

# Negligence In the Proper and Scientific Treatment of Bio-Medical Waste Severely Affects Our Environment

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**Abstract**—Massive amount of bio-medical waste (BMW) produced along worldwide need proper, scientific, and eco-friendly treatment. There are many rules and treatment methods come time to time by WHO. But there is lack of proper and scientific treatment in many countries of the world especially in the poor and under developed countries. Violation of rules and regulations is also very common in many states and cities in our country due to lack of knowledge, attitude and practice about biomedical waste. There are many treatment methods practiced all over the world for proper and scientific management of bio-medical waste.

Present study in my study area (Siwan) show lack of awareness and good management practice. Only few methods were practiced by health-care personnels here, i.e., colour-coding bins, autoclaving, chemical disinfectant, Effluent treatment plants (ETP), and needle cutter. Here, solid biomedical waste treatment is managed at some extent by Medi-care Pvt. Lim. Muzaffarpur, Bihar, but liquid biomedical waste treatment is in very poor condition. There is lack of proper working ETP for waste water treatment processes (WWTP). Only 10% private health-care facilities are equipped with ETP. When these untreated waste water released into the domestic drainage and finally reached into local river (here Daha River), then pollute the whole environment of water system and in this manner harmful chemicals present in the biomedical waste reached into underground water level. In my present study the average value of BOD was 3.96 mg/L which is higher than permissible limit, and the average value of COD was 29.33 mg/L which is very high in compare to permissible limit. The high value of BOD and COD clearly indicate that the Daha River became a polluted River. Biomedical waste either it is solid, liquid or gaseous in nature causes many problems, it is a cause of many dangerous and infectious diseases, cause of many antibiotic-resistance micro-organisms development as well as cause of pollution of whole environment. There is no Common bio-medical waste treatment facility (CBMWTF) within 75 km around Siwan, and Medi-care Pvt. Lim. Muzaffarpur, Bihar which manage BMW management of Siwan at some extent is 127 km far from Siwan. So, it

is a very tough task to manage BMW from such a long distance for Medi-care Pvt. Lim. Muzaffarpur, Bihar. Hence this negligence in the proper and scientific treatment of biomedical waste severely affects our environment.

## I. INTRODUCTION

Biomedical waste is niche of many diseases causing harmful pathogens and a major cause of diseases. BMW also contains chemical waste, hazardous waste, radio-active waste, cytotoxic waste and infectious waste. Improper biomedical waste disposal leads to diarrhea, tetanus, AIDS, dengue, Hepatitis B and D, Japanese encephalitis, tick fever, typhoid, bacteremia, infectious diseases and many more. Proper and scientific treatment of BMW is very necessary for massive amount of BMW produced daily along worldwide. There are many methods which are used in the treatment of BMW. Colour-coding method for segregations of BMW, autoclaving, dry heat, and micro-waving for sterilization of instruments, disinfection, hydroclaving, shredding, mutilation, encapsulation, incinerators for burning of BMW, needle shredders/cutter for cutting of needles, Effluent treatment plant (ETP) for waste water treatment process (WWTP), plasma pyrolysis, deep burial, recycling for energy recovery or plastic to diesel or fuel oil or for road making are generally used treatment methods for BMW. There are some rules passed by World Health Organization (WHO) time to time for proper, scientific and economically feasible BMW management along worldwide. In India also there were rules passed by central government for its proper management but till now successful ratio of proper management is not so high. Two major rules of BMW management (BMWM) are BMWM Rule 1998 and BMWM Rule 2016. Some important features of

BMW management rule 1998 and BMW management rule 2016 are below:

**BMWM Rule 1998**

Health-care related activities like vaccination camps, blood donation camps, surgical camps or any other health-care activities not covered under this rule

Pretreatment of the laboratory waste was not required

Use of chlorinated plastic bags, gloves, and blood bag was mentioned

Liquid waste treatment by ETP was not mandatory

Training and immunization of all HCWs was not compulsory

No barcoding system for bags and containers containing BMW for disposal

Reporting of all accidents during handling and disposal of BMW was not compulsory

Requisite BMW treatment facility setup or requisite treatment at a CBMWT was compulsory for HCFs

BMW classified into 10 categories on the basis of treatment options

Chemical treatment with 1% hypochlorite

Deep burial to be allowed in town having less than 5 lakhs population

Cytotoxic drugs disposal in secured landfills

Drugs were discarded into Black bags

Blue bag was used for infected metals waste, glass waste, and plastics waste and then sent for autoclaving, microwaving, and incinerator

Permissible limit for emission from incinerators was SPM (suspended particulates matter)-150 mg/Nm<sup>3</sup>

Monitoring of implementation of rules not defined

No district level monitoring by State pollution control board (SPCB) of each state

No district level monitoring committee submit its report once every 6 months to the State pollution control board (SPCB)

Table 1: Categories of BMW according to BMWM Rule 1998

Option	Treatment and Disposal	Waste Category
Category 1	Incineration /deep* burial	Human Anatomical Waste (human tissues, organs, body parts)
Category 2	Incineration /deep* burial	Animal Waste, tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals / colleges, animal houses)
Category 3	Local autoclaving/ micro waving/ incineration	Microbiology & Biotechnology waste (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents, wastes from production of biological, toxins, dishes and devices used for transfer of cultures)
Category 4	Disinfectants (chemical treatment @/autoclaving/micro waving and mutilation shredding #	Waste Sharps (needles, syringes, scalpels blades, glass etc.)
Category 5	Incineration \$/ destruction and drugs disposal in secured landfills	Discarded Medicines and Cytotoxic drugs (wastes comprising of outdated, contaminated and discarded medicines)
Category 6	Incineration\$, autoclaving/micro waving	Solid Waste (Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, line beddings)
Category 7	Disinfections by chemical treatment @ autoclaving/micro waving& mutilation shredding. #	Solid Waste (waste generated from disposable items other than the waste sharps such as tubing, catheters, intravenous sets etc.)

Category 8	Disinfections by chemical treatment @ and discharge into drain	Liquid Waste (waste generated from laboratory and washing, cleaning, house-keeping and disinfecting activities)
Category 9	Disposal in municipal landfill	Incineration Ash (ash from incineration of any bio-medical waste)
Category 10	Chemical treatment@ and discharge into drain for liquid and secured landfill for solids	Chemical Waste (chemicals used in production of biological, chemicals, used in disinfection, as insecticides, etc.)

Source: [http://www.mppcb.nic.in/Bio\\_Categories.htm#Top](http://www.mppcb.nic.in/Bio_Categories.htm#Top)

@ Chemical treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection.

# Mutilation/shredding must be such so as to prevent unauthorized reuse.

\$ There will be no chemical pretreatment before incineration. Chlorinated plastics shall not be incinerated.

\* Deep burial shall be an option available only in towns with population less than five lakhs and in rural areas

**BMWM Rule 2016**

Health-care related activities like vaccination camps, blood donation camps, surgical camps or any other health-care activities covered under this rule

Pretreatment of the laboratory waste is required

Phase-out the use of chlorinated plastic bags, gloves, and blood bags within 2 years

Liquid waste treatment by ETP is mandatory

Training and immunization of all HCWs is not compulsory

Barcoding system for bags and containers containing BMW for disposal

Reporting of all accidents during handling and disposal of BMW is compulsory

No HCFs shall setup BMW treatment and disposal plant on their site, if, a CBMWTF is available within 75 km of the HCF

If no CBMWTF not available with the 75 km range then HCFs shall setup BMW treatment and disposal plant after taking permission from authority

BMW classified into 4 categories on the basis of treatment options

Chemical treatment with 10% hypochlorite

Deep burial to be allowed in remote rural or remote area. The underground water level should be a minimum of 6 meter below the lower level of deep burial pit

Cytotoxic drugs should be returned to manufacturer or CBMWTF for incinerator at 1200°C or encapsulation or plasma pyrolysis at 1200°C

Drugs and expired antibiotic should be sent back to incinerators or to the manufacturer

Yellow bag is used for anatomical waste, soiled waste, expired or discarded medicines, chemical waste, chemical liquid waste and laboratory waste; Red bag is used for plastic waste, white container is used for sharps and cardboard boxes with blue marking is used for glass waste and then sent for recycling

Permissible limit for emission from incinerators is SPM (suspended particulates matter)-50 mg/Nm<sup>3</sup>

Monitoring of implementation of rules by Ministry of environment, forest and climate change in the country once a year

District level monitoring by State pollution control board (SPCB) of each state

District level monitoring committee shall submit its report once every 6 months to the State pollution control board (SPCB)

Table.2 Categories of BMW according to the new updated rule of BMW Management-2016

Category	Types of Waste	Types of Bag or Container to be used	Treatment and Disposal options
1-Yellow	(a) Human Anatomical Waste: Human tissues, organs, body parts and fetus		Incineration or plasma pyrolysis or deep burial

	below the viability period [as per the Medical Termination of pregnancy Act 1971, amended from time to time].	Yellow colored non-chlorinated plastic bags	
	(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 colored 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 BMW treatment facility or hazardous waste treatment, storage and disposal facility for incineration at temperature >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 colored 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 another wastewater. The combined discharge shall conform to the discharge norms given in Schedule-3.

	(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 non-chlorinated chemicals on site as per National AIDS Control Organization or World Health Organization guidelines thereafter for Incineration.
2-Red	Contaminated Waste (Recyclable): Waste 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 colored non-chlorinated plastic bags or containers	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.
3-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.
4-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	

The BMW Rule 1998 were modified time to time in year 2000, 2003, and 2011 but it is not effective modification while modification in 2016 is more convenient and acceptable with some strict rules and also focuses on minimizing environmental pollution due to toxic emission from incinerators. BMW Rule 2016 contains 4 categories, 4 schedules, 5 forms and 18 rules while in old rule of BMW 1998 there were 10 categories and 6 schedules. There is some amendment with some modification came in 2018 and 2022 in rule 2016.

Table.3. Treatment Instrument/Methods and their Treatment Purposes

Treatment Instrument/Methods	Treatment purpose
Colour-coding	For segregations of BMW
Autoclaving	Sterilization of instruments
Dry heat	Sterilization of instruments
Micro-waving	Disinfects the waste by moist heat and steam generated
Disinfection	Sterilization of instruments
Hydroclaving	Sterilization of instruments
Shredding/Mutilation	Used to cut/shred/destroy waste such as syringes, scalpels, glass vials, blades, plastics, catheters, broken ampules, intravenous sets/bottles, blood bags, gloves, bandages etc.
Encapsulation/immobilization	Coating the waste with inert materials that resist biodegradation
Incinerators	Burning of BMW
Needle shredders/cutter	for cutting of needles
ETP	for waste water treatment process (WWTP)
Plasma pyrolysis	Used to destroy wide types of waste i.e., infectious waste, sharps, plastics, dialysis waste, hazardous waste, chemotherapeutic waste, chemotherapy waste, and low-level radioactive waste (except mercury waste), on plasma-based technology.
Deep burial	To avoid recycling of sharps objects
Recycling	for energy recovery or plastic to diesel or fuel oil or for road making

## II. MATERIAL AND METHODS

Time period of study- 3 years

Study Area- Different government and private hospital of Siwan

Primary and secondary data were collected from Bihar State Pollution Control Board (BSPCB) Patna and District Health Society (DHS) of Siwan.

Data collection of ‘‘Daily Collection Report of Biomedical Waste’’ of Sadar hospital and many private hospitals in Siwan (Bihar) by Medicare Environmental Management Pvt. Ltd. Muzaffarpur, Bihar, India.

About Physiochemical parameter of Daha-River Water

The time period of study was 3 months from July-2022 to September-2022.

Waste water samples were collected from Shiv-Ghat and Pulwa Ghat of the Daha River, Siwan for finding of different physiochemical parameter and diseases causing micro-organisms in river environment by Bihar State Pollution Control Board Patna

Questionary based survey was done for estimation of processes (like ETP for WWTP) used for proper and scientific treatment of liquid BMW.

### III. RESULT AND DISCUSSION

In any establishment for safe, proper and scientific management of health-care waste; Handling, segregation, mutilation, disinfection, storage, transportation and final disposal are some important steps (Acharya and Singh Meeta, 2000). A critical analysis of BMW management was put forward by Mastorakis et al. (2011), who pushed for responsible collection, transportation, processing, and disposal of hazardous and nonhazardous bio-Medical waste. According to Jang et al. (2006), current methods for managing medical wastes—including the production, composition, segregation, transportation, and disposal of BMW—do not adhere to existing standards. Some of the hinderance arise in the proper health-care waste management are lack of concern, awareness, motivation and cost factor (P Sulmer et al.1989). World half population is suffering from exposure to improper BMW and this BMW generation rate is increasing faster than coping infrastructure (Harhay MO et al,2009).

In my study finding in my study area Siwan, Bihar, there was lack of proper and scientific treatment of BMW. Only few methods were practiced by health-care personnels here, i.e., colour-coding bins, autoclaving, chemical disinfectant, Effluent treatment plants (ETP), and needle cutter. These methods were given in the Fig.1, fig.2, fig.3, and fig.4. While its worst conditions were shown in the fig.5, fig.6, fig.7, fig.8, fig.9, fig.10, and fig.11. and fig.12. Colour coding system for BMW is of the best method for sorting of BMW. These are yellow, red, blue/white and black. Yellow colour coding is for infectious waste, bandages, gauzes, cotton or any other things in contact with body fluids, human body parts, placenta; red for plastic waste such as catheters, injections, syringes, tubing I.V bottles; blue/white for all types of glass bottles and broken glass articles, outdated and discarded medicines; and black for all metal articles sharps blades and needles. So, sorting on this basis is very effective for proper disposal.

Colour-coding bins are used for segregation at source point where BMW is generated (fig.1). There were generally five colour-coded bins were provided in the hospital premises i.e., yellow, red, white, blue and green. Yellow for anatomical waste, red for plastic waste, white for sharp objects, blue for glass ware objects and green for general domestic like waste. But

in fig.5 and fig.6 we can see its misuse. Open dumping and burning are very common practice for solid biomedical waste in the town. Burning of biomedical waste releases very toxic gases like furan, dioxin etc. Autoclaving was used for sterilization of instruments (Fig.3). Needle cutter/shredders were used for needle cutting (Fig.2). Also, sterilization of instruments was done by chemical disinfectant like by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment. Effluent treatment plants (ETP) were used for waste water treatment processes (WWTP) here by few selected private hospitals only (Fig.4). Datta et al., 2017 stated that the finest BMW management practices focus on reducing waste output or recovering as much waste as feasible rather than disposing of it. Priyadarshah et al. 2016 argued that hospital trash poses a severe health risk to the community due to improper disposal and treatment methods. It is chemically dangerous, infectious, and frequently radioactive in origin.

According to the data collected for the study year 2019, 2020 and 2021 of Siwan District (Table.4), showed that 917.42 Kg/day, 5874.48 Kg/day and 384.53 Kg/day biomedical waste generated in the year 2019, 2020 and 2021 respectively in this district. This massive amount of biomedical waste generated per day remained untreated properly due to lack of proper and scientific management system. Here, solid biomedical waste treatment is managed at some extent by Medi-care Pvt. Lim. Muzaffarpur, Bihar, but liquid biomedical waste treatment is in very poor condition. And according to the BMW management Rule-2016, no health care facilities (HCFs) shall setup BMW treatment and disposal plant on their site, if, a Common bio-medical waste treatment facility (CBMWTF) is available within 75 km of the HCF. But in my present study area Siwan, there is no CBMWTF within 75 km, and Medi-care Pvt. Lim. Muzaffarpur, Bihar which manage BMW management of Siwan at some extent is 127 km far from Siwan. So, it is a very tough task to manage BMW from such a long distance for Medi-care Pvt. Lim. Muzaffarpur, Bihar.

On the other hand, liquid BMW remain totally untreated and this untreated liquid BMW released into domestic drainage system which finally reached into Daha River (Siwan, Bihar) and affect all physiochemical parameters of this river. For natural water the permissible limit of BOD (biochemical

oxygen demand) is 3 mg/L or less than it, and the permissible limit of COD (chemical oxygen demand) is 10.0 mg/L. But in my present study the average value of BOD was 3.96 mg/L which is higher than permissible limit, and the average value of COD was

29.33 mg/L which is very high in compare to permissible limit. The high value of BOD and COD clearly indicate that the Daha River became a polluted River.

TABLE.4. YEAR WISE GENERATION (WT.) OF BIOMEDICAL WASTE IN SIWAN DISTRICT

YEAR 2019	YEAR 2020	YEAR 2021
917.42 kg/day	5874.48 kg/day	384.53 kg/day



Fig.1 Coloured Bins for Colour-Based segregation



Fig.2 Needle Shredder for cutting of needles



Fig.3 Autoclaving machine for sterilization



Fig.4. Effluent treatment plant (ETP)

PIC FROM DIFFERENT LOCATION IN TOWN



Fig.5 Colour coded Bins are present but BMW



Fig.6 Colour coded Bins are uselessly thrown  
thrown openly in cart

BEMOAN CONDITION OF TOWN BMW MANAGEMENT



.7 BMW thrown in open cart and blood



Fig.8 BMW thrown openly in hospital premises  
is flowing out through it



Fig.9 BMW thrown openly in hospital premises



Fig.10 BMW thrown openly along road side  
In Hospital Road, Siwan, Bihar



Fig.11 BMW thrown openly along road  
side in Hospital Road, Siwan, Bihar



Fig.12 BMW thrown openly along road  
side in Hospital Road, Siwan, Bihar

#### IV. CONCLUSION

Present study reveals that there is lack of proper, scientific and eco-friendly management of BMW in my study area (Siwan, Bihar). Only few treatment methods were practiced by health-care personnels here, i.e., colour-coding bins, autoclaving, chemical disinfectant, ETP, and needle cutter. Here open dumping of BMW is very common in Hospital Road, Siwan. Open dumping of these BMW provides an infectious site for interaction of many different types of animals with these BMW and in this manner these animals and many microorganisms become carrier of many diseases. There is no CBMWTF within 75 km around Siwan, and Medi-care Pvt. Lim. Muzaffarpur, Bihar which manage BMW management of Siwan at some extent is 127 km far from Siwan. So, it is a very tough task to manage BMW from such a long distance for Medi-care Pvt. Lim. Muzaffarpur, Bihar. And on the other hand, untreated liquid BMW released into the domestic drainage and finally reached into Daha River, then it pollutes the whole environment of water system and in this manner harmful chemicals present in the biomedical waste reached into underground water level. The high value of BOD and COD clearly indicate that the Daha River became a polluted River. All this show negligence in the proper and scientific treatment of biomedical waste in the town.

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