mutilation/combination of sterilization and shredding. Treated waste to be sent for energy recovery
	Expired or discarded medicines	Yellow-colored nonchlorinated plastic bags	Expired cytotoxic drugs and items contaminated with cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature >1200° C or to CBMWTF or hazardous waste treatment, storage, and disposal facility for incineration at >1200° C or encapsulation or plasma pyrolysis at 1200° C
	Chemical waste	Yellow-colored nonchlorinated plastic bags	Disposed of by incineration or plasma pyrolysis or encapsulation in hazardous waste treatment, storage, and disposal facility
	Chemical liquid waste	Separate collection system leading to effluent treatment system	After resource recovery, the chemical liquid waste shall be pretreated before mixing with other waste forms
	Discarded linen, mattresses beddings contaminated with blood or body fluids	Nonchlorinated yellow plastic bags or suitable packing material	Nonchlorinated chemical disinfection followed by incineration or plasma pyrolysis or for energy recovery
	Microbiology, biotechnology, and other clinical laboratory waste	Autoclave safe plastic bags or containers	Pretreat to sterilize with nonchlorinated chemicals on-site as NACO or WHO guidelines, thereafter for incineration
Red	Contaminated waste (recyclable)	Red-colored nonchlorinated plastic bags or containers	Autoclaving or microwaving/hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered recyclers or for energy recovery or plastics to diesel or fuel oil or for road making
White (translucent)	Waste sharps including metals	Puncture proof, leak proof, tamper proof containers	Autoclaving or dry heat sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete; combination of shredding cum autoclaving and sent for final disposal to iron foundries
Blue	Glassware Metallic body implants	Cardboard boxes with blue-colored marking	Disinfection or through autoclaving or microwaving or hydroclaving and then sent for recycling

AIDS = Acquired immunodeficiency syndrome, NACO = National AIDS Control Organization, WHO = World Health Organization, CBMWTF = Common bio-medical waste treatment and disposal facility

Recommendations

This increased amount of BMW puts forward a complex problem that requires short term– decision making and quick response. To overcome this problem, besides the exciting facilities, temporary transit centres and temporary treatment centres need to be established to provide sufficient capacity to treat the increased BMW. The medical waste that is infectious and contagious should be directly transported to treatment centres or should at least be transferred and amalgamated to transit centres. A special transportation facility also needs to be established concerning practical situations. To manage COVID-19 wastes which is generated at various facilities, The Indian government has issued special guidelines during this pandemic in addition to 2016 BMWM (Table 6).[27] The implementation of the guidelines should be strictly monitored by specially appointed government officials.

Conclusion

As a pandemic is not an ordinary period and during these times waste generation is also higher, special measures are required to deal with the increased BMW. Special attention is also required to manage the generated waste as it can also be contagious and hazardous to control the spread of this COVID-19 pandemic.

Acknowledgements

None.

Conflict of Interests

The author stated that there are no potential conflicts of interest.

Table 6.[27]

Guidelines for COVID-19 Waste Management	
COVID-19 isolation wards	1. Keep separate colour-coded bins/bags/ containers in the ward and maintain proper segregation of waste as per BMWM rule 2016 as amended and CPCB guidelines for implementation of BMW management rule. 2. As precaution, double-layered bags (using 2 bags) should be used for the collection of waste from COVID-19 isolation boards to ensure adequate strength and no leaks. 3. Collect and store BMW separately before handing over the same CBWTF use a dedicated collection bin labelled as COVID-19 to store COVID-19 waste and keep separately in the temporary storage room before handing over to permit staff of CBWTF. Biomedical waste collected in such isolation wards can also be lifted directly from the ward into CBWTF collection van. 4. In addition to mandatory labelling bags or containers used for collecting by medical waste from COVID-19 wards should be labelled as COVID-19 waste this marking would enable CBWTFs to identify the waste easily for priority treatment and disposal immediately upon the receipt. 5. General waste lacking contamination shall be disposed of as solid waste as per SWM rules 2016 6. Maintain a separate record of waste generated from COVID-19 isolation wards 7. Use dedicated trolleys and collection bins in COVID-19 isolation ward is a label "COVID-19 waste" to be pasted on these items also. 8. The (inner and outer) surface of containers/bins/trolleys used for storage of COVID 19 waste should be disinfected with 1% sodium hypochlorite solution 9. Report opening or operation of COVID-19 wards to SBCBS 10. Depute dedicated sanitation workers separately for BMW and general solid-waste so that waste can be collected and transferred timely to a temporary waste storage area
Sample collection centres and laboratories for COVID-19 suspected patients.	Report opening or operation of COVID-19 sample collection centres and labs to concerned SPCB. Guidelines given at section (a) for isolation wards should be applied suitably in case of test centres and laboratories also.
Quarantine Camps/Homes Care for COVID-19 suspected patients	1. Treat the routine waste generated from quarantine centres/camps as general solid-waste and the same need to be disposed of as per SWM rules 2016. However biomedical Waste if any generated from quarantine centres or camps should be collected separately in yellow coloured bags and bins. 2. Quarantine camps/centres shall inform CBWTF operator as and when the waste is generated so that the waste may be collected for treatment and disposal at CBWTFs. 3. In case of homecare for suspected patients by medical waste should be collected separately in yellow bags, plus the same must be handed over to permit waste collector engaged by local bodies.
Duties of Common Biomedical Waste Treatment Facilities (CBTWF)	1. Report to SBCBS/PCCS about receiving of waste from COVID-19 isolation ward/quarantine camps/quarantine homes/COVID-19 testing centres. 2. The operator of CBWTF shall ensure regular sanitation of workers involved in handling and collection of biomedical waste.

	3. Workers shall be provided with adequate PPE including three mask, splash-proof gowns, nitrile gloves, gumboots and safety goggles. 4. Use dedicated Vehicles to collect COVID-19 ward waste, it is not necessary to place a separate label on such vehicles. 5. Vehicles should be sanitised with sodium hypochlorite or any appropriate chemical disinfectant after every trip. 6. COVID-19 waste should be disposed of immediately upon receipt at the facility 7. In case it is required to treat and dispose of more quantity of biomedical waste generated from COVID-19 treatment CBWTF may operate their facility for the extra hours by giving information to SPCBs/PCCs. 8. The operator of CBWTF shall maintain a separate record for collection, treatment and disposal of COVID-19 waste. 9. Do not allow any worker showing symptoms of illness to work at the facility. May provide adequate leave to such workers by protecting their salary.
Duties of SPCBs/PCCs	1. Shall maintain records of COVID-19 treatment wards/quarantine centres/quarantine homes in respective states 2. Ensure proper collection and disposal of biomedical waste as per BMW rules 2016 and SoPS given in this guidance document. 3. Allow CBWTFs to operate for extra hours as per needed 4. May not insist on the authorisation of quarantine cams as such facilities do not qualify as health facilities. However, allow CBWTF's to collect biomedical waste as and when required.

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