

Analysing Impact of Covid-19 on Biomedical Waste

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Abstract As the whole world fights the consequences of the coronavirus pandemic, another crisis is anticipated to emerge — Infectious Biomedical waste. Contemplate the imbalances between human life and nature caused by the biomedical waste, consider the confrontation with resource shortage, lack of awareness and spread of diseases. Think about spectre of unresolved contradictions that the hospitals hope to resolve. All these events are looming before the health care industry. Growing healthcare industry leads to the production of medical waste resulting in adverse health effects. The outbreak of the infectious diseases creates an enormous burden on both, public health as well as economic stability and such diseases contribute to the leading cause of death and disability hampering health and human progress. This study has been undertaken to delve into biomedical waste management practices specifically in Pune city. The primary data was collected through the pilot surveys in few hospitals of Pune which displayed the multiple problems with their waste management process, segregation, and disposal. So, as a part of this study, researcher's aim to answer whether the hospitals in Pune are failing to adequately recognize the structural barriers that obstruct change. Also, the paper highlights the current scenario of Biomedical Waste (BMW) key issues.

Keywords—*Biomedical waste, segregation, awareness, healthcare, practices, covid.*

I. INTRODUCTION

The world has been on a standstill as a result of the outbreak of the coronavirus pandemic that is claiming lives and leaving many people sick, and this pandemic has burdened India's already stressed waste management system. People have been quarantining and isolating themselves for the past thirteen months now, owing to the detrimental effects of the novel Coronavirus. There has been a huge demand for medical protective supplies such as masks, gloves, hand sanitizers, hospital gowns, and other components of Protective Equipment (PPE). Medical institutions, hospitals, and households have stocked up these essentials to save lives and prevent the spread of the virus. This has resulted in an increase in biomedical waste. Bio-Medical Waste (BMW) refers to any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological and including categories mentioned in Schedule I of the Bio-Medical Waste (Management and Handling) Rules, 2016 [1]. COVID-19 has caused hospitals to become overrun as patients and health care workers to go through medical supplies and disposable personal protective equipment at a rapid rate. Governments are encouraged to treat this waste as urgent to minimize possible secondary

impacts on the health of both the public and the environment.

Problem Statement: The open dumping spaces of biomedical waste on the premises of many hospitals don't make for the safety of citizens, but they're what's available for the residents of Pune. On any given day, a group of waste pickers and sanitization staffers are seen collecting the waste at their risk. On the contrary, the staff do not seem to follow the safety protocols and are operating without even wearing the masks. To make matters worse, these dumps are dangerously close to the main road, where any passer-by is likely to get infected by it, oblivious to environmental contaminants and diseases [2].

This research has particularly undertaken areas and hospitals in Pune since the number of cases of covid-19 are on increasing rate. Pune is already witnessing a surge in environmental pollution owing to biomedical waste. On one hand, it struggling to contain the spread of the novel Coronavirus, which has infected many lives, and on the other, the rise in biomedical waste generation is testing Pune's waste management capacity. As the health care industry is set up generation of waste is inevitable. Pune, 'The Queen of Deccan' being the fulcrum of health care industry with 100+ multispecialty hospitals too doesn't shy away from scoring high in sector of biomedical waste

generation. Pune contributes to about 19.58% of the total biomedical waste load of Maharashtra [3]. When it comes to waste, the first scenario that comes to mind is a garbage landfill site full of plastic waste and scavenger birds looming in the sky. However, one significant type of waste that is often overlooked is this Biomedical Waste. This is partly owing to lack of knowledge and with this paper it is aimed to shed some light in the havoc that can be unleashed. if the biomedical waste is not treated properly and has attempted to analyze the existing scenario of biomedical waste in terms of its generation, handling and treatment during this current pandemic situation in Pune.

II. LITERATURE REVIEW

Praveen Mathur, Sangeeta Patan, and Anand S. Shobhawat, Department of Environment Science, MDS University, Ajmer [4] stated the impact of waste generated by the medical activities and their straight way impact on mankind. Their paper highlights that disposal of biomedical waste and exposure to such waste possess a serious threat to the environment and hence requires specific treatment or management before disposal. Other than that, the papers deals with the problems relating to bio-medical waste and procedures for handling and disposal method and also create awareness among health personnel regarding the biomedical waste.

B.R. Babu, A.K. Parande, R.Rajalakshmi, P.Suriyakala, and M.Volga [5] intend to create awareness amongst the personnel involved in health care services through their paper. Their paper also highlights how the biomedical waste (BMW) management in Indian hospitals is grim and needs a serious action and how other countries manage biomedical waste.

Dr. Anjali Acharya, Dr. Vasudha Ashutosh Gokhale and Deepa Joshi [6] in their paper mentioned the impact of biomedical waste on city environment by taking Pune as their base to research. They also mentioned the ongoing practices to handle biomedical waste in Pune and how most of the Hospitals and clinics in Pune are becoming a major threat to the public as they are not following the biomedical waste management rules meant to prevent contamination and spreading of diseases

There's a monthly status of COVID-19 biomedical waste generation and treatment facilities involved in collection, treatment & disposal since June 2020. In order to monitor COVID-19 related biomedical waste and to compile the data through electronic manifest system, CPCB developed COVID-19 waste tracking software named "COVID19BWM". This software tracks COVID-19 related biomedical waste at the time of generation, collection and disposal. As per the information submitted by State Pollution Control Boards/Pollution Control Committees as well as daily data received from COVID19BWM tracking

App., the average quantity of COVID-19 related biomedical Waste generation is about 146 TPD for the month of December 2020 [7].

III. METHODOLOGY

Study Sample

A pilot study was conducted in few hospitals of Pune city. Four private hospitals and Four government hospitals were included. The study was conducted in some of the hotspot areas of Pune. Hospitals and health care centers were selected using a random sampling method for Primary data collection. Among the hospital studied, some were multispeciality hospitals based on beds, each having more than 200 beds. Primary data was collected from the Health Care Centers using Empirical survey work. The researchers also visited PMC in order to obtain data specifically regarding biomedical waste generation.



Fig 1: Locations of Surveyed Hospitals in Pune City.

Study Methods and Tools:

The entire research was carried out in three stages:

The first stage was observation. A careful observation of

- How effective the waste management process is, especially during COVID-19?
- Is the segregation of biomedical waste and covid relate waste done properly?
- Is the color-coded approach followed?

The second stage was analysis of awareness of biomedical rules among healthcare staff.

- Questionnaires were given to the staff of hospital authorities. A good response was collected.
- Discussions were performed with them to understand their approach towards BMW management.
- Major issues regarding hospitals were known after discussions with them

The third stage was a visit to PMC for obtaining the data of BMW in entire Pune city.

- Everyday Pune Municipal Corporation sweeps a lot for systematic collection and treatment of Biomedical Waste. A data regarding BMW generation per day was obtained.
- Discussions were performed with the PMC staff, where they focused on how the transportation of BMW takes place in Pune.



Fig 2: Waste Collecting Vehicle near Hospitals.

TABLE 1: Biomedical waste categories and their segregation, collection, treatment, processing, and disposal options as laid down under Bio-Medical Waste Management Rules, 2016, Government of India

Category	Type of Waste	Type of Bag or Container to be use	Treatment and Disposal option
1	2	3	4
Yellow	(a) Human Anatomical Waste: Human tissues, organs, body parts and fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, amended from time to time)	Yellow coloured non-chlorinated plastic bags	Incineration or Plasma Pyrolysis or deep burial
	(b) Animal Anatomical Waste : Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary hospitals or colleges or animal houses.		
	(c) Soiled Waste: Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components.		Incineration or Plasma Pyrolysis or deep burial* In absence of above facilities, autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery.
	(d) Expired or Discarded Medicines: Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc.	Yellow coloured non-chlorinated plastic bags or containers	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 common bio-medical waste treatment facility or hazardous waste treatment, storage and disposal facility for incineration at >1200°C Or Encapsulation or Plasma Pyrolysis at >1200°C. All other discarded medicines shall be either sent back to manufacturer or disposed by incineration
	(e) Chemical Waste: Chemicals used in production of biological and used or discarded disinfectants.	Yellow coloured containers or non-chlorinated plastic bags	Disposed of by incineration or Plasma Pyrolysis or Encapsulation in hazardous waste treatment, storage and disposal facility
	(f) Chemical Liquid Waste : Liquid waste generated due to use of chemicals in production of biological and used or discarded disinfectants, Silver X-ray film developing liquid, discarded Formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities etc.	Separate collection system leading to effluent treatment system	After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other wastewater. The combined discharge shall conform to the discharge norms given in Schedule III.
	(g) Discarded linen, mattresses, beddings contaminated with blood or body fluid	Non-chlorinated yellow plastic bags or suitable packing material	Non-chlorinated chemical disinfection followed by incineration or Plasma Pyrolysis or for energy recovery. In absence of above facilities, shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery or incineration or Plasma Pyrolysis.
	(h) Microbiology, Biotechnology and other clinical laboratory waste: Blood bags, Laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures.	Autoclave safe plastic bags or containers	Pre-treat to sterilize with nonchlorinated chemicals on-site as per National AIDS Control Organisation or World Health Organisation guidelines thereafter for Incineration.

Red	Contaminated Waste (Recyclable) (a) Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vaccutainers with their needles cut) and gloves.	Red coloured non-chlorinated plastic bags or container	Autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered or authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making, whichever is possible. Plastic waste should not be sent to landfill sites.
White (Translucent)	Waste sharps including Metals: Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes both used, discarded and contaminated metal sharps	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 (having consent to operate from the State Pollution Control Boards or Pollution Control Committees) or sanitary landfill or designated concrete waste sharp pit.
Blue	(a) Glassware: Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes.	Cardboard boxes with blue colored marking	Disinfection (by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment) or through autoclaving or microwaving or hydroclaving and then sent for recycling.
	(b) Metallic Body Implants	Cardboard boxes with blue colored marking	

Disposal by deep burial is permitted only in rural or remote areas where there is no access to common bio-medical waste treatment facility. This will be carried out with prior approval from the prescribed authority and as per the Standards specified in Schedule-III, BMW Rules 2016. The deep burial facility shall be located as per the provisions and guidelines issued by Central Pollution Control Board from time to time.

Acronyms - WHO: World Health Organization, AIDS: Acquired Immunodeficiency syndrome, BMW: Bio-medical waste, NACO: National AIDS Control Organisation.

IV. DATA ANALYSIS

The primary data collected is further analyzed using systematic statistical and qualitative techniques to summarize, contract, evaluate data.

Following is the general analysis of BMW Management from Primary data.



Fig 3: Waste Dumped in front of Hospital

Table 2: General Analysis of BMW Management in Pune City.

BMW Management	Variables	Govern ment	Private	Total
How is waste treated in your hospital	Segregation	3	4	7
	Storage	1	0	1
	Treatment plant	0	0	0
	Incineration	0	0	0
	Autoclave	0	0	0
Duration of waste stored in hospitals	12 hours	0	0	0
	24 hours	4	4	8
	More than 24 hours	0	0	0
Are colour coding containers(yellow/black/white/red) available for segregation of waste	Yes	1	3	4
	No	3	1	4
Does hospital maintain BMW records	Yes	2	3	5
	No	2	1	3
Is waste in form of liquid directly generated in	Yes	0	0	0
	No	4	4	8

sewage line				
Is there provision of personal protective requirements for hospitals staff/workers	Yes	4	4	8
	No	0	0	0
Is waste double packed before transportation	Yes	0	1	1
	No	4	3	7

INFERENCE : The waste treated is Segregated in three government and four Private Hospitals out of eight surveyed hospitals. Only one hospital is having storage facility. None of the hospital have the facility of Incineration, Auto Clave or Treatment plant. Duration of Waste stored in all the eight Hospitals is majorly 24 hours. The Government Transport vehicles collect biomedical waste every single day from Hospitals to Treatment plants. 90% of Government Hospitals don't have the facility of segregation of waste in colour coding bins. Only 1% of the Private Hospitals is not having segregation of waste in colour coding bins. Two Government Hospitals and three from Private maintain BMW records. In all the Hospitals surveyed, the segregation of waste is directly into sewage. There is provision of personal protective requirements for hospitals staff/work in all Hospitals. Only in one of the Private hospital the waste is doubled packed before transportation.

Table 3 and 4 : Training Programs in Hospitals

Managements/Audits/Training	Variables	Government	Private	Total
Frequency of trainings	Once in 1 month	2	1	3
	6 months	1	2	3
	12 months	1	1	2
Frequency of government audits	Once in 1 month	0	0	0
	6 months	3	2	5
	12 months	1	2	3

Managements/Audits/Trainings	Variables	Government	Private	Total
Is hospital assigned with BMW management team	Yes	1	2	3
	No	3	2	5
Do hospitals	Yes	3	4	7

arrange training programs for staff/workers	No	1	0	1
Is new staff given training for BMW management	Yes	1	2	3
	No	3	2	5
Have hospitals given special training on handling covid BMW	Yes	4	3	7
	No	0	1	1

INFERENCE : The frequency of trainings is comparatively more in Government Hospitals. Two government Hospitals have BMW training once in 1 month whereas two private hospitals have once in 6 months

government Hospitals have BMW training once in 1 month whereas two private hospitals have once in 6 months

One government Hospital and one private hospital have once in 12 months.

The Government audits are in 6 months in five hospitals while three hospitals have it in 12 months. One of the Government hospital and two of the private Hospitals are assigned with BMW management team. Remaining three of the government hospitals and two of the private hospitals are not having any BMW management team. One from Government and 2 from private arrange special training program for new staff. More than 60% of Hospital is not having any training programs for new staff. 90% hospital gave special training to staff in case of managing Covid BMW. One private hospital was noticed to not give training in managing Covid BMW.

Results and Discussions:

• Hospital 1:

This Multi-speciality hospital located in Sangamwadi area of Pune having 553 beds was studied in survey. On observations, it was found that face masks continue to go into residual waste here. The duration of waste stored is 12 hours and it is discarded in 24 hours. There is a facility of accumulation and segregation of particular waste through color (RED/YELLOW/BLACK) and labeled containers. However, there is no mechanism to decrease toxicity of waste generated. Separate containers are used for segregating and two different vehicles come to hospital, one that transports general waste and other that has covid protective waste.

• Hospital 2

Situated in Shivaji Nagar, this private hospital has 100 beds. Here, the main issue that our team identified was the BMW in form of liquid is directly generated in sewage system. This is very dangerous practice that can cause severe harm to the environment. Training is required for the staff as most of them are uneducated and not even aware of the colour code for the bio-medical waste. Before disposal into garbage bins, the waste is disinfected using sodium hypochlorite and double packaging is done in order to ensure the safe transportation of the waste.

- Hospital 3

This hospital is one of the branches of Maharashtra's largest hospital chain located in Deccan Gymkhana area of Pune. Despite being such a reputable brand, there is an inadequate designated area for storage of biomedical waste. There was no separate lift that could be used to collect waste from each floor and bring to the main storage area. On surveying, the staff mentioned that there should be a separate lift, but they are bound to follow the wrong practice as there can't be new lift constructed due to lack of space in the hospital.

- Hospital 4:

This hospital in Aundh area of Pune having a huge 80 acre area under it displays the carelessness in waste management. The carelessly discarded masks, gloves and tissues could be potential sources for the spread of this highly contagious virus and shockingly, the premises here are littered with PPE Kits, gloves, masks, with hungry strays scattering it further, endangering their own and human lives.



Fig 4: Segregation unit of BMW using colour code



Fig 6: BMW is doubled packed before transportation.

V. RECOMMENDATIONS AND SOLUTIONS

Hospitals of Pune serve all breeds of patients irrespective of their socio-economic background. Hence, the awareness quotient of rural and urban audience differs, which leads to mishandling of biomedical waste. The inadequacy in disposal and treatment of biomedical waste is creating the absolute unhygienic situations in Pune City. The breeding of mosquitoes on dumped waste in the surrounding of hospital and its spread is of big concern for environmental safety. Therefore, it becomes very important to take proper measures:

1. The first and foremost, as observed, many of the workers and staff in healthcare industry are not well trained. So, it becomes extremely important to aware and train them about the biomedical waste management rules. There should be trained and educated separate staff in health care centers for the handling of Bio medical waste.
2. In order to facilitate smooth and efficient biomedical waste management process, records should be maintained of bio medical waste quantity daily, monthly and annually which will help authorities to keep track and know the status.
3. Awareness creates a huge impact, so campaigning programs must be arranged to increase the awareness about bio medical waste handling. This will help to spread more knowledge among the people who handle it without care.
4. Segregation plays an important role. If proper segregation is achieved, the volume of infectious wastes can be effectively reduced, while the volume of recyclable wastes would increase, risks can be minimized.
5. A color-coded system should be strictly followed at the source when the waste is segregated. It will help to effectively manage waste, which will reduce risks.
6. A written Bio medical waste management program and a well-documented instructions must be included in a health care facility's policy and procedure manuals.
7. There must be consistent and efficient effort by Pune municipal corporation authorities and workers for maintaining healthy and hygienic atmosphere within the city.
8. As an individual, a person always strive for substantial change in the society, but what if when the efforts are collective? Probably the change will be inevitable. Hence, working out the idea of cleanliness competition among hospitals and societies is way to go healthy and hygienic. They will compete among themselves, and the Pune municipal corporation will evaluate the

competitors on basis of their excellence in given tasks.

9. An absolute implementation of the policies and measures for collection, segregation and decomposition of biomedical waste should be ensured.
10. Vermicomposting is method to look out for, as the biodegradable medical waste is key source of the given process to yield good quality compost. This eco-friendly method of decomposition is carried out by mixing cow dung slurry with bio-medical waste and then decomposed bio-medical waste is fed to epigeic earthworms. The usage of *Eisenia fetida* earthworm yields the best result among the others in bread of earthworms. Repetition of same set of earthworms showed improved rate of vermicomposting. Vermicomposting is surely the result-oriented approach for reducing and recycling biomedical waste.

VI. CONCLUSION

Road ahead looks challenging when it comes to handling biomedical waste, as novel coronavirus disease (COVID-19) cases continue to rise across the country, because it requires strong guidelines along with mass public awareness and their support. Hospitals in Pune in their usual course deal with segregation, management, and storage of biomedical waste as directed by Central Pollution Control Board, but the situation in times of Covid 19 is typical due to its highly contagious nature, transmission cycle and multiplicity of the virus, thereby creating many challenges before the society. Many COVID-Care centers in Pune are not segregating biomedical waste in the right, procedural manner. Apart from the risk of contact transmission, improper disposal practices of biomedical waste in these hospitals and localities is causing adverse environmental effects including soil and groundwater contamination, killing beneficial microbes in septic systems, physical injuries through sharps, etc. An effective communication strategy, awareness and education can help to reduce biomedical waste problem now. It's about time people in Pune start taking care of the biomedical waste they generate because the COVID clouds aren't gone and they are still lingering there to look back and remember that if the biomedical waste not handled properly, it could put many lives in danger. People can blame the lack of policies and rules, curse the illiteracy in the surrounding, or they can be conscious at their end. And it's time, Pune, one of the most livable city in India becomes conscious about it

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