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BIO-MEDICAL WASTE MANAGEMENT IN INDIA: CONTEMPORARY APPROACHES AND WAY FORWARD

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ABSTRACT

The rights of citizens to clean and healthy environment provides the foundation for management of BMW in India. With increasing population and economic development leading to large amount of waste generated it becomes imperative to have an adequate, safe and sustainable management of bio-medical waste (BMW). India was one of the first countries to implement BMW Management rules in 1998 under Environmental Protection Act 1986. But National Green Tribunal states that only 1.1 lakh of the 2.7 lakh healthcare facilities identified across the country are authorized under the BMW management rules, reflecting the service level gap creating risks of inadequate disposal posing serious health hazard. It has become more evident after SARS COVID-19 breakout which highlighted the policy level framework of BMW management System an existing practices. Lessons learnt from this can help as driving force to achieve benchmark in this field. This study briefly reviews the evolution of policy level framework, nature of existing practices and situation of BMW Management in India. Collective analysis of these factors and equating it with best practices available globally, contemporary advancements and innovation can help pave a way forward.

KEYWORDS: ***Hospital Waste, Bio-medical waste (BMW) Management, India, SARS-CoV2, COVID-19***

1. INTRODUCTION

Hospital waste refers to all discarded biological or non-biological waste which is not fit for further usage. Medical waste is a subset of hospital waste which means- 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 bio-medical waste (Management and Handling) (second Amendment) Rules, 2000 by Ministry of Environment and Forests Notification.

All BMW are hazardous. According to WHO, Nearly 85% of all waste generated by hospital is general waste. About 15% waste is BMW, which includes Infectious waste - 10%. Non-infectious waste such as radioactive and chemical wastes -5%. The remaining waste though mixed with non-hazardous waste, can be injurious to humans or animals as also being detrimental to the environment and needs special handling and treatment due to its highly toxic contents and infectious properties. [1]

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1.1. Sources of generation of BMW

Primary sources		Secondary sources
Hospital	Medical College	Clinic
Nursing Home	Immunization centers	Ambulance Service
Dispensaries	Nursing Homes	Home treatment
Maternity home	Animal research centers	Slaughter houses
Dialysis center	Blood bank	Funeral Service
Research lab	Industries	Educational institutes

Table1: Sources of Biomedical waste generation

Source: International Journal of Current Engineering and Technology, (2013)[2]

At source, it is categorized into five major categories- Sharps,Pathological waste, Chemical waste, Pharmaceutical waste and Radioactive wastes.

1.2. Material wise composition of Bio-medical waste

By weight		
	Plastic	14%
Combustible		
	Dry cellublostic solid	45%
	Wet cellublostic solid	18%
Non-combustible		20%

Figure 1: Biomedical waste composition

Source: http://isebindia/95_99/99-07-02.html

Health Hazards may include-Infection, Genotoxicity and Cytotoxicity, Chemical toxicity, Radioactivity hazards, or Physical injuries, along with adverse olfactory and visual aesthetics.

Ill managed waste causes pollution, growth of carriers like insects, rodents and worms and can cause ailments like typhoid, cholera, hepatitis and AIDS by usage of syringes and needles. In addition to health risks associated with poor management of medical waste, its impact on environment, especially to the risks of pollution of water, air and soil must also be considered.

2. BIO-MEDICAL WASTE MANAGEMENT RELATED LEGISLATIONS

Until fairly recently, BMW management was not generally considered an issue. In the 1980s and 1990s, concerns about exposure to human immunodeficiency virus (HIV) and hepatitis B virus (HBV) led to questions about potential risks inherent in medical waste. Thus hospital waste generation and its appropriate management and disposal is a major concern due to its risk threat to the health of patients, immediate hospital staff and to the overall general population. Thus it becomes important for the health care establishments to segregate, disinfect and dispose this waste using appropriate and available eco-friendly methods.

2.1. BMW (Management & Handling) Rules,1998

These rules were restricted to healthcare facilities with more than 1000 beds and they are required to obtain authorization. These rules provide for the Healthcare Facilities (HCF) to segregate the biomedical waste as per the 10 categories like Human Anatomical Waste, Animal Waste, Waste Sharps, Liquid and Solid waste etc. into colored bags—yellow, red, blue/white and black according to

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the category of the biomedical waste in the containers clearly marked with the bio-hazard and cytotoxic hazard symbol.[3] The HCFs could store this waste for up to 48 hours after which they either treat it in-situ or is sent to a Common Biomedical Waste Treatment Facility (CBMWTF). The CMBWTF then treated the waste according to the color of the bag. Different colors called for different types of treatments such as incineration, deep burial, autoclaving, shredding, chemical treatment, disposal in a landfill, etc. If BMW was to be transported outside the premise where the waste is generated it carried with itself information like senders as well as receivers name and address. [4]

In the World Health Organization (WHO) meeting in Geneva, in June 2007, core principles for achieving safe and sustainable management of health-care waste were developed.

2.2.BMW Management Rules-2016, salient features:

1. The ambit of the rules was expanded to include vaccination camps, blood donation camps, surgical camps or any other healthcare activity;
2. Phase-out the use of chlorinated plastic bags, gloves and blood bags within two years;
3. Pre-treatment of the laboratory waste, microbiological waste, blood samples and blood bags through disinfection or sterilization on-site as prescribed by WHO or NACO;
4. Provision of training to all its health care workers and immunize all health workers regularly;
5. 5. Establishment of a Bar-Code System for bags or containers containing BMW for disposal;
6. Availability of Annual Report on its website within period of two years, report major accidents;
7. More stringent standards for incinerator to reduce the emission of pollutants in environment;
8. Existing incinerators to achieve the standards for retention time in secondary chamber and Dioxin and Furans within two years;
9. BMW was classified in to 4 categories instead of 10 to improve the segregation of waste at source;
10. Procedure to get authorization simplified. Automatic authorization for bedded hospitals. The validity of authorization synchronized with validity of consent orders for Bedded HCFs. One time Authorization for Non-bedded HCFs;
11. Operator of a common BMW treatment and disposal facility to ensure its timely collection from the HCFs and assist the HCFs in conduct of training.
12. No occupier to establish on-site treatment and disposal facility, if a service of common BMW treatment facility is available at distance of 75 kilometers.

This has several advantages as installation and functioning of individual BMW treatment facility as well as recruiting separate, dedicate, and skilled workforce require high capital investment. CBMWTF is a popular concept in developed countries because by operating it at its full potential, the cost of treatment/kg BMW gets significantly reduced. Further, this makes control and checking of various waste disposal plants less tedious. [5]

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3. BIO-MEDICAL WASTE MANAGEMENT ECOSYSTEM IN INDIA

	PROCESS	STAKEHOLDERS	METHODS USED	INFRASTRUCTURE
COLLECTION	Identification of waste generated in hospitals	WASTE GENERATORS / WASTE COLLECTOR	In non chlorinated bags	Bar coded bags to be provided to HCF
SEGREGATION	Educate Segregate into four bags		Four different color coded bags	Color coded bags/ bins to be used for each type of waste (4 types)
STORAGE	Identify storage area at each source		• Yellow bags to be collected within 48 hours • To be stored in trolley systems	To be stored in secure area accessible to transport team
TRANSPORTATION	Safely transport BMW to nearest waste treatment plant	BMW TREATMENT PLANT	Bio medical waste transport vehicles with proper signage	
PROCESSING	Process as per BMW guidelines		• On site • Nearest Waste treatment plant	
DISPOSAL	Carbon to landfill, effluent treated and recycled, rest recycled			

Table 2: BMW management in India

Source: Author

3.1. Waste survey: Smart cities, Command and Control Centers collect healthcare system data, use of GIS based systems

3.2. Waste Generation: Major focus on minimization of BMW

3.3. Waste segregation, accumulation and storage: The latest guidelines for segregation of BMW recommend the following color coding:

Category	Type of bag / container used	Type of waste	Treatment/ disposal options
	Non-chlorinated plastic bags Separate collection system leading to effluent treatment system	a) Human Anatomical Waste b) Animal Anatomical Waste c) Soiled Waste d) Expired or Discarded Medicines & Cytotoxic drugs along with glass or plastic ampoules, vials etc. e) Chemical Waste f) Micro, Bio-t and other clinical lab waste g) Chemical Liquid Waste h) Discarded linen, mattresses, beddings contaminated with blood or body fluids. **Also routine mask & gown as per BMW rules, 2018.**	Incineration or Plasma pyrolysis or deep burial*

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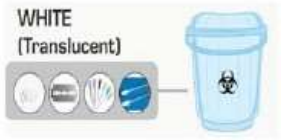
	Non-chlorinated plastic bags or containers	**Contaminated Waste (Recyclable)** Vacutainers, tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles) and gloves	Autoclaving/ microwaving/ hydroclaving and then sent for recycling, not sent to landfill
	(Translucent) Puncture, Leak, tamper proof containers	**Waste sharps including Metal sharps**-Needles, Syringes with fixed needles, Needles from needle tip cutter/burner, Scalpels, Blades	Auto or Dry Heat Sterilization followed by shredding or mutilation or encapsulation
	Cardboard boxes with blue colored Marking. **Puncture proof and leak proof boxes or containers with blue colored marking, as per BMW rules, 2018**	**Broken/ discarded glass**-Medicine vials & ampoules except those contaminated with cytotoxic wastes. **Metallic Body Implants**	Disinfection or autoclaving, microwaving, hydroclaving and then sent for recycling

Figure 2: Waste segregation and storage in India [6]

3.4. Waste transportation: Separate closed biomedical hazard vans marked with bio hazard symbol are utilized. GPS enabled separate vans

3.5. Waste treatment: Summary of the most used methods for traditional medical waste treatment:

- **Autoclave:** the disinfection of medical waste by an autoclave consists of exposing the materials to saturated steam under pressure in an enclosed environment. It is a popular method of disinfection in hospitals. Commonly, autoclaves are used in conjunction with physical treatment processes such as shredding or grinding.
- **Chemical treatment:** the disinfection by application of chemicals to contaminated materials.
  Chemical treatment can be considered most suited for treating liquids like blood, urine, stool and hospital sewage.
- **Microwave irradiation:** a volumetric heating process to reduce and disinfect medical waste volumes using High energy electromagnetic field.
- **Incineration:** A common treatment process used to eliminate all forms of combustible materials, while sterilizing inorganic portions. It is not desirable due to human health related concerns, environmental issues and financial impact. [7]

3.6. Waste disposal: As stated by Health Care without Harm, an international coalition of 470 organizations in 52 countries, non-incineration treatment technologies are a growing and developing field. Most medical waste is incinerated. Some technologies are still essentially prototypes, while others, such as autoclave technology, have been used for decades.
The role of incinerator in increasing environmental air pollution has been checked by issuing new standards for incinerators and improving its operations.

4. SCENARIO OF BIO-MEDICAL WASTE MANAGEMENT IN INDIA

Healthcare is becoming one of India's largest sectors

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both in terms of revenue and employment and with growing healthcare, there is a requirement of management of BMW. India's public healthcare spending was 3.6% of India's GDP in 2016 as against notably higher number for developed countries and 5%- 9% for key developing countries.

According to the CPCB annual report of 2016, total quantity of BMW generation in the country is approximately 517 tons per day (TPD). Besides, as per a joint report by Associated Chambers of Commerce and Industry of India (ASSOCHAM) and Velocity in 2018, the total quantity of medical waste generated in India is 550 TPD, and these figures are likely to increase close to 775.5 TPD by 2022. [8] In a large tertiary care hospital in India, the waste generated is about 1-2 kg/bed/day as against 2.8 kg/bed/day from a similar sized hospital in USA.[9] According to a Parliament report tabled in February 2019 To grapple with these manifold increase in generation of BMW, 199 common Bio-Medical Waste

Treatment Facilities (CBWTFs) are in operation and 23 are under construction (CPCB, 2017), which is inadequate for health facilities in 750 districts of the country. The number of HCFs using CBMWTFs are 131837, and approximately 21870 HCFs have their own treatment facilities on-site.

There are various gaps which need to be focused upon. One such is that in most of the hospitals strict enforcement/ monitoring of BMW Rules 2016 are not being followed properly. The training of Health Care Facility staff and the awareness of the Hazards of BMW is still a challenge in most of the country. The compliance is being enforced through penalties and via awareness. The CTF are operational in most Tier 1 cities and Tier 2 cities of India and compliance is high today because of NGT. But lack of awareness lead to issues of improper segregation. In Tier 2 and 3 cities the general waste is also mixed with BMW. In 2009, about 240 individuals in Gujarat, India had become infected with Hepatitis-B a consequence to the reuse of unsterilized syringes. According to All India Syringes and Needles and Syringes Manufacturing Association nearly 20% syringes come from recycled sources. [10]

Other challenges in BMW management include speed of data availability, under-reporting of waste generated and handling capacity, operation of healthcare facility without authorization under Biomedical Waste Management Rules.

The MoEF (Ministry of Environment, Forest, and Climate change) reviews HCFs once a year through state health secretaries and the SPCB (State Pollution Control Board).The advisory committee on BMWM is now mandated to meet every 6 months.

NGT suggests a need to review effectiveness of the monitoring mechanism, including securing information by way of electronic manifest system from the handlers of such waste and its online reporting by the state pollution control boards on daily basis by developing necessary software and, creating awareness.

5. COVID-19 PANDEMIC AND WAY FORWARD

The SARS-CoV-2 virus, responsible for COVID-19, has spread across at least 190 countries and more than 217,000 confirmed cases of COVID-19 and at least 6075 casualties in India have been reported (as of June 4, 2020 according to the World Health Organization), since it was first reported in China in 2019.

India's pollution watchdog, the Central Pollution Control Board (CPCB), has released guidelines for handling, treatment and safe disposal of BMW generated during treatment, diagnosis and quarantine of patients confirmed or suspected to have the novel coronavirus disease (COVID-19).

Waste treatment facilities to immediately dispose the COVID-19 waste. The Common Bio-Medical Waste Treatment Facilities (CBWTF) operators ensure regular sanitization of workers involved in handling and collection of biomedical waste and provided with adequate personal protective equipment. Facilities use dedicated vehicles to collect COVID-19 ward waste and to sanitize such vehicles after every trip.

At the quarantine facilities and during home care need to follow strict steps to ensure safe handling and disposal of waste, biomedical waste generated is collected separately in yellow colored bags and bins.

Post COVID-19 pandemic, public expenditure on health will be increased by investing in grass root level health institutions and ramping up health and wellness centers in rural and urban areas as suggested by the Government of India. Setting up of Infectious Diseases Hospital Blocks and strengthening of lab network and surveillance by Integrated Public Health Labs in all districts. Block level labs coupled with Public Health Units for management of pandemics.

6. CONCLUSION

Despite India being among the first country to initiate measures for safe disposal of BMW, there is an

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urgent need to take action for strengthening the existing system capacity, increase the funding and commitment towards its safe disposal.

There is a large gap in reach of Biomedical Waste Management in India. Tier-3, 4 and 5 cities along with rural regions lag behind in availability of Biomedical Waste Management practice and inclusion of these regions in near future is imperative to bridge this gap.[11] Furthermore existing available infrastructure and governance needs to be improved to achieve better efficiency by means of introduction of new technology and smart systems. Healthcare management and monitoring system integrated into Smart City mission is a step in right direction. Availability of finances is a major issue for its upgradation can be improved by tools like Foreign Direct Investment and encouragement of private sector. Policy level steps regarding affordability and profitability to make the sector lucrative economically. Adoption of Global practices and innovations use can be taken from countries like Japan South Korea which have one of the highest rated Healthcare systems in the world.[12] Awareness among Healthcare workers and allied services and common citizens about threats of ill management and proper methods of Management according to clinical protocols and appropriate education, awareness and training of Healthcare workers is necessary in this regard. Waste minimization at source level with strict monitoring and audits of waste generated sources. BMW treatment can be decentralized and treated at the source by methods which create less environmental impact. Each and every healthcare facilities which generates biomedical waste, needs to set up requisite treatment facilities to ensure proper treatment of wastes and its disposal so as to minimize the risk of exposure to staff, patients, doctors and the community from biomedical hazards. BMW Management Board must be established in each district.

Outbreak of COVID-19 pandemic has tested the system, forced it to perform more efficiently and helped evolution of the policy level guidelines. This has also brought awareness among common citizens.

The lessons learnt from this pandemic coupled with existing policies and management systems can help in rapid transformation of the sector to achieve the established benchmarks.

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