Chapter-1

Introduction

'Bio-medical waste' means any waste generated during diagnosis, treatment or immunization of human being or animals. Management of health care waste is an integral part of infection control and hygiene programs in healthcare settings. These settings are a major contributor to community-acquired infection , as they produce large amounts of biomedical waste. Biomedical waste can be categorized based on the risk of causing injury and or infection during handling and disposal. Waste targeted for precautions during handling and disposal include sharps (needles or scalpel blades). Pathological waste (anatomical body parts, microbiology cultures and blood samples) and infectious wastes (items contaminated with body fluids and discharge such as dressings, catheters and I.V. lines).Other wastes generated in healthcare settings include radioactive wastes, mercury containing instruments and polyvinyl chloride (PVC) plastics. These are among the most environmentally sensitive by-products of healthcare (Askarain et al., 2004 ; Remy , 2001). WHO stated that 85% are non-infections but hazardous wastes. In the U.S.A, about 15% of hospital waste is regulated as infectious waste. In India this could range from 15%to 35% depending on the total amount of waste generated (Glenn &Carwal, 1999; Anonymous, 1998; Chitnis et al., 2005)

The management of bio-medical waste is still in its infancy all over the world. There is a lot of confusion with the problem among the generators, operates, decision-makers and the general community about the safe management of bio-medical waste. The reason may be a lack of awareness. Hence resources material on the environment for hospital administrators, surgeons, doctors, nurses, paramedical staff and waste retrievers, is the need of the hour (Almuneef&Memish, 2003; Acharya &Meeta, 2000).

Sources of Bio-Medical Waste

While urban solid waste has attention of town planners, environment activists and civic administers , there is yet lack of concern for some special sources of waste and its management. One waste is Bio-medical waste generated primarily from health care establishment, including hospitals, nursing homes, veterinary hospitals, clinics and general practitioners, dispensaries, blood banks, animal houses and research institutes. The other sources of biomedical waste are the following:

Households,

Industries, education institutes and research centres ,

Blood banks and clinical laboratories,

Health care establishments (for humans and animals): (Anonymous, 2000; Chitnis et al., 2000).

The sectors generates all types of waste listed under bio-medical waste are shown in Fingue1.

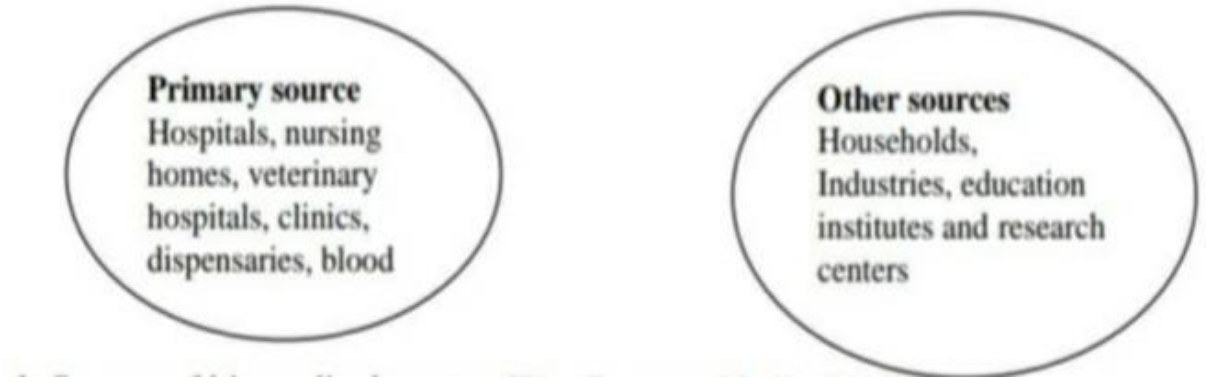


Figure 1. Sources of biomedical waste (The Gazette of India, 1998)

Categories of biomedical waste

Categories of biomedical wastes are given in Table1.

Table1. Categories of biomedical wastes

CATEGORY	SOURCE OF WASTE	TREATMENT AND DISPOSAL

1.	Human anatomical waste (human tissues, organs, body parts)	Incineration/Deep burial
2.	Animal waste	Incineration/Deep burial
3.	Microbiology and biotechnology waste	Local autoclaving/microwaving incineration
4.	Sharp waste	Disinfection
5.	Discarded medicines and cytotoxic drugs	Incineration/destruction and drug disposal in secured landfills
6.	Solid waste	Incineration autoclaving/microwaving
7.	Liquid waste	Disinfection by chemical treatment and discharge into drains
8.	Incineration ash	Disposal in municipal landfills
9.	Chemical waste	Chemical treatment and discharge into drains for liquids and secured landfills for solids

Classification of Healthcare Waste

Health Care Facilities (HFCs) are primarily responsible for management of the healthcare waste generated with the facilities, including activities undertaken by them in the community. The health care facilities , while generating the waste are responsible for segregation, collection, in-house transportation , pre-treatment of waste are responsible for waste, before such waste is collected by Common Bio-medical Waste Treatment Facility (CBWTF) Operator. Thus, for proper management of the waste in the healthcare facilities the technical category of the staff in accordance with the BMWM Rules. 2016.

Waste generated from the healthcare facility is classified as:

- Bio Medical Waste
- General Waste
- Other Waste

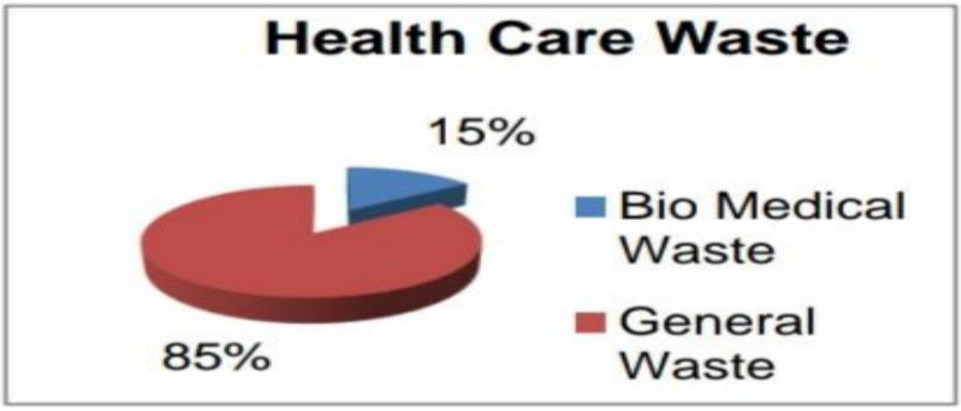


Figure1 Percentage – wise classification of waste generated from the Healthcare Facility

a) Bio Medical Waste

Bio-medical waste means any waste, which is generated during the diagnosis, treatment or immunization of human being or animals or research activities pertaining thereto or in the production or testing of biological or in the health camps. Bio-medical waste includes all the waste generated from the Health care Facility which can have any adverse effect to the health of a person or to the environment in general if not disposal properly. All such waste which can adversely harm the environment or health of a person is considered as infectious and such waste has to be managed to be BMWM rules, 2016.

The quantity of such waste is around 10% to 15% of total waste generated from the Health Care Facility . This waste consists of the materials which have been in contact with the patient's blood, secretions, infected parts, biological liquids

such as chemicals, medical supplies, medicines, lab discharge, sharps metallic and glassware, plastics etc.

Bio Medical Waste Management Rules, 2016 categories the bio-medical waste generated from the health care facility into four categories based on the segregation pathway and colour code. Various types of bio medical waste are further assigned to each one of the categories, as detailed below:

1. Yellow Category
2. Red Category

3. White Category
4. Blue category

These categories are further divided as per the types of waste under each category as follows:**Table1: Categories of Biomedical Was**

CATEGORY	TYPE OF WASTE
YELLOW	**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).
	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.
	Soiled Waste Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components.
	Discarded or Expired Medicine Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc.
	Chemical Waste Chemicals used in production of biological and used or discarded disinfectants
	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 an d floor washings, cleaning, house - keeping and disinfecting activities etc
	Discarded linen, mattresses, beddings contaminated with blood or body fluid, routine mask & gown.

CATEGORY	TYPE OF WASTE
	Microbiology, Biotechnology and other clinical laboratory waste (Pre-treated) 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.
RED	Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes without needles, fixed needle syringes with their needles cut, vaccutainers and gloves
WHITE	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
BLUE	Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes.

b) General waste

General waste consists of all the waste other than bio-medical waste and which has not been in contact with any hazardous or infectious, chemical or biological secretions and does not includes any waste sharps. This waste consists of mainly:

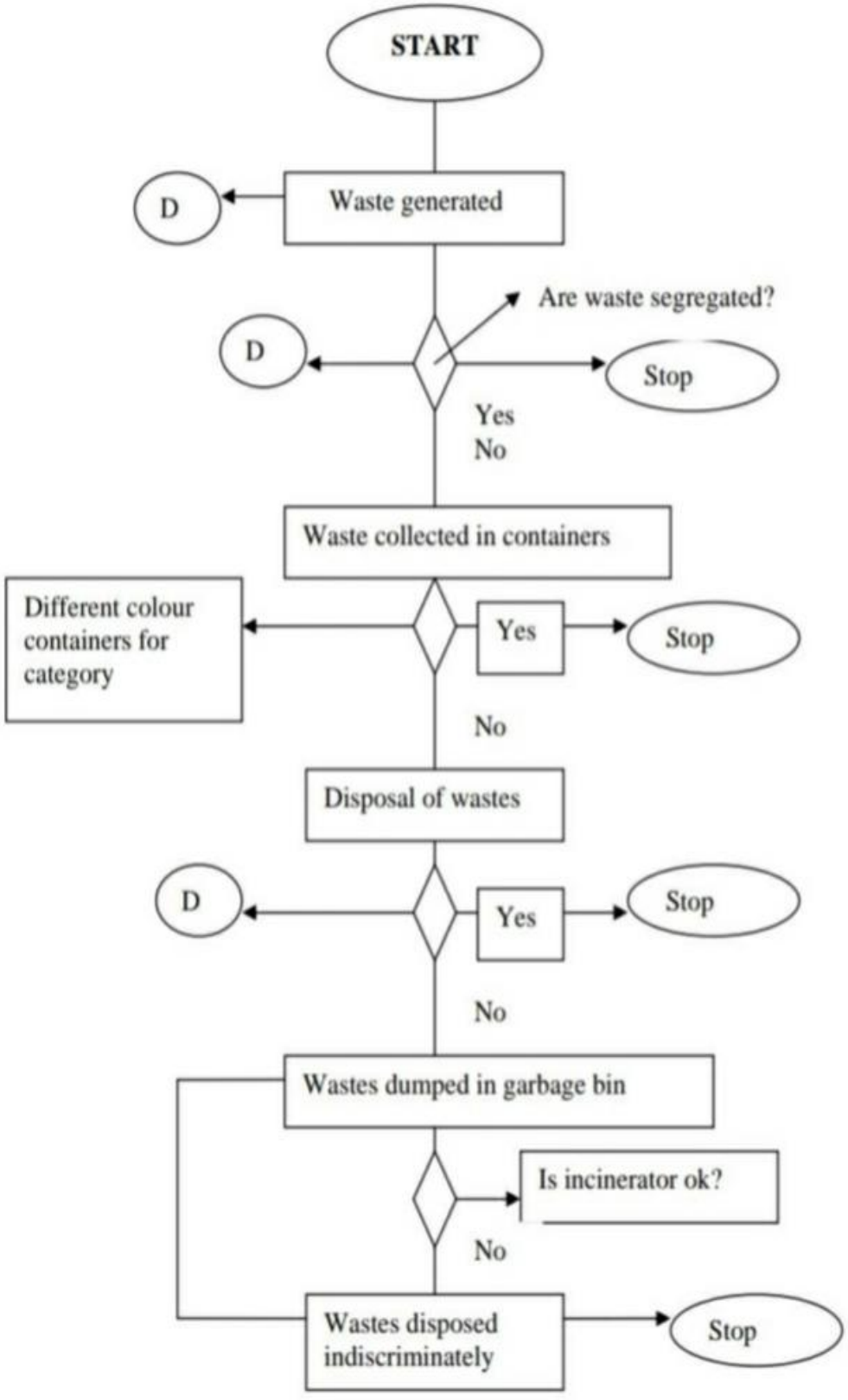
(1) News paper, paper and card boxes (dry waste)
(2) Plastic water bottles (dry waste)
(3) Aluminium cans of soft drinks (dry waste)
(4) Packaging materials (dry waste)
(5) Food Containers after emptying residual food (dry waste)
(6) Organic/ Bio-degradable waste-mostly food waste (wet waste)
(7) Constructions and Damolition wastes

These general waste are further classified as dry wastes and wet wastes and should be collected separately.

This quantity of such waste is around 85% to 90% of total waste generated from the facility. Such waste is required to be handled as per solid Waste Management Rules, 2016 and construction & Demolition Waste Management Rules, 2016, as applicable.

c) Other wastes

Other wastes consists of used electronic wastes, used batteries and radio-active wastes which are not covered under biomedical wastes but have to be disposed as and when such wastes are generated as per the provisions laid down under E-waste (Management) Rules, 2016, Batteries (Management & Handling) Rules, 2001, and Rules/ guidelines under Atomic Energy Act, 1962 respectively.



Figures2: Categorization & Classification of Waste in Health Care Facilities

Effects of biochemical waste

The improper managements in bio-medical waste causes stern environments problems that causes to air, water and land pollution that causes damage can be classified into biological, chemical and radioactive. There are several lagislations and guidelines in India concerning environment problems, which can be addressed. The classification of radioactive waste generated as part of bio-medical waste is conered. Some of the effects of pollution on air, radio activities, land, health and hazards are discussed (Sadhu and Singh 2003; www. Ipaindia.org/files/2007pdf).

Air Pollution

Air Pollution can be caused in both indoors and outdoors atmosphere. Biomedical waste that generated by air pollution are been classified in three types namely-Biological, Chemical and radioactive (http://kapcb. Kar.nic.in/BMW).

In- door air pollution

Pathogens presents in the waste can enter remain in the air foe a long period in the form, of spores or as pathogens segregation of waste, pre-treatment at sources etc., can also reduce this problem to a great extent. Sterlizing the rooms will also help in checking the indoor air pollution due to biological (Askarian et al 2004b; Baveja et al 2000). The indoor air pollution caused due to the above chemicals from poor ventilation can cause diseases like sick Building Syndrome (SBS). Proper building design and well-maintained air conditioners can reduce the SBS. Chemical should be utilized a s per prescribed norms. Over use of chemicals should be avoided (Bdour 2004, Saurabh& Ram 2006).

Out-door air pollution

Outdoor air pollution can be causes by pathogens. The biomedical waste without pre-treatment if transported outside the institution, or if it is dumped in open areas, pathogens can enter into the atmosphere . Chemical pollutants that cause outdoor air pollution have two major sources-open burning and

incinerators. Open burning of bio-medical waste is the most harmful practice. When inhaled can causes respiratory diseases. Certain organic gases such as dioxins and furans are carcinogenic (Burd 2005). The design parameters and maintenances of such treatment and disposal technology should be as per the prescribed standards (Bdour 2004).

Radioactive emission

Research and radio-immunoassay activities may generate small quantities of radioactive gas. Gaseous radioactive material should be enacuateddirectly to the outside. The use of such device requires maintenance of the trap and monitoring of the off-gas(Malviga 1999).

Water pollution

The liquid waste generated when let into sewers can also lead to water pollution if not treated properly (Rao, 1995; Rao & Garg, 1994). Water pollution can alter parameters such as pH, BOD, DO, COD, etc. There are instances where dioxins are reported from water bodies near incinerator plants. Dioxins enter the water body the air (Chitins et al, 2000; Ravikant et al, 2002; Saini &Dadhwal 1995).

Radioactive effluent

Radioactive waste in liquid from can comes from chemical or biological research , from body organ imaging, from decontamination of radioactive spills, from patient's urine and from scintillation liquids used in radioimmunoassay. Under circumstances , urine and faces can be handled as no radioactive waste so long as the patient's rooms is routinely monitored for radioactive contamination (Patil&Pokhrel, 2004 ; Shah et al, 2001).

Land Pollution

Soil pollution from bio-medical waste is caused due to infectious waste, discarded medicines, chemicals used in treatment and ash and other waste generated during treatment processes. Heavy metals such as cadmium, lead

mercury etc., which are present in the waste will get absorbed will get absorbed by plants and can then enter the food chain.. Nitrates and phosphates present in leachates from landfills are also pollutants. Exercise amount of trace nutrient elements and other elements including heavy metals in soil are harmful to crops and are also harmful to animals an human beings (Mehta 1998). The permissible limits of some elements in soil for plants are presented in the table 2. Minimizing the waste and proper treatment before disposal on land are they ways of reducing this kind of pollution (Silva et al 2005). The waste generated from various countries is given in Table 3.

Table2. Comparison of treatment technologies for medical wastes.

REATME IT YSTEMS	AUTOCL AVE	HYDROCLAVE	MICROWA VE	INCI NER ATO R	CHEMICAL
Description	Steam sterilizatio n (direct heating)	Steam sterilization(indir ect heating) simultaneous shredding and dehydration	Microwave heating of pre-shredded waste	High tempe rature waste incine ration	Mixing pre-ground waste with chemicalssuch as chlorine
terilization fficacy	Medium	Medium	Medium	High	Dependent on chlorine strength
apital cost	Low	Low	High	High	Moderate
perating ost	Low	Low	High	High	Low
ir emission	Odorous but non-toxic	Somewhat odorous but non-toxic	Somewhat odorous but non-toxic	Can be highly toxic	Some chlorine emission

Water mission	Odorous may contain live micro-organisms	Odorous but sterile	Negligible	None	None

Table 3. Amount and compositions of hospital waste generated

a.Amount

COUNTRY	QUALITY (Kg/bed/day)
UK	2.5
USA	4.5
FRANCE	2.5
SPAIN	3.0
INDIA	1.5

a. Hazardous/non-hazardous

Hazardous 15%

Hazardous but non-infective	5%
Hazardous and infective	10%

Non-hazardous 85%

Health hazards

According to the WHO, the global life expectancy is increasing year after year. However, deaths due to infectious disease are increasing. A study conducted by the WHO in 1996, reveals that more than 50,000 people die everyday from infectious diseases. One of major causes for the increases in infectious diseases is improper waste management. List of infectious and diseases documented to have spread through bio-medical waste. Tuberculosis , pneumonia, diarrhoeal diseases , tetanus, whooping cough etc., are other common diseases spread due to improper waste management (Chitins et al, 2002; chitins et al, 2003; Tudor et al, 2005; Marinkovic et al, 2005).

Occupational health hazards

Occupational health concerns exits for janitorial and laundry workers, nurses, emergency medical personnel , and refuse workers. Injuries from sharps and exposures to harmful chemicals waste and radioactive waste also causes health hazards to employees in institutions generating bio-medical waste. Proper management of waste can solve the problem of occupations hazards to a large extent (Patil&Shekar, 2001).

Hazards to the general public

The general public's health also be adversely affected by bio-medical waste. Improper practices such as dumping of bio-medical waste in municipal dustbins, open spaces , water bodies etc., leads to the spread of diseases. Emission from incinerators and open burning also leads to exposure to harmful gases which can causes cancer and respiratory diseases (Manohar et al, 1998; Da silva et al, 2005).

Plastic waste can choke animals, which scavenge on openly dumped waste. Injuries from sharps are common features-affecting animals . Harmful chemicals such as dioxins and furans can causes serious health hazards to animals and birds. Certain heavy metals can effect the reproductive health of the animals (Code &Christic, 1999).

2. Environments managements system

The EMS is a broad framework aimed at providing effective directions foe an institutions in response to the changing external and internal factors. Waste system of the hospitals was studied by (Das et al., 2001; CPHEE 1998; Kelkar, 1998 et al, 2000). Figures 2v shows the waste managements flow chart and process floe chart of the existing indicated the sequence from generation of waste to its final disposal . Figure 3 shows the interference of the points and data (Jaswal&Jaswal 2000) .colour coding and type of container for disposal of biochemical wastes is given in table 4 Biomedical waste specialize are in the three categories namely:

Table 4. Type of container and colour code for collection of bio-medical waste

CATEGORY	WASTE CLASS	TYPE OF CONTAINER	COLOUR
1.	Human anatomical waste	-Do-	Yellow
2.	Animal waste	-Do-	
3.	Microbiology and biotechnology waste	-Do-	Yellow/red
4.	Sharp waste	Plastic bag puncture proof container	Blue/white translucent
5.	Discarded medicines and cytotoxic waste	Plastic bags	Black

6.	Solid (biomedical waste)	-Do-	Yellow
7.	Solid (plastic)	Plastic bag puncture proof containers	Blue/white translucent
8.	Incineration waste	Plastic bag	Black

Figure 3. A process flow chart of the exiting waste system of the hospital management of the infectious waste is crucial in today's health care arena (Saurabh, & Ram, 2006)

Disposal Methods

Different methods are used for the disposal of bio-medical waste and are discussed below:

Incineration

It is a controlled combustion process where waste is completely oxidized and harmful microorganism present in it are destroyed/ denatured under high temperature .An article regarding plasma pyrolysis of medical waste was reported by Neema and Garenshprasad (2002). The authors stated that the operating cost of the system would be Indian Rupees 13 per kilometers (kg), and the energy recovered would cost Indian rupees 8 per kg: thus the net cost would be Rs 7 per kg. Amount and composition of hospital waste generated are in table 5. Incineration is popular in countries such as japan where land is a scare resources., as they do not consume as much area as a landfill. Sweden has been a leader in using the energy generated from incineration over the past 20 years. Denmark also extensively uses waste-to-energy incineration in localized combined heat and power facilities supporting district heating schemes (Gupta, 1998).

Table5. Machinery requirements for Common Waste Treatment Facility

1.	Incinerators	2 numbers
2.	Autoclaves	one
3.	Microwave equipment	(Optional)
4.	Shredders	2 nos
5.	Chimney	30 M
6.	Effluent treatment plant	1
7.	Vehicle washing equipments	1

8.	Water pumps, storage, air compressors	1
9.	Generator for electricity	1

Autoclaving ; Autoclaving is a low-heat thermal process where steam is brought into direct contact with waste in a controlled manner and for sufficient duration to disinfect the wastes. For ease and safety in operation , the system be horizontal type and exclusively designed for the treatment of bio-medical waste. For optimum results, pre-vacuum based system be preferred against the gravity type system. It shall have temper-proof control panel with efficient display and recording devices for critical parameters such as time , temperature , pressure data and batch number etc (NEERI 1995, Bacini& Brunner, 1991 ; Pruss et al, 1999).

Microwaving . microbial inactivation occurs as a result of the thermal effect of electromagnetic radiation spectrum lying between the frequencies 300 and 3000,000 MHz. Microwave heating is an inter-molecular heating process. The heating occurs inside the waste material in the presences of steam (Pruthvish et al, 1998).

Hydroclaving is similar to that of autoclaving except that the waste is subjected to indirect heating by applying steam in the outer jacket. The waste is continuously tumbled in the chamber during the process.

Shredder: Shredding is a process by waste are deshaped or cut into smaller pieces so as to make the waste unrecognizable. It helps in prevention of reuse of bio-medical waste and also acts as indentifier that the waste have been disinfected and are safe to dispose off. A shredder is to be usedfor shredding in bio-medical waste with minimum requirements (Singh & Sharma 1996; Shah et al, 2001 ; Rasheed et al, 2005).

Standards for treatment and disposal of bio-medical waste

Standards for incinerators

All incinerators shall meet the following operating and emission standards

A. Operating Standards

1. Combustion efficiency (CE) shall be at least 99.00%.
2. The Combustion efficiency is computed as follows:

   C.E = %Co2/ %Co2 +%Co8*100

3. The temperature of the primary chamber shall be 800 +- 50c.
4. The secondary chamber gas residences time shall be at least 1 (one) second at 1050 + 50 C . with minimum 3% Oxygen in the stack gas.

B.Emission standards

The emission standards are given in Table 6.

Table 6. EPA Emission limits for new hospital/medical/infectious waste incinerators

POLLUTANT		EMISSION LIMITS	
	SMALL	MEDIUM	LARGE
Particulate matter	69mg/dscm	34mg/dscm	34mg/dscm
Carbon monoxide	40ppmv	40ppmv	40ppmv
Dioxins/furans	125ng/dscm total or2.3ng/dscmTEQ	25ng/dscm total or 0.6ng/dscmTEQ	25ng/dscm total or 0.6ng/dscmTEQ
Hcl or 99%reduction	15 ppmv or 99%reduction	15 ppmv or 99%reduction	15 ppmv or 99%reduction
Sulphur dioxide	55ppmv	55ppmv	55ppmv
Nitrogen oxides	250ppmv	250ppmv	250ppmv

Mg= milligrams, dscm=dry standards cubic meter, ppmv = parts per million by volume ng = nanograms, REQ = toxic equivalent ; Capacities ; small = less than or equal to 200 lbs/hr to 500 lbs/hr; large = greater than 500 lbs/hr.

Standards for liquid waste

Table 7. shows the effluent generated from the hospital should conform to the following limits

TABLE.7emission standards waste incinrators

S,No	CONTAMINANT	LIMIT
1	Total particulate	20mg/m3
2	Carbo monoxide	55mg/m3
3	Sulphur dioxide	180mg/m3
4	Nitrogen oxides	380Mg/m3
5	Hydrogen chloride	50Mg/m3 or 90%removal
6	Hydrogen fluoride	4mg/m3
7	Total hydrocarbons as CH4	32Mg/m3

Common Biomedical treatment Facilities

Table 8 and 9 shows the machinery requirements for common Waste Treatment Facility.

Table 8. Effluent generated from hospital

PARAMETERS	PERMISSIBLE LIMITS
pH	6.5-9.0
Suspended solids	100 mg/L
BOD	30 mg/L
Oil and grease	10 mg/L
COD	250 mg/L

Table 9. Design and operation Requirements for biomedical Waste Incinerators and Emission control systems .

S. NO.	PARAMETERS	INCINERATOR TYPE MODULAR (EXCESS AIR AND STARVED AIR)	INCINERATOR TYPE MASS BURN
1.	Incinerator		

2.	Minimum Incineration Temperature	1000 degree C at fully mixed height	1000 degree C determined by an overall design review
3.	Minimum Residence Time	1 second after final secondary air injection ports	1 second calculated from the point where most of the combustion has been completed and the incineration temperature fully developed
4.	Primary Air (Under fire)	Utilize multi-port injection to minimize waste distribution difficulties	Use multiple plenums with individual air flow control
5.	Secondary Air (Over fire)	Up to 80% of total air required	At least 40% of total air required
6.	Overfire Air Injector Design	That required for penetration and coverage of furnace cross section	That required for penetration and coverage of furnace cross section
7.	Auxiliary Burner Capacity	Secondary burner 60% of total rated heat capacity and that required to meet startup and part-load temperature	60% of total output and that required to meet start-up and part-load temperatures
8.	Oxygen Level at the Incinerator Outlet	6-12%	6-12%
9.	Turndown Restrictions	80-110% of designed capacity	80-110% of designed capacity
10.	Maximum CO Level	55 mg/mm3 @ 11% (4 hr rolling average)	55 mg/mm3 @ 11% (4 hr rolling average)
11.	Combustion Efficiency	99.9% (8 hr rolling average)	99.9% (8 hr rolling average)
12.	Emission Control System		
13.	Flue Gas Temperature at Inlet or Outlet of Emission Control Device	Not to exceed 140 degrees C	Not to exceed 140 degrees C

Common Biomedical treatment Facilities are setup for the treatment and disposal of biomedical Waste generated in a number of health care facilities. They are likely to be more economical than individual waste treatment facilities. Resources can be utilized optimally in case of common Facilities (Annoymous 1997; Ranyal , 2000; http:/.cpcb.nic.in).

Present Scenario :

Waste Management is one of the important public health measures. If we go into the historical background before discovery of bacteria as cause of disease , the principal focus of preventive medicine and public health has been on sanitation. The provision of potable water, disposal of odar from sewage and

refuse were considered the important factors in Prevention of epidemics . The current status of practice is given in Figuere4 .

The vehicles transporting the waste to the facility shall be designed exactly as per the standards of Bureau of Indian Standards (Anonymous , 2005). They should also be labelled with symbols meant for hazardous waste. The common Treatment facilities should comply with all the emission and effluent standards of the pollution control Board (Anonymous, 2005)

Biomedical waste in Delhi, India

With increasing awareness in general populations regarding hazards of hospital waste, public interest, litigations were filled against erring officials. Some landmark decisions to streamline hospital waste management have been made in the recent time (http:/health.delhigovt.nic.in/Health/files/bio.html)

All health care institutions are required to handle biomedical waste in a specified manner. Delhi is generating approximately 6500 metric tons of waste out of which 65 tons are Biomedical Waste. The government hospitals and major private hospitals have their own arrangement for treatment of biomedical waste (Anonymous, 1998, Gayathri and Kamala p, 2005, Saurabh G, Ram B, 2006).

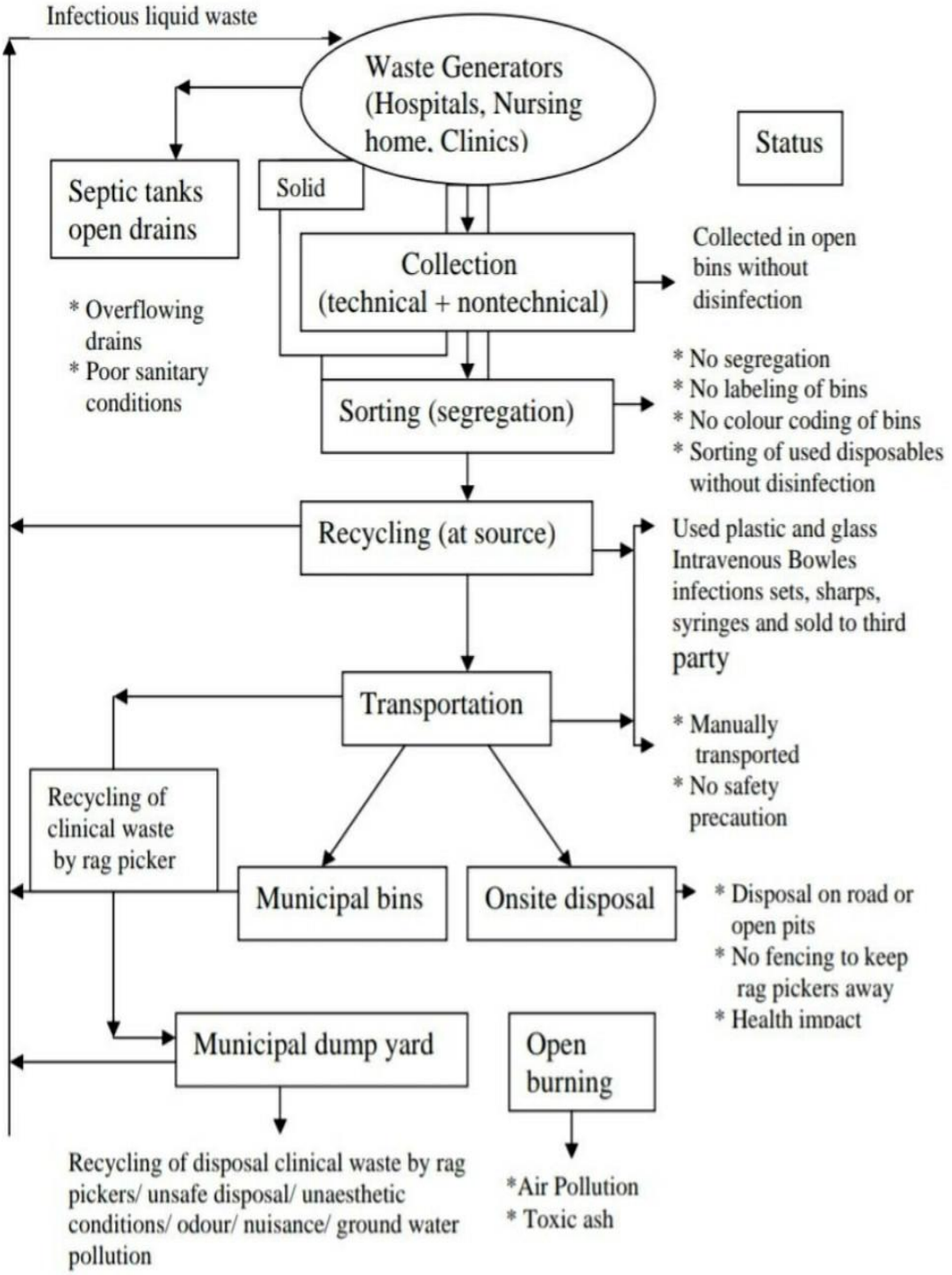


Figure 4. current status of medical waste disposal in Lucknow , India.

Chapter-2

Objectives

- To assess the levels of the knowledge, attitudes and practices among doctors, post graduates, interns ,staff in the different departments of tertiary care teaching hospital.
- To assess the gaps in knowledge, attitudes and practices among these health care workers in the different department oda tertiary care teaching hospital.
- Health care waste is a unique category of waste by the quality of its composition, sources of generation , its hazardous nature and the need for appropriate protection handling, treatment and disposal mismanagement of the waste affects not only the generators, operators but also the common people too.
- Biomedical waste (BWM) means any solid and/or liquid waste including its containers any intermediate product which is generated during the diagnosis, treatment or immunization of human being or animals or in research pertaining thereto or in the production or testingsthere of.
- To generate adequate knowledge amongst the health care employees about the biomedical waste management rules and regulations and their understandings of segregation, will help in the component disposal of the waste in their respective organizations.
- Teaching institute play a critical role in the health care setup as it is from these places that the future health care professionals and all those persons involved in the care giving to the community are trained.

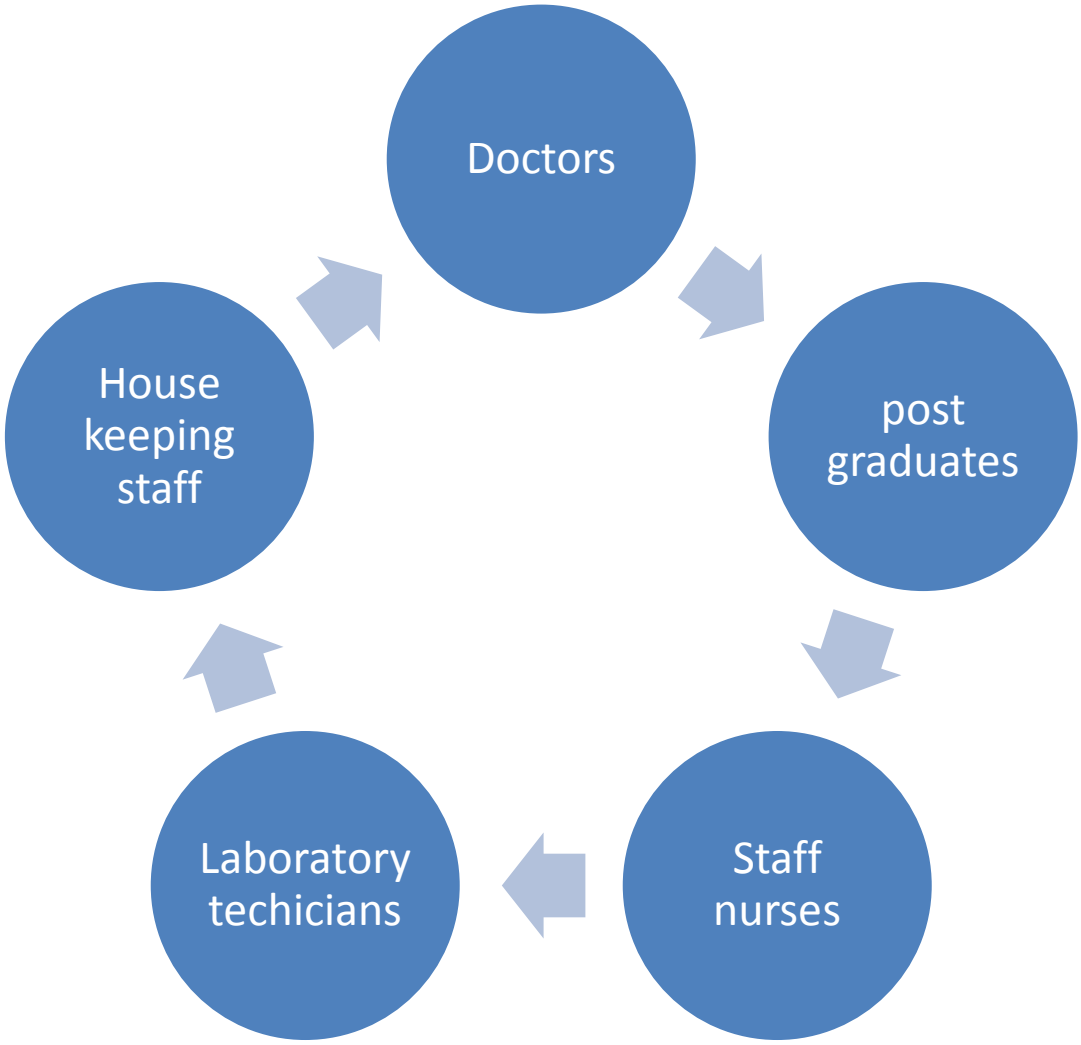
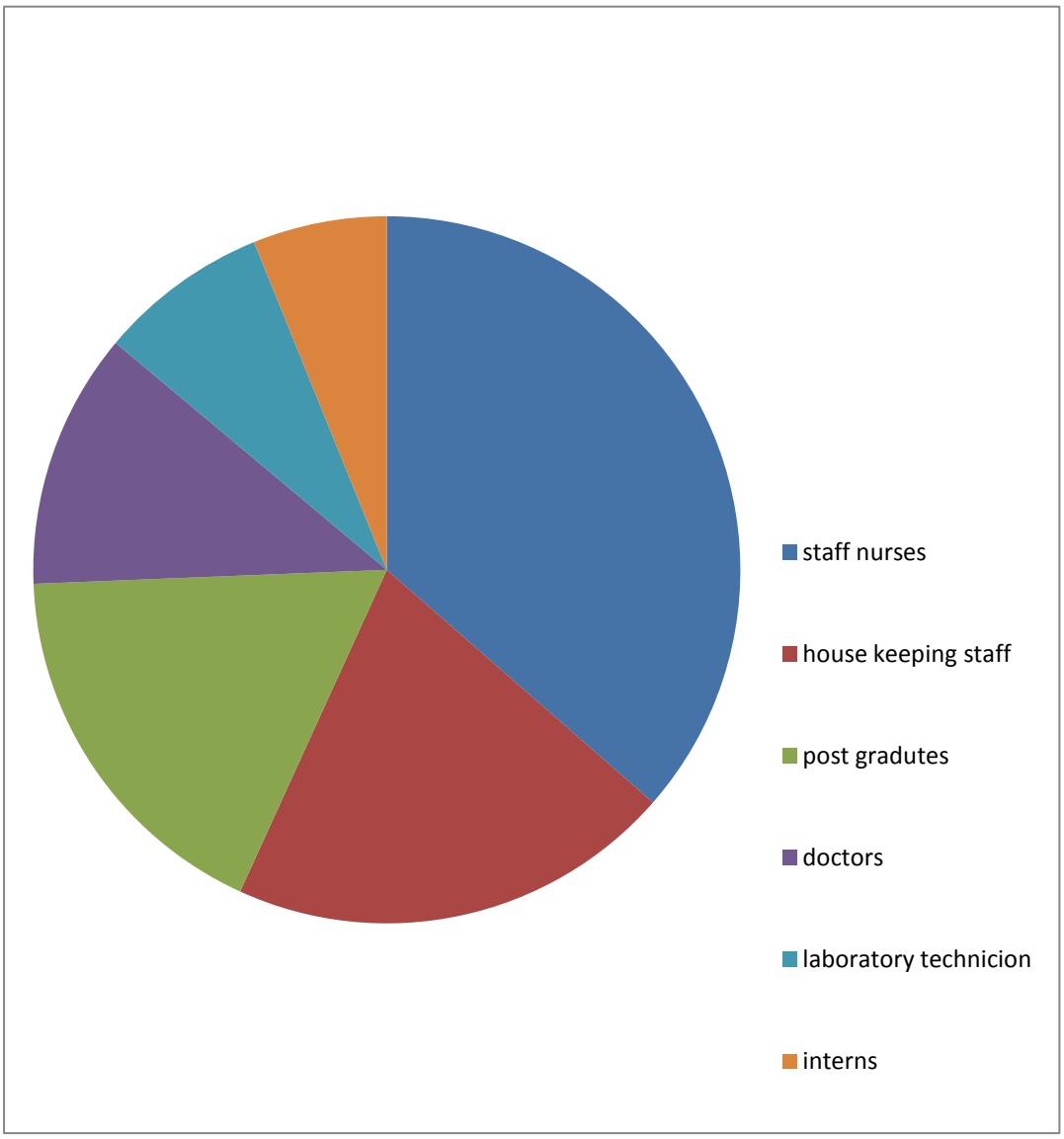


Figure- People involved .

Eligibility criteria



All consenting individuals amongst the different cadres staff were included into the study there were 2056 eligible participants, which was taken as the samplings frame.

Water sample were collected from four including project site for ground water sampling.

❖ Rainfall

The average rainfall over the project site as a whole is 45cm it generally increases from south-west to east or north-east. Over 70% of the annual rainfall is received during the monsoon months of july to September.

S.no	year	Annual average rainfall(in mm)	Number of rainy days
1	2022	685	34
2	2021	400	32
3	2020	993	38
4	2019	595.6	35
5	2018	600	41
6	2017	485.6	39
7	2016	516	31

❖ Wind speed

Wind speed and direction data recorded during the study tenure is useful in identify the influences of meteorology on the air quality of the area.

Chapter -4

Review & Literature

1. Steps involved in Bio-medical Waste Management

First five steps (segregation , collection, pre-treatment , Intramural Transportation and storage) is the exclusive responsibility of Health Care Facility. While Treatment and Disposal is primarily responsibility of CBWTF operator except for tab lab and highly infectious waste, which is required to be pre-treated by the HCFsegregated at the point of generation by the person who is generating the waste in designated colour coded bin/container.

Following are the responsibility of HCF for management and handling of bio-medical waste:

2. 1.Biomedical Waste

First five steps (segregation , collection, pre-treatment , Intramural Transportation and storage) is the exclusive responsibility of Health Care Facility. While Treatment and Disposal is primarily responsibility of CBWTF operator except for tab lab and highly infectious waste, which is required to be pre-treated by the HCFsegregated at the point of generation by the person who is generating the waste in designated colour coded bin/container.

a. Biomedical Waste & General waste shall not be mixed. Biomedical waste & General Waste shall not be mixed. Storage time of waste should be as less as possible so that waste storage, transportation and disposal is done within 48 hours.
b. Phase out use of chlorinated plastic bags(excluding blood bags) and gloves by 27/3/2019.
c. No secondary handling or pilferage of waste shall be done at healthcare facility. If CBWTF facility is available and disposal only through such CBWTF operator.

d. Only Laboratory and highly infectious waste shall be pre-treated onsite before sending for final treatment or disposal through a CBWTF operator.
e. Provide bar-code labels on all colour coded bags or containers containing segregated bio-medical waste before such waste goes for final disposal through a CBWTF.
f. The management of bio-medical waste can overall be summarized in the following steps:

- Waste segregation in color coded and barcode labeled bags/containers at sources of generation.

- Pre-treat Laboratory and highly infectious waste

- intra-mural transportation of segregated waste to central storage area

- Temporary storage of biomedical waste in central storage area

- Treatment and Disposal of biomedical waste through CBWTF or Captive facility

3. **Bio medical Waste segregation**

Bio – medical waste generated from a healthcare facilty is recqurired is required tobesegeregated at the Point of generation as per the colour coding stipulated under Schedule| of BMWM Rule,2016 Following activites to be followed to ensure proper waste segregation:

- Waste must be segregated at the point the **point of generation** of source and not in later Stages. As defied earlier too**, "point of Generation"** means the location where Waste initially generate, accumulate and is under the control of docter / nusr Staff etc. Whp is proving treatment tp the patient and in the process generating bio- medical Waste.
- Posters/ placards for n bio- medical waste segregation should be provided in all the Wards as well as in waste storage area.

- Adequate number of colour coded bins / continers and bags should be availanele at The point of bio- medical waste.
- Colour coded plactic bags should be in line with the Plastic Waste Management Rules, Specifications for plastic bags and containers given at Annexure 1.
- Provide Personnel Provocative Equipment to the bio- medical waste handling staff.

2.1 Color Coding and Type of Container / Bags to be used for Waste Segregation& Collection

As per Schedule I of thr bio Medical Waste Management Rules, 2016 following colour Coding and type of container/ bags is needed to be used bu the HCFs for segregation and Collection of generated ni bio Medical Waste from the facility.

S. No.	Category	Type of waste	Colour & Type of Container
1.	Yellow Category	- Human Anatomical Waste - Animal Anatomical Waste - Soiled Waste - Discarded or Expired Medicine - Microbiology, Biotechnology and other clinical laboratory waste - Chemical Waste (yellow-e) - Chemical Liquid Waste	Yellow coloured non-chlorinated Plastic Bags   Note: (i) Chemical waste (yellow-e) comprising of un-used, residual or date expired liquid chemicals including spent hypo of X-Ray, should be stored in yellow container
2.	Red Category	Contaminated Waste (Recyclable)	Red Coloured Non Chlorinated Plastic Bags (having thickness equal to more than 50 µ) and Containers 

3.	White Category	Waste Sharps including metals	White Coloured translucent, puncture proof, leak proof, Temper Proof containers 
4.	Blue Category	• Glassware • Metallic Body Implants	Puncture proof, leak proof boxes or containers with blue coloured marking  

3 Bio Medical Waste Collection

3.1 Time of Collection

- Bio-medical waste should be collected on daily basis from each ward of the hospital at a fixed interval of time. There can be multiple collections from wards during the days.
- HCF should ensure collection, transportation, treatment, treatment and disposal of bio-medical waste as per BMWM Rules, 2016 and HCF should also ensure disposal of human anatomical waste, animal anatomical waste, soiled and biotechnology waste within 48 hours.
- Collection times should be fixed and appropriate to the quantity of waste produced in each area of the health care facility.
- General waste should not be collected at the same time or in the same trolley in which bio medical waste is collected.

- Collection should be daily for most wastes, with collection timed to match the pattern of waste generation during the day. For example, in a IPD ward where the moringRoutine begin with the changing of dressing, infections waste could be collected mid-moring to prevent solied bandages reming in the area for longer than necessary.
- General waste collection, must be done immediately ag the visiting hours of the HGFs, as visitors coming to facility generate a lot of general waste and in order to Avoid accoumlation of such general waste in the G The collecting timings must enabke the G to minize or nullify the use of interim storage of waste in the departments.
- Bio- medical waste collection by the staff. Should be provided with PPEs.

2 Packaging

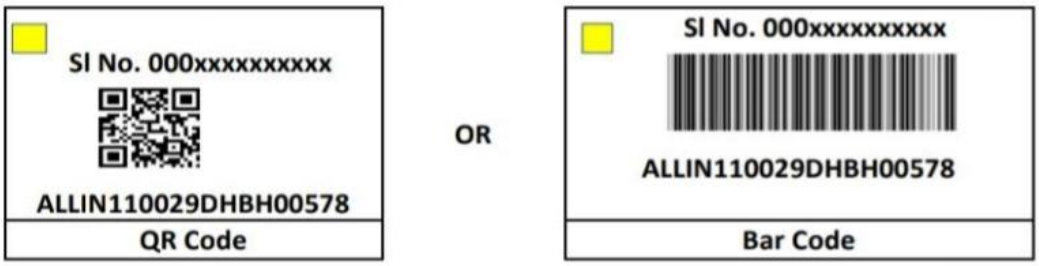
- Bio- medical waste bags and sharps containers should be filled to no more. Than three Quarters full. Once this level is reache, they should be sealed ready for collection.
- Plastic bags should never be stapled but may be tied or sealed with a plastic tag or Tie.
- Replacment bags or containers should be available at each waste – collection.location so that full ones can immediately be replaced.
- Colour coded waste bags abd and containers should be printed with the bio-hazard Symbol, labeled with detais such as date, type of waste, quantiy,senders name and receivers details as well as bar coded label to allow them to be tracked till final disposal.
- Final disposal. Ensure the a Bar coded stickers are pasted on each bag as per the guidelines of CPCB by 27 March, 2019

3 Labeling

All the bags/containers bins used for collection and storage of bio-medical waste, must Be labeled with the Symbole of Bio- Hazard

prCytotxic of bio- medical as the case my as per The type pf of waste in accordance with the BMWM Rules,2016 .

Bio- medical waste bags / containers are required to be provided with bar caode labels in accordance with CPCB guidelines for " Guidelines for barcode System for Effective Management of Biomedical Waste".



Bio-Hazard Label

Cyto-Toxic Label

3.4 Interim Storage

- Interim storage of bio medical waste is discouraged in the wards/ different departments of HCF
- If waste is needed to be stored on interim basis in the departments it must be stored in the dirty utility/sections.
- No waste should be stored in patient care area and procedures areas such as operation Theatre. All infectious waste should be immediately removed from such areas.
- In absence of dirty utilities/ sections such BMW must be stored in designated place away from patient and visitor traffic or low traffic area.

4 In House Transportation of Bio Medical Waste

4.1Transportation Trolley

In house transportation of Bio Medical Waste from site of waste generation/ interim storage of central waste collection centre, within the premises of the hospital must be done in closed trolleys/ containers preferably fitted with wheels for easy manoeuvrability. Such trolleys or carts are designated for the purpose of Bio Medical Waste Collection only. Patient trolleys must not be used for BMW transportation. Size of such waste transport trolleys should be as part

the volume of waste generated from the HCFs.

Typical waste collection trolley for Red category of BMW

4.2 Route of intramural transportion of bio-medical waste;-

Bio Medical Waste Generated from different wards or laboratories in the Health care facilities must be transported in the covered trolleys/carts through a route which has low traffic flow of patients and visitors.

Route of transportation preferably be planned in such a way that:

- Transportation does not occur through high risk areas
- Supplies and waste are transported through separate routes.
- Waste is not transported through areas having high traffic of patients and visitors
- Central Waste collection area can be easy accessed through this route
- Safe transportation of waste is undertaken to avoid spillage and scattering of waste

5 Central Waste Collection Room for bio-medical Waste

Each Healthcare facility should ensure that there is a designated central waste collection room situated within its premises for storage of bio-medical waste till the waste is picked and transported for treatment and disposal at CBWTF. Such room should be under the responsibility of a designated person and should be under lock & key. The following points may be considered for construction of central waste collection room:

- The location of central waste collection room must be away from the public/visitors access.
- The space allocation for this room must be as per the quantity of waste generated from the hospital.
- The Planned space must be sufficient so as to store at least two days generation of waste.
- Central waste collection room must be roofed and manned and should be under lock and key under the responsibility of designated person.
- The entrance of this centre must be accessible through a concrete ramp for easy transportations of waste collection trolleys.
- Flooring should be of tiles or any other glazed material with slope so as to ease the cleaning of the area.
- Exhaust fans should be provided in the waste collection room for ventilation.
- It is to be ensured by the health care facility that such central storage room is safety inspected for potential fire hazard for potential fire hazard and based on such inspection preventive measure has to be taken by the healty care facility like installation of fire extinguisher, smoke detector etc.
- There should also be provision for water supply adjacent to central waste storage area for coleaning and washing of this station and the containers. The drainage from the storage and washing area should be routed to the Effluent Treatment Plant.

- Sign boards indication relevant details such as contact person and the telephone number should be provided.
- The entrance of this station must be labelled with " Entry for Authorized Person Only" and Logo of bio medical Waste Hazard.
- It is to be ensured that no general waste is stored in the central waste collection area.

Other Considerations for Central Waste Collection Area

- To ensure there is no pilferage of recyclables, it is to be ensured that central storage area is under lock and key, guarded by a designated person.
- Healthcare facilities need to maintain the record of waste generated and handed over to the authorized recyclers.
- To ensure protection from the animals, it is to be ensured by the healty care facility that there is no stray anima in the health care facility premises and health care facilities has installed cattle traps at the entrance of the health care facilities.
- To ensure protection against the pests it is to be ensured by the HCFs. That it has engagement of the pest control agency for taking the pest control measures in the central storage area on regular basis.

5.1 Central Storage for HCFs Having Captive Treatment and Disposal System

For the health care facilities which are having captive treatment facility tor treatment and disposal of biomedical waste through incinerators, autoclaves/microwaves, shredders etc. within its premises must ensure that waste generated from the HCF is stored in this central waste collection area till it is transpo:ted to reception area of captive waste treatment facility within the premises.

For HCFs having its own treatment and disposal facility through u~i. of deep burial pits i.e. Primary Health Centres (PHCs) which doesn't fall

under coverage area of any CBWTF, interim Storage area used for daily waste collection will serve as Central Waste Collection Area. The collected waste is needed to be store in this place before it is disposed of by the deep burial pits as per the specifications given under the BMWM Rules, 2016.

6 Record Keeping

1. Every healthcare facility need to maintain the records w.r.to category wise bio-medical waste generation and its treatment disposal (either by captive facility or through CBWTF) on daily basis. (Please Refer to Annexure 2: Format for Bio Medical Waste Register I Record)

2. Category wise quantity of waste generated from the facility f'Yi.ust be recorded in Bio Medical Waste Register/logbook being maintained at central waste collection area under the supervision of one designated person.

3. A weighing machine as per the specifications given in CPCB guidelines for bar code system needs to be kept in central waste collection centre of the HCF having 30 or more than 30 nos. of beds for weighing the quantity of Bio Medical Waste.

4. HCFs having less than 30 beds shall maintain records of receipts printed by the CBWTF.

5. Records on Annual Report on bio-medical waste management submitted to SPCB/PCC

6. Records w.r.t. Accident Report submitted to SPCB/PCC including "Nill" report

7. Records shall be maintained on training on BMW Management including both i,C . Induction and in service training records.

8. Maintain records for Annual Health check-up of all the employees.

9. Maintain record on Immunisation of all the employees

10. Records shall be maintained w.r.t. minutes of meeting of Bio Medical Waste Management committee

11. Records shall be maintained indicating details of accident occurred including preventive and corrective actions taken by the HCFs in relation to such accidents.

12. Records for the operation of the biomedical treatment equipment installed, if any for the treatment of biomedical waste. Please refer Annexure 9 for format of logbook/records maintained for incinerator/plasma pyrolysis and autoclave/hydroclave

13. Records of testing of Effluent generated from health care facility

14. Record of recyclable waste (plastic/glass) handed over to the authorized recycler in kg/annum.

The records related to the handling of BMW by healthcare facilitki-s-needs to be retained for a period of five years.

7 Updating of Information in Website

All bedded healthcare •• facilities as prescribed under BMWM Rules,~ 19/80 ,e separate page/web link in its website for displaying the information pc, ,OJ, m .g to t hospital by 15/03/2020. The following information should be uploaded and updated time to time:

1. Contact Address and details of the Healthcare Facility :
2. No. of beds :
3. Details of :
   a) Authorisation under BMWM Rules, 2016:
   b) b) Consent under Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981 :
4. Quantity of bio-medical waste generation (in kg/day):

5. Mode of disposal of bio-medical waste (through CBWTF or through captive treatment facility):
6. Name and address of the CBWTF through which waste is disposed off (as applicable) :
7. n case, HCF is having captive treatment facility.
   a) bio-medical waste treated (in kg/day)
   b) Details of treatment equipment
   c) Total nos. and capacity of each treatment equipment (in kg/day)
   d) Operating parameters of the treatment equipment as per BMWM Rules, 2016
8. Monthly records of bio-medical waste generation (category wise):
9. No. of trainings conducted on Bio-medical Waste Management in the current year:
10. Stats of immunization of Health Care Workers involved in handling of BMW:

SEGREGATION, TREATMENT AND DISPOSAL OF BMW

1 Treatment Option for Bio-medical Waste

As per BMWM Rules, 2016 the treatment and disposal of BMW generated from the HCF must be carried out in accordance with Schedule I, and in compliance with the standards provided in Schedule II of BMWM Rules, 2016.

It is also emphasized in the rules that no healthcare facility shall est;,_blish on-site treatment and disposal facility for BMW, if a service of CBWTF is available within 75 kilometre of travelling distance of the facility. All the public healthcare facilities within reach of 75 kilometres of CBWTF needs to dispose of the BMW through such CBWTF only and are not allowed to establish its own treatment and disposal facility. For the public health care facilities especially in rural areas where there is no

CBWTF within range of 75 kilometres, the disposal of BMW can still be made through a CBWTF who is willing to provide treatment services and authorized by the concerned SPCB/PCC to operate in an area beyond 75 Km radial distance. In case of no reach to any CBWTF, the BMW generated from HCFs should be disposed in captive treatment and disposal facility or by deep burial pit as authorised by the respective SPCB/and as specified in these guidelines

The collection, treatment, processing and disposal options for ;.~oth the categories of healthcare facilities; having linkage with CBWTF or not having linkage with CBWTF, are detailed here as per Schedule I of BMWM Rules. 2016

Yellow Category

Type of Waste: Yellow (a): Human Anatomical Waste

Segregation

Human tissues, organs, body parts and fetus below the viability period. This includes, placenta and extracted tooth.

Type of bag and container

Collect the waste in yellow colored non chlorinated plastic U~g and store in yellow coloured container

Treatment and Disposal:

For HCF having linkage with CBWTF

No treatment of waste is required to be carried out at the health care facility except pre-treatment (sterilization) of Yellow (h) category waste by autoclaving/ microwaving/ hydroclaving or sterilize as per methods prescribed in WHO Blue book 2014. Yellow category waste along with pre-treated waste should be stored in central storage point and must be handed over to CBWTF. It is mandatory for each health care facility that dead fetus waste should be handed over to CBWTF in yellow bag with a

copy of theofficial Medical Termination of Pregnancy (MTP) certificate from the Obstetrician or the Medical Superintendent/ SMO/ CMO of the HCF.

For HCF without linkage to CBWTF

This waste should be disposed through Plasma Pyrolysis unit or twin chambered compact incinerator with 2 seconds retention time in secondary combustion chamber and adequate air pollution control devices to comply with revised emission norms prescribed under BMW Management Rules, 2016.

Disposal of the waste in the deep burial pit should not be practiced unless the hospitals is located in rural or remote isolated place. Use of deep burial pit should be as authorised by the respective SPCB/PCC.

Copy of official MTP certificate from the MO 1/C for fetus below the vitality period must be kept with the HCF.

Type of Waste: Yellow (b): Animal Anatomical Waste

Segregation

This waste include 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.

Type of bag and container

Collect the waste in yellow coloured non chlorinated plastic bag and store in yellow coloured container.

Treatment and Disposal:

For HCF having linkage with CBWTF

No treatment of waste is required to be carried out at veterinary hospital except pretreatment (sterilization) of Yellow (h) category waste (if applicable) by autoclaving/ microwaving/ hydroclaving or sterilize as per methods prescribed in WHO Blue book 2014. Yellow category waste along with pre-treated waste should be stored in central storage point and must be handed over to CBWTF.

For HCF having own treatment and Disposal facility

Animal anatomical waste should be disposed through Plasma Pyrolysis unit or twin chambered compact incinerator with 2 seconds retentioniJ time in secondary combustion chamber and adequate air pollution control devices to comply with revised emission norms prescribed under BMW Management Rules, 2016

Animal anatomical waste can also be disposed in captive deep burial pits only in case of those veterinary hospitals located in rural or remote isolated place. Use of deep burial pit should be as authorised by SPCB/PCC.

No treatment of waste is required to be carried out at the health care facility. As per BMW Rules, 2016 all the expired and discarded medicines including cytotoxic drugs expired 'cytotoxic drugs are either returned back to the manufacturer or are handed over to the CBWTF to be disposed of through incineration at temperature > 1200°C.

For healthcare facllltles where there no established system for returning the drugs to the manufacturer It Is recommended that the expired and discarded medicines are handed over only to CBWTF for disposing of through incineration.

For HCF having own treatment and Disposal facility

Expired and discarded medicines are required to be sent back to manufacturer or can be disposed though nearest common biomedical Waste or Hazardous waste incinerators with prior intimation to SPCBs./PCCs.

This waste can also be disposed through twin chambered captive incinerator with 2 seconds retention time in secondary combustion chamber, which can withstand a temperature of 1200°C and having adequate air pollution control devices to comply with emission norms.

Type of Waste: Yellow (e) - Chemical Waste

Segregation:

This waste comprises of chemicals used in production ot biological, discarded containers of chemicals and disinfectants etc. This includes solid or liquid residual chemicals used in HCFs.

Type of bag and container: Collect solid chemical waste in yellow coloured containers or non-chlorinated yellow plastic bag. Collect un-used, residual or date expired liquid chemicals in yellow container.

Treatment and Disposal:

For HCF having linkage with CBWTF

No treatment is required to be carried out at the facility. The chemical waste (liquid or solid chemicals) should be collected into different yellow coloured plastic containers, whereas empty chemical containers with residual chemicals should be collected in yellow bags and handover to CBWTF operator for final disposal by

incineration. It is required to specify the name of chemical on the yellow containers so that it would help CBWTF operator to decide whether to incinerate or transfer to Hazardous Waste TSDF for final disposal.

For HCF having own treatment and Disposal facility

Segregation:

Items contaminated with blood/body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components. This includes used infectious material such as caps, shoe-cover, blotting paper/gauze, wooden swab stick, paraffin blocks, indicators tapes and disposable Jsingle use non-linen based) masks and gowns.

Type of bag and container: Collect the waste in yellow coloured non chlorinated plastic bag and store in yellow coloured container

Treatment and Disposal:

For HCF having linkage with CBWTF

No treatment of waste is required to be carried out at the health care facility. Waste must be handed over to CBWTF

For HCF having own treatment and Disposal facility

Soiled waste should be disposed through Plasma Pyrolysis uni~.IOr in twin chambered compact incinerator with 2 seconds retention time in secondary combustion chamber and adequate air pollution control devices to comply with revised emission norms prescribed under BMW Management Rules, 2016. In absence of above, soiled waste can also be treated by autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or

combination of sterilization and shredding for ultimate disposal through waste to energy plants.

Soiled waste can also be disposed in captive deep burial pits only in case of the hospitals located in rural or remote isolated place. Use of deep burial pit should be as authorised by SPCB/PCC.

Type of Waste: Yellow (d) - Expired and Discarded Medicine

Segregation: Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc .. This includes cytotoxic drugs dispensed in dextrose I saline bottles and disposables used in delivery of cytotoxic drugs.

Type of bag and container: Collect all the expired and discarded medicines except for cytotoxic drugs waste in a separate yellow colored non chlorinated plastic bag (different form being used for human anatomical waste) and store in yellow colored container.

All the cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules. vials etc must be collected in separate yellow colored non chlorinated plastic bag labeled as cytotoxic hazard.

This waste should be incinerated in captive incinerator or it can be sent to nearby Hazardous Waste TSDF for final disposal

Type of Waste: Yellow (f) - Chemical Waste

Segregation:

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. Leftover, unused, residual or ,(, date expired liquid chemicals shall not be discharged as chemical liquid waste.

Type of bag and container:

Not applicable since this liquid waste containing waste chemicals is collected and pre-treated prior to disposal through Effluent Treatment Plant. However, recyclable liquid chemicals such as spent X-ray hypo should be collected in yellow containers and sold or given to only authorised recyclers for resource recovery.

Treatment and Disposal:

As per the BMWM Rules 2016, the chemical liquid waste of the hospital must be collected through a separate collection system for pre-treatment. Hospitals with large standalone labs shall install separate drainage system leadin!i/to pre-treatment unit prior to mixing the same with rest of the wastewater from hospital for further treatment. For middle and small healthcare facilities having no system of separate drainage/collection system, the liquid waste is required to collected on-site in containers for pre-treatment before mixing the same with other wastewater. Silver X ray film developing fluid should be given or sold to the authorized recyclers for resource recovery, else it should be handed over to CBWTF as yellow(e) chemical waste.

Depending on type of chemical effluent generated, pre-treatment should comprise of neutralization/precipitation, followed by disinfection prior to mixing with rest of the wastewater from hospital. Prior to mixing with rest of the hospital effluent, disinfection should be done preferably by passing the effluent through u,f sterilizer rather than using disinfecting chemicals since use of chemicals may affect performance of biological treatment in down-stream.

Type of Waste: Yellow (g) - Discarded Linen, Mattresses, beddings contaminated with Blood, body flulds, routine mask and gown.

Segregation

This includes discarded linen from bedsheets, beddings, re-usable routine masks and gowns.

Type of bag and container: Collect the waste in yellow coloured non-chlorinated plastic bag and store in yellow coloured container

Treatment and Disposal:

For HCF having linkage with CBWTF

Disinfect the waste linen with non-chlorinated chemical disinfection and hand over to the CBWTF operator for final disposal by Incineration. The waste mattresses should be cut into pieces and disinfected and can be sent to the CBWTF operator for final disposal by incineration. Alternatively, waste mattresses can be cut into pieces and disinfected with non-chlorinated chemicals for disposal as general waste (dry-waste) for energy recovery in cities having waste to energy plants or RDF (Refuse Derived Fuel) plants.

The waste mattresses shall not be sold or auctioned. Used bed sheets that are not soiled and re-usable can be sold or auctioned only after washing and disinfection. Disposable (single use non-linen based) masks and gowns, after use shall be treated as yellow-c (soiled waste).

For HCF having own treatment and Disposal facility

The waste mattresses after cutting into pieces and disinfected with non-chlorinated chemicals and can be incinerated in captive incinerator or can be disposed as General waste in dry bins in cities having RDF or waste to Energy Plants.

Type of Waste: Yellow (h) Microbiology, Biotechnology and Other Clinical Laboratory Waste:

Segregation:

Microbiology, Biotechnology and other clinical laboratory waste, waste blood bags (containing date expired or contaminated blood), Laboratory cultures, stocks or specimen of micro- organisms, live or attenuated vaccines, human cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures. This includes plastic culture plates and other highly infectious wastes.

Type of bag and container: Collect the waste in yellow coloured non chlorinated plastic bag and store in yellow coloured container

Treatment and Disposal:

For HCF having linkage with CBWTF

Pre-treatment by disinfection before handing over the waste to CBWTF operator. Pretreatment can be done by autoclave / microwave / Hydroclave.

Pre-treatment can also be done by USllQ non-chlorinated chemical disinfectants like a5dehydes, ime based powders or solutions, ozone gas, ammonium saHs and phenofic compounds.

The pre-treated waste bags should be handed over to CBWTF operator on daily basis .

For HCF having own treatment and DlspoUI faclility

Pre-treated waste should bedisposed off by a HCF by installing twin chambered compact incinerator with 2 seconds retention time in secondary combustion chamber and adequate air pollution control devices

to company with revised emission norms prescribed under BMW Management Rules, 2016.

Pre-treated waste can be disposed in captive deep burial pits rn case of the hospitals k>ca1ed m remote in rural or isolated places. Use of deep burial pit should be as authoosed by SPCB/PCC.

2. Red Category

Segregation:

Red category waste is contaminated recyclable waste containing primarily plastics generated from disposable items such as tubing, bottles, intravenous tubes and sets, cath6ta's. urine bags, syringes (without needles and fixed needle syringes with their needles cut), vacutainers and gloves. This includes waste pipette tips, plastic pipette, eppendort, rubber teats. drains, oxygen mask, thick plastic splash proof gowns, rubber apfon, ICT test cards, ELISA plate and vials not containing blood samples.

Type of bag and container: Colect the waste in red coloured non chlorinated plastic bag ar.d store in red cooured container

Treatment and Disposal:

For HCF havlng linkage with CBWTF

Contamireteo recyclable waste containing mainly plastics and rubber shall be put in red ccloored non chlo(inated pCastic bags and containers. Syringes after removing/cutting the .~ shootd also be pot in this category. Vacutainers/vials with blood samples should be Pf'ei-treated given at section 3.1 .1.h and disposed as yetlow-h category waste.

No or~ trcatmoot d Red ca1eg0f}' waste is requtred. All such waste is needed to be ~ rt to C8"'1/TF fo, final treatmeot and disposal

For HCF haYing own treatment and Disposal facility

All the recyclable waste generated from the HCF must be sterilized using autoclaving/microwaving / hydro-calving followed by shredding or mutilation or combination of sterilization and shredding. Recyclable waste must to be disposed of only through registered or authorized recyclers or to waste to energy plants or plastics to diesel or fuel oil or for road making, whichever is possible.

Chapter-5

Observation

Type of bag and container:

Puncture proof, leak proof boxes or containers with blue coloured marking

Treatment and Disposal:

For HCFs having linkage with CBWTF

Dispose of the empty glass bottles by handing over to CBWTF without any onsite treatment. The residual chemicals in glass bottle should be collect,~ as chemical waste in yellow coloured container/ bags and over to CBWTF as yellow(e) waste.

For HCFs having own treatment and Disposal facllty

The waste glass bottles / broken glass has to be sterilized or disinfected (either by autoclaving or microwaving or hydroclaving or by Sodium Hypochlorite Solution) followed by soaking & washing with detergent prior to sending it for recycling. Broken glass should also be disinfected and if the same cannot be given/or sold for recycling it can be disposed in sharps pit. The residual chemical in glass bottle should be collected as chemical waste in yellow coloured container/ bags as yellow(e) waste and send the same to either a CBWTF or common hazardous waste Treatment and Disposal Facility

Glass vials with positive controls should be pre-treated and disposed as yellow(h) waste.

Type of Waste: Blue (b) Metallic Body Implants

Segregation

Implants used for orthopaedic surgeries. This include metal sternal wire, Gigli saw wire and Orthopaedic Splint.

Type of bag and container:

Puncture proof, leak proof boxes or containers with blue coloured marking.

Treatment and Disposal: Dispose of the waste by handing over to CBWTF. In case of no access to CBWTF, metallic body implants should be disinfected (either by autoclaving or microwaving or hydroclaving or by Sodium Hypochlorite Solution) and later washed with detergent prior to sending/sold to metal recyclers.

Important Considerations

- The treatment of BMW must meet the standards for treatment of bio medical waste as specified in Schedule II of BMW Rules, 2016.
- The autoclave used for sterilization of waste blood bags, microbiology waste, including vials containing vaccine / positive controls must be dedicated for treatment of bio-medical waste only.

Type of bag and container:

Puncture proof, leak proof boxes or containers with blue coloured marking

Treatment and Disposal:

For HCFs having linkage with CBWTF

Dispose of the empty glass bottles by handing over to CBWTF without any onsite treatment. The residual chemicals in glass bottle should be collected as

chemical waste in yellow coloured container/ bags and over to CBWTF as yellow(e) waste.

For HCFs having own treatment and Disposal facility

The waste glass bottles / broken glass has to be sterilized or disinfected (either by autoclaving or microwaving or hydroclaving or by Sodium Hypochlorite Solution) followed by soaking & washing with detergent prior to sending it for recycling. Broken glass should also be disinfected and if the same cannot be given/or sold for recycling it can be disposed in sharps pit. The residual chemical in glass bottle should be collected as chemical waste in yellow coloured container/ bags as yellow(e;).waste and send the same to either a CBWTF or common hazardous waste Treatment and Disposal Facility.

Glass vials with positive controls should be pre-treated and disposed as yellow(h) waste

Type of Waste: Blue (b) Metallic Body Implants

Segregation

Implants used for orthopaedic surgeries. This include metal sternal wire, Gigli saw wire and Orthopaedic Splint.

Type of bag and container:

Puncture proof, leak proof boxes or containers with blue coloured marking.

Treatment and Disposal: Dispose of the waste by handing over ~ - CBWTF. In case of no access to CBWTF, metallic body implants should be disinfected (either by autoclaving or microwaving or hydroclaving or by Sodium Hypochlorite Solution) and later washed with detergent prior to sending/sold to metal recyclers.

Important Considerations

- The treatment of BMW must meet the standards for treatment of bio medical waste as specified in Schedule II of BMW Rules, 2016
- The autoclave used for sterilization of waste blood bags, microbiology waste, including vials containing vaccine /
- ETP will be necessary if discharge from HCF is connected with City's /Town's public sewerage network not having any terminal sewage treatment plant or if the HCF is not connected to public sewerage network. Treated wastewater from healthcare facility should conform to the standards of liquid waste as listed in schedule of BMW Rules, 2016.

  Bedded HCFs with >10 beds should establish Effluent Treatment Facility with immediate effect, while HCFs with 10<beds, ETP should be installed by 31st December, 2019.

- Chemical disinfection is to be performed by 1 - 2% Hypochlorite Solution or equivalent disinfection like aldehydes , lime , ammonium salts, phenolic compounds etc. (refer: WHO guidelines for infection control in health care facilities). Chemical disinfection performed must meet the standard of chemical disinfection as listed in schedule 2 of BMWM Rules., 2016. Refer to Annexure 6: preparation of Hypochlorite solution.
- HCFs may provide Bio-medical waste such as pleural fluid, ascetic fluid, HBsAG positive blood, placentra etc. only to the authorized vendors/ pharmaceutical industry involved in utilization of the same for production of drugs, reagent chemicals, markers, etc. An intimation in this regard shall be provided to concerned SPCBs.

Spill Management Procedures:

Healthcare Facility have to ensure environmentally sound management of mercury or other chemical spills.

In case of mercury spill, the following steps as given in CPCB guidelines on "Environmentally Sound Techniques for Mercury Waste Generated from Healthcare Facilities " shall be followed;

(1) Evacuate area; As far as possible , keep people who are not involved in the cleanup away from spill area to limit exposures and to prevent the spread of contamination.

(2) Put on face mask ; In order to prevent breathing of mercury vapour, wear a protective face mask .

(3) Remove jewelry so that the mercury cannot combine (amalgamate) with the precious metals.

(4) Put on rubber or latex gloves. If there are any broken pieces of glass or sharp objects, pick them up with care. Place all broken objects on a paper towel, fold the paper towel and place in a puncture proof yellow bag or container. Secure the plastic bag/container and label it as items contaminated with mercury.

(5) Locate all mercury beads and look for mercury in any surface cracks or in hard-to-reach areas of the floor. Check a wide area beyond the spill. Use the flashlight to locate additional glistening beads of mercury that may be sticking to the surface or n small cracked areas. Cardboard sheets may be ' used to push the spilled beads of mercury together'.

(6) A syringe (without a needle) shall be used to suck the beads of mercury. Collected mercury should be placed slowly and carefully into an unbreakable plastic container/glass bottle with an airtight lid half filled with water. After removing larger beads, use sticky tape to collect smaller hard-to-see beads. Place the sticky tape in a punctured proof yellow bag and secure properly. Commercially available powdered sulfur or zinc stains mercury a darker colour and can make smaller easier to see since (powder sulfer may be used because (1) it makes the mercury binds the mercury so that it

can be easily removed and suppresses the vapourization of any missing mercury).

(7) Place all the materials used during the cleanup, including gloves, mercury spills collected from the spill area into a yellow plastic bag or container with lid and sealed properly and labeled as mercury containing waste.

(8) Sprinkle sulphur or zinc powder over the area. Either powder will quickly bind any remaining mercury. I ncase , zinc powder is used, moisten the powder with water after it is sprinkled and use a paper towel to rub it into cracks in the flooring . Use the cardboard and then dampened paper towels to pick up the powder and bound mercury. Place all towels and cardboard in a yellow plastic bag and seal all the bags that were used and store in a designated area. All the mercury spill surfaces should be decontaminated with 10% sodium thiosulfate solution . keep a window open to ventilate after the cleanup . After ensuring all the mercury has been removed, resume normal vacuuming and utilize the cleaned area for routine operation .

(9) All the bags or container containing items contaminated with mercury should be marked properly and labeled as waste mercury containing. This waste shall be categorized as yellow-e chemical waste and shall be disposal as per the options given in flowchart(Figure 3).

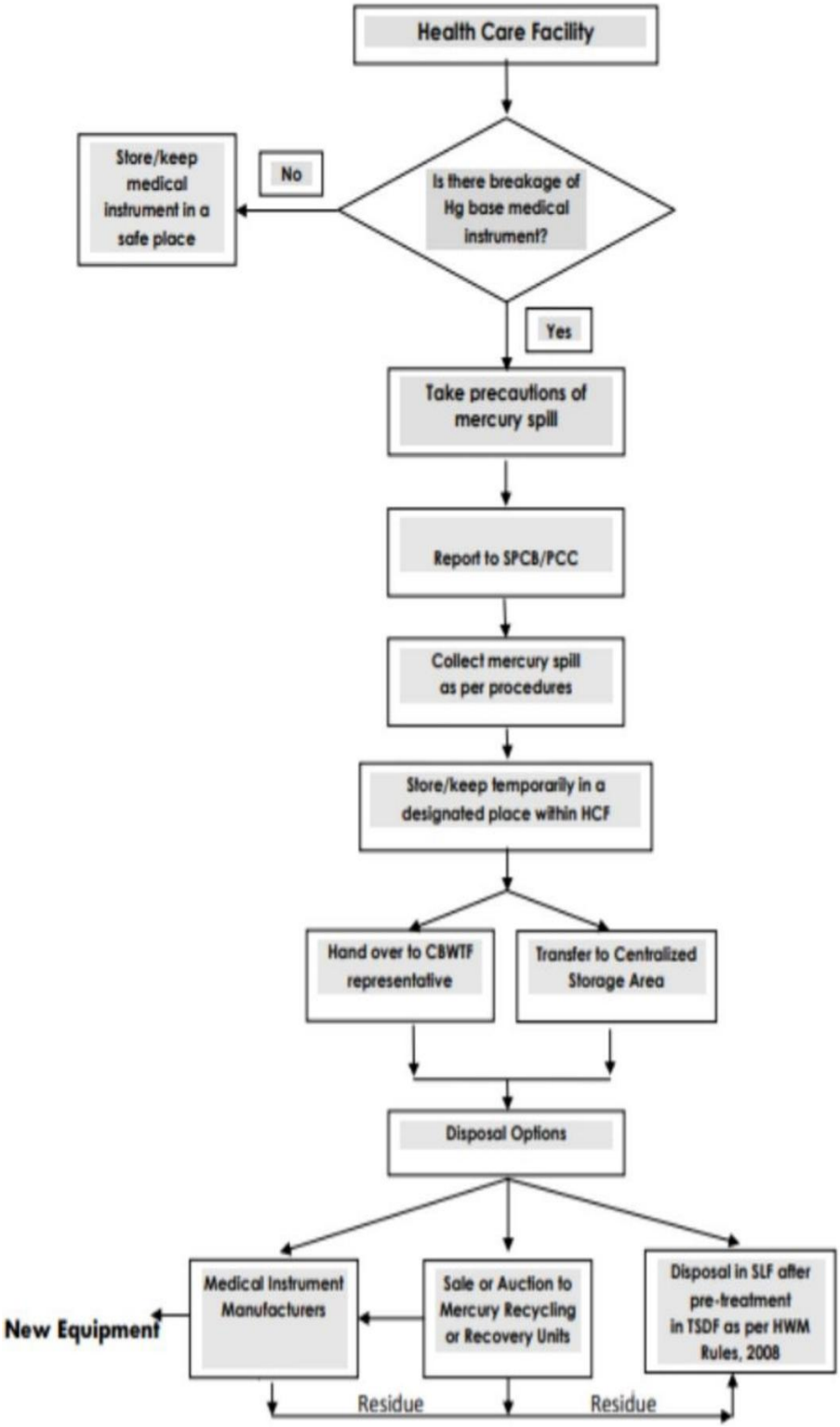


Figure 3: Flow chart showing management of mercury spills

Other chemicals spills should be absorbed in suitable absorption media such as dry sand, proprietary booms, absorbent pads etc. and collected separately. Waste collected from chemicals spills has to be categorized as yellow-e waste . which shall be collected in separate yellow bag and handed over to operator of CBWTF or Hazardous Waste TSDF (in case of captive facility).

3.1 Standards for incineration

All incinerators shall meet the following operating and emission standards-

A. Operating Standards

1. Combustion efficiency (CE) shall be at least 99.00%.
2. The combustion efficiency in computed as follows:
3. The temperature of the primary chamber shall be a minimum of 800 0c and the secondary chamber shall be minimum of 10500C+or -500c.
4. The secondary chamber gas residence time shall be at least two seconds.

B. Emission standards

S. NO.	PARAMETERS	STANDARDS	
(1)	(2)	(3)	(4)
		Limiting concentration in mg Nm3 unless stated	Sampling duration in minutes unless stated
1.	Particulate matter	50	30 or 1 Nm3 of sample volume whichever is more
2.	Nitrogen Oxides NO and NO2 expressed as NO2	400	30 for online sampling or grab sample
3.	HCL	50	30 or 1 Nm3 of sample volume whichever is more
4.	Total Dioxins and Furans	0.1 ng TEQ/Nm3 (at 11% O2)	8 hours or 5 Nm3 of sample volume whichever is more
5.	Hg and its compounds	0.05	2 hours or 1 Nm3 of sample volume whichever is more

C.Stack Height

Minimum stack height shall be 30 meters above the ground and shall be attached with the necessary monitoring facilities as per requirements of

monitoring facilities as per requirement of monitoring of' general parameters' as notified under the Environment (Protection) Act, 1986 and in accordance with the central pollution control board guidelines of emission regulation part-3.

Important considerations for captive incinerators

a. The existing incinerators shall comply with the above revised emission norms within a period of two years from the date of notification.
b. The existing captive incinerators shall with the standards for dioxins and furans of 0.1ng TEQ/Nm3, within two years from the date of commencement of these rules. To achieve the same, the existing secondary combustion chambers of the incinerator and the pollution control devices shall be suitably retrofitted if required to achieve the emission limits.
c. Ash from incineration of biomedical waste shall be disposal of at common hazardous waste treatment and disposal facility. However , it can also be disposed of in municipal landfill, if the toxic metals in incineration ash are within the regulatory quantities as defined under the hazardous waste (management and handling and transboundary movement) rules, 2008 as amended from time to time .
d. Waste to be incinerated shall not be chemically treated with any chlorinated disinfectants.
e. Only low sulphur fuel light diesel oil or low sulphur heavy stock or diesel, compressed natural gas, liquefied natural gas or liquefied petroleum gas shall be used as fuel in the incinerator.
f. Shall monitor the stack gaseous emission (during optimum operational capacity of the incinerator) once in three months through a laboratory approved under the environment (Protection) Act, 1986 and record of such analysis results shall be maintained and submitted to the prescribed authority. In case of dioxins and furans, monitoring should be done once in a year.

g. Shall install continuous emission monitoring system for parameters as stipulated by state pollution control board or pollution control committees in authorization and transmit the real time data should be transmitted to the servers at state pollution control board or pollution control committees and central pollution control board.
h. Incinerators (combustion chambers) shall be operated with such temperature , retention time and turbulence, as to achieve total organic carbon content in the slag and bottom ashes less than 3% or their loss on ignition shall be less than 5% of the dry weight.
i. Shall use combustion gas analyzer to measure CO2, CO and O2 periodically so as to operate incinerator at suitable conditions to achieve desired combustion efficiency.

Operating and Emission Standards for disposal by plasma pyrolsis or gasification:

i. Operating Standards

All the operators of the plasma pyrolysis or gasification shall meet the following operating and emission standards :

1. Combustion efficiency (CE) shall be at least 99.99%.
2. The combustion efficiency is computed as follows:
3. The temperature of the combustion chamber after plasma gasification shall be 1050+ 50c with gas residence time of at least 2(two) second, with minimum 3% Oxygen in the stack gas.
4. The stack height should be minimum of 30 m above ground level and shall be attached with the necessary monitoring facilities as per requirements of monitoring of ‘general parameters’ as notified under the environment (protection) Act, 1986 and in accordance with the CPCB guidelines of emission regulations part-3

ii. Air emission standards and air pollution control measures

1. Emission standards for combustion based incinerator shall be applicable for the plasma pyrolsis or gasification also.
2. Suitably designed air pollution control devices shall be installed or retrofitted with the 'plasma'.
3. Pyrolsis or gasification to achieve the above emission limits, if necessary.
4. Waste to be treated using plasma pyrolsis or gasification shall not be chemically treated with any chlorinated disinfectants and chlorinated plastic shall not be treated in the system.

iii. Disposal of ash vitrified material

The ash or vitrified material generated from the ' plasma pyrolsis or gasification shall be disposed at common hazardous waste treatment and disposal facility. However , it can also be disposed the regulatory quantities as defined at schedule 2 under hazardous and other waste management and handling rules, 2016. Vitrified slag may be utilized as sub-surface for road making with permission from concerned SPCB/PCCs.

3.3 standards for autoclave

The autoclave should be dedicated for the purpose of disinfecting and treating bio-medical waste.

1). When operating a gravity flow autoclave, medical waste shall be subjected to;

1) A temperature of not less than 121c and pressure of pounds per square inch (psi) for an autoclave residence time of not less than 60 minutes; or

2) A temperature of not less than 135 c and a pressure of 31 psi for an autoclave residence time of not less than 45 minutes;or

3) A temperature of not less than 149c and a pressure od psi for an autoclave residence time of not less than 30 minutes.

2) when operating a vacuum autoclave, medical waste shall be subjected to a minimum of three pre-vacuum pulse to purge the autoclave of all air. The air removed during the pre-vacuum , cycle, should be decontaminated be means of HEPA and achieved carbon filtration, steam treatment , or any other method to prevent release of pathogen. The waste shall be subjected to the following;

1) A temperature of not less than 121c and pressure of 15psi per an autoclave residence time of not less than 45 minute ;or
2) A temperature of no less than 135c and pressure of 31 psi for an autoclave residence time of not less than 30 minutes;
3) Medical waste shall not be considered as properly treated unless the time, temperature and pressure indicators indicate that the required time, temperature and pressure were reached during the autoclave process. If for nay reasons, time temperature or pressure indicators that the required temperature , pressure or residence time was not reached, the entire load of medical waste must be autoclave again until the proper temperature, pressure and residence time were achieved.
4) Recording of operational parameters ; each autoclave shall have graphic or computer recordings devices which will automatically and continuously monitor and record dated, time of day , load identification number and operating parameters throughout the entire length of the autoclave cycle.
5) Validation test for autoclave ; the validation test shall use four biological indicator strips, one shall be used as a control and left at room temperature, and three shall be placed in the approximate centre of three containers with the waste . personal protective equipment(gloves, face mask and coveralls) shall be used when opening containers for the purpose of placing the

biological indicators. At least one of the containers with a biological indicators should be placed in the most difficult location for steam to penetrate, generally the bottom centre of the waste pile. The occupier or operating conditions. The temperature , pressure and residence rime at which all biological indicators vials or strips for three consecutive tests show complete inactivation of the spores shall define the minimum operating conditions for the autoclave. After determining the minimum temperature, pressure and residence time, the occupier or operator of a common biomedical waste treatment facility shall conduct this test once in three months and records in this regard shall be maintained.

6) Routine Test: A chemical indicator strip or tape that changes colours when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different locations to ensure that the inner content of the packages has been adequately autoclaved. The occupier or operator of a coman bio medical waste treatment facility shall conduct this test during autoclaving of each batch and records in this regard shall be maintained.

7) **Spore testing:** The autoclave should completely and consistently kill the approved biological indicator at the maximum design capacity of each autoclave unit. Biological indicator for autoclave shall be Geo-bacillus-tearo-thermophilus spores using vials or spore strips; with at least 1X10 spores. Under nio circumstances will an autoclave have minium operating parameters less then a residence time of 30 minituts, a temperature less than 121o C or a pressure less than 15 psi. The occupier or operator of a common bio medical waste treatment and disposal facility shall conduct this test at least once in every week and records in this regard shall be maintained.

3.3.4 Standards of Microwaving

1) Microwave treatment shall not be used for cytotoxic, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items
2) The microwave system shall comply with the efficacy test or routine tests and a performance guarantee may be provided by the supplier before operation of the limit
3) The microwave should completely and consistently kill the bacteria and other pathogenic organisms that are ensured by approved biological indicator at the maximum design capacity of each microwave unit. Biological indicators for microwave shall be Bacillusatrophaeuss pores using vials or spore strips with at least 1 x 10 4 spores per detachable strip. The biological indicator shall be placed with waste and exposed to same conditions as the waste during a normal tre~;.ment cycle.

3.3.5 Standards for Efficacy of Chemical Disinfection

Microbial inactivation efficacy is equated to "Log10 kill" which is defined as the difference between the logarithms of number of test microorganisms before and after chemical treatment. Chemical disinfection methods shall demonstrate a 4Log,o reduction or greater for Bacillus Subtilis (ATCC19659) in chemical treatment systems.

3.3.6 Standards for Dry Heat Sterilization

Waste sharps can be treated by dry heat sterilization at a temperature not less than 185°C, at least for a residence period of 150 minutes in each cycle, which sterilization period of 90 minutes. There should be automatic recording system to monitor operating parameters.

(i) Validation test for Sharps sterilization unit ;.c. Waste sharps sterilization unit should completely and consistently kill the biological indicator Geobacillus Stearothermophillus or Bacillus Atropheausspores using vials with at least log106 spores per ml. The test shall be carried out once in three months

(ii) Routine test A chemical indicator strip or tape that changes colour when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste to ensure that the inner content of the sharps has been adequately disinfected. This test shall be performed once in week and records in this regard shall be maintained.

3.3.7 Standards for Liquid Waste

1) The effluent generated or treated from the premises of bedded HCFs before discharge into the sewer should conform to the following limits

Parameters	**Permissible Limits**
pH	6.5-9.0
Suspended solids	100 mg/l
Oil and grease	10 mg/1
BOD	30 mg/1
COD	250 mg/1
Bio-assay test	90% survival of fish after 96 hours in 100% Effluent.

2) Sludge from Effluent Treatment Plant shall be given to common bio-medical waste treatment facility for incineration or to hazardous waste treatment, storage and disposal facility for disposal

Note-

1) Above limits are applicable to all bedded Health Care Facilities in case their; - discharge line is connected to public sewerage network,

which is not having terminal sewage treatment plant; or - discharge line is not connected to public sewers

Health Care Facilities meeting above criteria but having less than ten beds are given time till 31st December, 2019 to set up suitable effluent treatment plants and to comply with above standards

2) In case discharge from HCF is connected to a public sewerage network having terminal Sewage Treatment Plant, then general discharge standards as notified under the Environment (Protection) Act, 1986 (29 of 198€?shall be applicable (as given at Annexure 8):

3) Non-bedded occupiers shall dispose infectious liquid wastes only after treatment by disinfection as per Schedule - II (6) of the principal rules.\

3.4 Standards for Deep Burial

- Yellow (a), (b) and (c) wastes namely human anatomical, animal anatomical and soiled waste are permitted for deep burial only in rural or remote areas where there is no access to common bio-medical waste treatment facility after obtaining authorization from SPCB/PCCs.
- A pit or trench should be dug about two meters deep. It should 1 6e half filled with waste, and then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.
- It must be ensured that animals do not have any access to burial sites. Covers of galvanized iron or wire meshes may be used
- On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.
- Burial must be performed under close and dedicated supervision
- The deep burial site should be relatively impermeable and nq,tShallow well should be close to the site.

- The pits should be distant from habitation, and located so as to ensure that no contamination occurs to surface water or ground water. The area should not be prone to flooding or erosion.
- The location of the deep burial site shall be authorized by the prescribed authority i.e CPCB/ SPCB or District Pollution Control Board Office.
- The institution shall maintain a record of all pits used for deep burial.
- The ground water table level should be a minimum of six meters below the lower level of deep burial pit.

3.5 Suggested method for design of concrete pit for waste sharps

If required, a sharp pit must be constructed within the hospital premise to dispose of the sharp waste generated from the facility. Prior to disposal in concrete pit, sharps waste should be disinfected and treated in following methods;

Autoclaving along with sharp containers followed by shredding or mutilation;

-Combination of shredding cum autoclaving along with sharp containers

-Sharp pit must be a 1 m x1 mx1 m concrete lined circular or r()'ctangular pit as shown in figure 4.

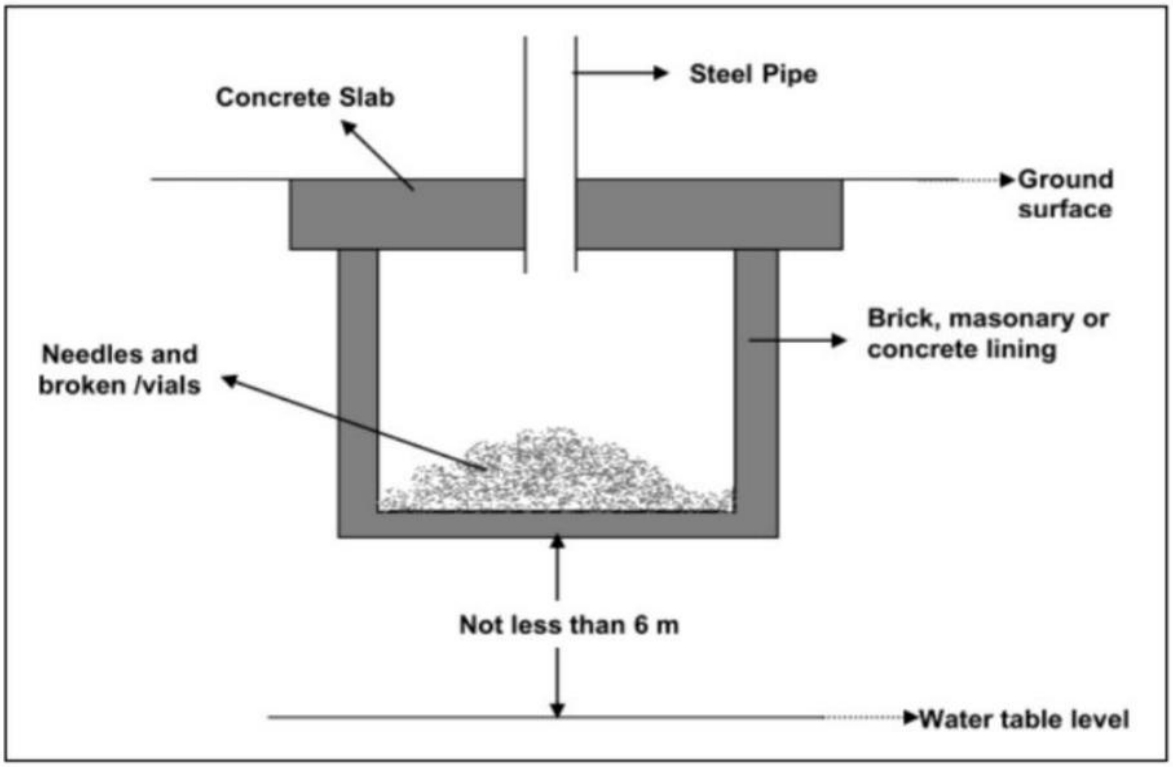
-Pit can be dug and lined with brick, masonry or concrete rings

-The pit should be covered with a heavy concrete slab, in which a galvanized steel pipe of about 1.0m height and suitable diameter is fixed to feed the shredded or mutilated sharps waste.

-The top opening of the steel pipe shall have a provision of locking after the treated waste sharps has been disposed in

-The pit should be covered with a heavy concrete slab, in which a galvanized steel pipe of about 1.0m height and suitable diameter is fixed to feed the shredded or mutilated sharps waste.

-For high water table regions where water table is less than 6m beneath bottom of the pit, a tank with above mentioned arrangements shall be made above the ground.



Layout of sharp pit for disposal for sharp waste .

3.6 Effluent Treatment Plant

Effluent Treatment Plant should be provided in every HCF to treat the wastewater generated from the hospital in order to comply with the effluent standards prescribed under the BMWM Rules, 2016. Sources of wastewater generation from the hospital are wards, laboratories, used disinfectants, floor washing, washing of patients area, hand washing, laundry, discharge of accidental spillage, firefighting, bathroom/toilet etc. Liquid waste generated due to use of chemicals or discarded disinfectants, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-

keeping and disinfecting activities should be collected separately and pr~..ttreated prior to mixing with rest of the wastewater from HCF.

The combined wastewater should be treated in the ETP having three levels of treatment; primary, secondary and tertiary;

- Primary Treatment: equalisation, neutralization, precipitation and clarification

- Secondary Treatment: High rate aerobic biological treatment, secondary settling tank
- Tertiary Treatment: Pressure Filtration, Disinfection and disposal to drain/sewer

Typical flow chart for the Effluent Treatment Plant is given below:

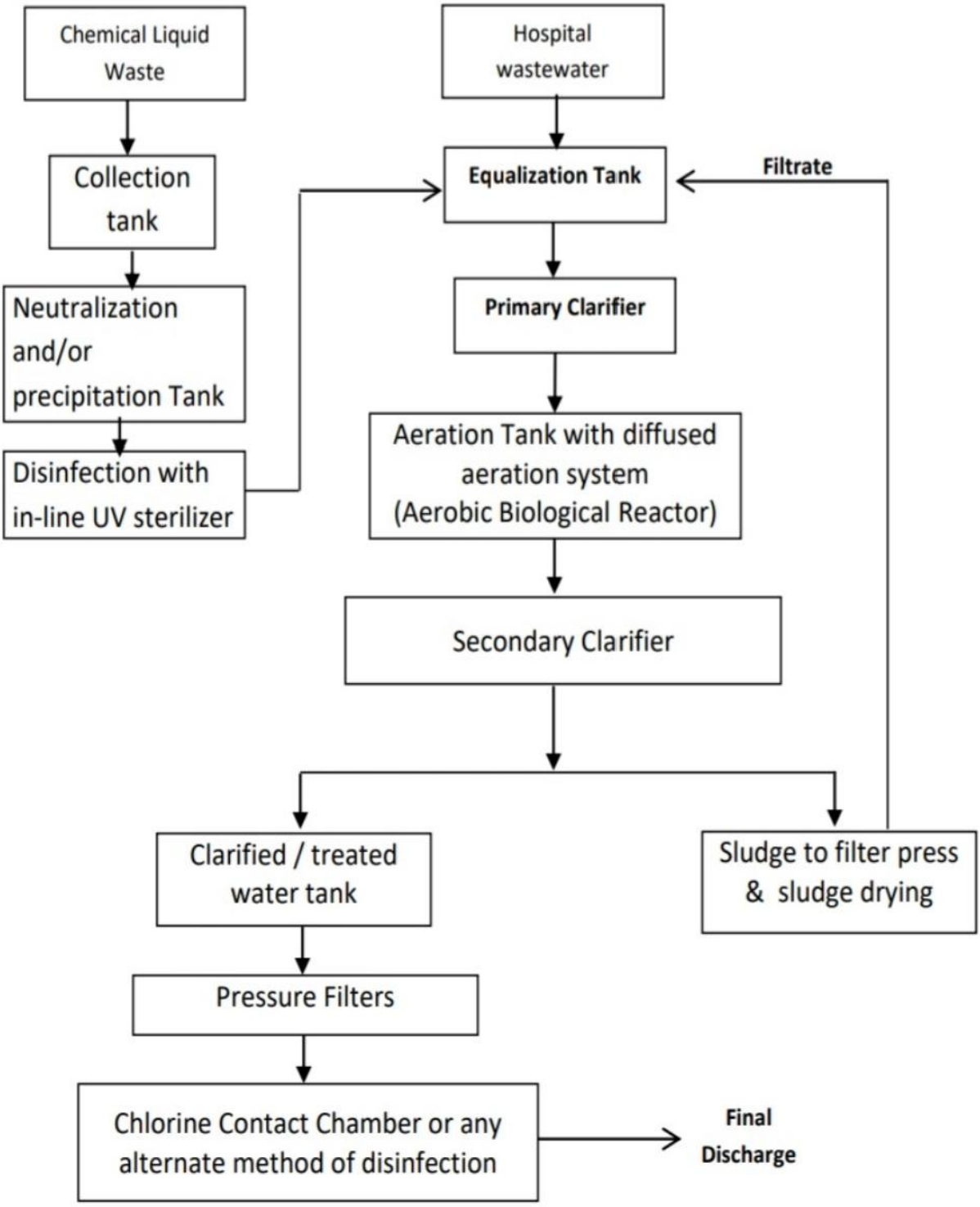


Figure-4 scheme of waste water

Options for reuse of treated wastewater: Wastewater generated from the HCF is treated in the ETP and shall be disposed into drain / sewer or could be reused in: Flushing, Horticulture, and Scrubber.

Chapter – 6

Summary & conclusion

BMW MANAGEMENT AT OUTREACH ACTIVITIES AND BY OCCASIONAL GENERATORS

n public health care facilities, each HCF is performing some outreach activities by providing ;ervices to the population outside the premises of HCF. Some of such activities like immunization >rogrammes and home delivery services generate bio medical waste and are needed to be 1andled in order to avoid any harm to environment and human health.

This section provides the details of the activities needed to be carried out by the health care vorkers during such activities so as to ensure that handling of the BMW generated from these ictivities are done as per the BMW Rules, 2016. This section details about the responsibility for nanagement of BMW during such activities, steps of BMW management for outreach activities md collection, treatment and disposal methods of BMW generated during such outreach 1ctivities.

4. 1 Responsibility

The occupier of the health care facility organising the outreach activities is totally responsible for ensuring that waste generated during such activity is properly segregated, collected, treated and disposed of as per BMWM Rules. 2016.

4.2 Out Reach Activities

Health Care Facility may provide any of the outreach services given below;

- Blood donation camps/Health camps;
- Home delivery by Skilled Birth Attendant (SBA);

- Antenatal Care:
- Point of care diagnosis;
- Immunization
- Family Planning activities;
- Other similar activity

During the above activities, the bio medical waste generated is required to be segregated, collected at the site of generation itself and has to be transported back to HCF for treatment and disposal. Alternatively, arrangement can be made with CBWTF operator to pick-up the segregated waste directly from camp-site after completion of activity. Anatomical waste and soiled waste needs to be treated and disposed within 48 hours once generated during the above activities.

4.3 Steps for Bio Medical Waste Management for Out Reach Activities

1 . Segregate biomedical waste at the point of generation i.e. during the outreach activity

2. Collection and packaging of waste in colour coded and bar code labelled bags/containers

3. Transportation of waste from outreach activity site to HCF or make arrangement with nearby CBWTF to collect the waste directly after completion of outreach activity

4. Treatment & disposal at HCF or CBWTF

4.4 Bio-Medical Waste Management by Occasional Waste Generators

Occasional bio-medical waste generator like first aid rooms at school, colleges, research laboratories at institutions, blood banks, health camps, first air rooms at companies, etc. are also required to dispose the bio-medical waste generated waste as per the provisions of BMWM Rules, 2016. Occasional generators are also requir~.d to obtain (one time) authorisation from the prescribed authority

under BMWM Rules, 2016. Following are the guidelines for the occasional bio-medical waste generators:

1) Obtain one-time authorisation under BMWM Rules, 2016 from the prescribed authority;
2) Obtain one-time authorisation under BMWM Rules, 2016 from the prescribed authority;
3) Inform CBWTF operator to pick-up bio-medical waste as and when it is generated
4) Segregate the bio-medical waste as per colour coded cata9ories stipulated under BMWM Rules, 2016;
5) The colour coded bags/containers should be labelled with bar code label (provided by the operator of CBWTF or any authorised vendor).
6) It shall be ensured that anatomical waste, soiled waste and biotechnology waste if generated is treated & disposed within 48 hours.
7) Maintain record pertains to quantum of category wise bio-medical waste generated and treated.

MANAGEMENT REQUIREMENTS

1. Role of Health Care Facillty

As per the BMWM Rules, 2016, the liability for implementing th1 ~e rules lies with the person having administrative control over the healthcare facility. This person in BMWM Rules is termed as an "Occupier" and defined as" a person having administrative control over the institution and the premises generating bio-medical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank, health care facility and clinical establishment, irrespective of their system of medicine."

In the context of public health systems in India, the role of an Occupier will be performed by designated Medical Superintendent

(MS)/Chief Medical Officer (CMO)/Senior Medical Officer (SMO)/ Principal Medical Officer (PMO) of the District Hospital, Sub Divisional
Hospital and Community Health Centre (CHC).

ln case of Primary Health Centre (PHC) and Sub Centre, the duties of occupier are to be performed by designated Medical Officer in charge (MO 1/C) of the PHC

The CMO/ SMO/ MS/Medical Officer in charge of the HCFs is responsible and liable for implementing, monitoring and review of activities related to Bio Medical Waste Management.

1.1 Responsibility of the Healthcare Facility

It is the overall responsibility of the in charge of the HCF to take all necessary steps to ensure that bio-medical waste is handled without any adverse effect to human health and the environment and in accordance with the BMWM Rules, 2016

He/she has to ensure that the BMW generated from the Health Care Facility is properly segregated, handled, stored, packaged, transported and disposed of, as per these guidelines to ensure successful implementation of BMWM Rules, 2016.

Over all roles and responsibility of the Health Care Facility is given in figure 5.

As per the provisions under BMW Management Rules, 2016, the following responsibilities have been bestowed upon Healthcare facilities;

- To ensure that all the legal requirements related to the Bio Medical Waste Management are complied with and are regularly updated.
- To ensure that annual reports and accidents reports are submitted to SPCB in a timely manner.
- To ensure that bio-medical waste is handled without any adverse effect to human health and the environment
- To make a provision within the premises for a safe, ventilated and secured location for storage of segregated biomedical waste at central storage area.
- To ensure that there shall be no secondary handling, pilferage of recyclables or inadvertent scattering or spillage by animals.

- To ensure that bio-medical waste from central storage area or the premises shall be directly transported to the common bio-medical waste treatment facility for the appropriate treatment and disposal
- To ensure pre-treatment of yellow-h waste comprisi;,g of microbiology, biotechnology and other clinical laboratory waste, waste blood bags (containing date expired or contaminated blood), Laboratory cultures, stocks or specimen of micro- organisms, llve or attenuated vaccines, human cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures and other highly infectious wastes before handling to over to CBWTF for final disposal.
- To pre-treat vacutainers/vials containing blood samples and handover to CBWTF as Red category waste.
- To ensure that all the requirements related to establishment of a pre-treatment facility within its premises (as given at section 3.1.1.h) fully complies with standards stipulated under BMWM Rules, 2016
- To phase out use of chlorinated plastic bags (excluding blood bags) and gloves by 27 March, 2019.
- To ensure that the solid waste other than BMW is disposed of as per Solid Waste Management Rules, 2016.
- To establish a bar-code system for bags or containers containing bio-medical waste destined for disposal at CBWTF or captive treatment and disposal facility before 27th March, 2019.

- To ensure all the staffs of HCFs are provided regular training on BMW handling both at the time of induction and on annual basis as well
- To ensure occupational safety of all the employees through annual health checkups, immunization and provisions of appropriate and adequate PPEs

- To ensure that BMW Register is maintained and is updated'1on day to day basis
- Bedded HCFs to ensure uploading annual records of the biomedical waste generated on its website by 15 March, 2020.
- To immediately inform the SPCB in case of any lapse by waste collection agency or CBWTF in collection of waste from the HCF.
- To ensure that all the activities of BMW management are monitored and reviewed.
- To ensure that the committee formed for monitoring and review of BMW management is functioning properly.
- To ensure that all the records related to BMW Management are maintained by HCF.

The above listed responsibilities are detailed in these guidelines, laying down steps needed to be undertaken by health care facility to fu~il these responsibilities

2 Authorization

.2.1 Responslblllty

"Authorization" means permission granted by the prescribed authority for the generation, collection, reception, storage, transportation, treatment, processing, disposal or any other form of handling of bio-medical waste in accordance with these rules and guidelines issued by the Central Government or Central Pollution Control Board (CPCB) as the case may be;

As per BMWM Rules, 2016, every hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank, health care facility and clinical establishment, irrespective of their system of medicine and by whatever name they are called are required to obtain authorization from the prescribed authority i.e. State Pollution Control Board/ Pollution Control Committee, as the cast ·may be. Validity of authorization in case of bedded health care facilities will be synchronized with the validity of the consents.

Armed Forces Healthcare Establishments shall obtain authorization from DGAFMS.

Overall responsibility of having valid authorizations and consents under various acts lies with the In-charge of the health care facility.

Authorization under Bio-Medical Waste Management Rules, 2016

Procedure for Authorization

In charge of the health care facility needs to apply to the respective S~ate Pollution Control Board (SPCB) in respect of States or Pollution Control Committees (PCC) in respect of Union Territories for fresh or renewal of authorization, for the activities being carried out in handling of Bio Medical Waste Management by the health care facility.

Application

Application must be submitted to the respective SPCB/PCC for fresh or renewal of authorization in prescribed format as per Form II as prescribed under Bio Medical Waste Management Rules. 2016 given at Annexure 3

Information requirements of Application

- Particulars of Health Care Facility: Name, Address, Contact Details etc
- Validity of Consents under Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981 (in case of bedded HCFs)
- Detail of HCF: Number of beds, Average number of patient treated per month
- Category wise Quantity of Waste Generated or disposed by the health care facility
- Detail of any treatment facility available in the premises of health care facility

Grant of Authorization

Upon verification and ensuring the HCF is having requisite facilities, the authorization is granted by the respective State Pollution Control Board (SPS13)1Pollution Control Committee (PCC) in a prescribed form, with unique number of authorization and date of issue.

(b) For non-bedded Healthcare Facilities

One-time authorization is required to be obtained from respective SPCBs.lPCCs in case of non-bedded health care facilities such as clinic, dispensary, veterinary. institution, animal house, pathological laboratory, blood bank, etc. These HCFs have to apply for a fresh authorization to amend earlier authorisation in case there is any change or variance in relation to the activities of HCF.

Authorization for non-bedded HCFs shall be deemed to have been granted, if not objected by the prescribed authority within a period of ninety 8ays from the date of receipt of duly completed application along with such necessary documents

2.3 Approval for Deep Burial Pits (For HCFs Not Under Agreement with CBWTF)

2.4 HCF if intends dispose BMW through deep burial pits, they shall obtain authorization from the respective prescribed authority i.e. SPCB/PCC office for establishment of deep burial pits and records of such pits needs to maintained.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-Ill. The deep burial facility shall be located as per the provisions and guidelir.'as issued by Central Pollution Control Board from time to time.

2.4 Agreement with Common Bio Medical Waste Treatment Facility (CBWTF)

Each health care facility which is situated within reach of 75 kilometres of CBWTF needs to have a valid agreement with authorised CBWTF for treatment and disposal of Bio Medical Waste generated from the HCF. HCFs located beyond 75Km may also join the CBWTF if operator is capable and willing to provide the services as required under BMW Rules, 2016.

It has to be ensured by the HCF, that the CBWTF operator collects the waste within a specified time, and the untreated biomedical waste especially untreated human anatomical, animal anatomical, soiled waste and biotechnology ;.l\laste is treated and disposed within a period 48 hours. Agreement must also specify the responsibilities of CBWTFs and payment conditions including options such as supply of non-chlorinated bags, supply of bar-coded labels, etc.

3. Reporting to State Pollution Control Board or Pollution Control Committee

3.1 Annual Reporting

As per the Bio Medical Waste Management Rules, 2016, the healthcare facility is required to submit the Annual Report to the SPCB/PCC on or before 30th June every year, tor the period from January to December of the preceding calendar year.

The annual report should be filled in the prescribed format as per the Form IV prescribed under BMW Management Rules, 2016.

The annual report contains details of following:

- Particulars of Occupier/ HCF
- Quantity of waste generated in kg/annum
- Details of storage, treatment, transportation, processing and disposal facility
- Details of training conducted on Bio Medical Waste Management

- Details of accident Occurred
- Details Emission and Effluent testing

Annual Report submitted to the State Pollution Control Board or Pollution Control Committee must also be enclosed with following details:

- Training imparted to the Health Care Workers involved in handling of bio-medical waste
- Minutes of Meeting of BMW Management Committee
- Details of Accident Occurred during one year, along with the remedial steps taken
- Records of testing of Emission of DG Sets/ boilers
- Records of Effluent generated and its characteristics from health care facility
- Records of pre-treatment of specified waste categories Record of recyclable waste handed over to the authorized recycler in kg/annum (where captive treatment facility is allowed by the SPCB/PCC)
- Records of health status of the Health Care Workers involved in handling of biomedical waste
- Records of immunisation of Health Care Workers involved in handling of biomedical waste

Each healthcare facility must also ensure that the annual report submitted to the concerned SPCB/PCC is also published in its own website

Please refer to Annexure 4: FORM IV: Annual Report

Accident Reporting

Any accident occur during the handling of Bio Medical Waste in the healthcare facility is having potential to either harm the environment or safety of the human health must be recorded by the HCF.

As per the Bio Medical Waste Management Rules, 2016, the accident~ are classified into two categories; major and minor.

Major Accidents

Major accidents include but not limited to following

- Toppling of the truck carrying bio-medical waste
- Accidental release of bio-medical waste in any water body

Chapter -7

Refferences

References :-

Acharya DB. Meeta S, (2000) Hoipital Waste Management. Mi11en1 a ?fess. New Delhi 2000.pp 15,47

Almuneef M. Memish Z. (2003) Effective medical waste management: ii can be done. J\merinm Journal of/nfectian Control. 31. JSR-192.

Anonymous (1998). Biomedical waste (management and handling) rules. The Gazette of India. Extraordinary. Part II, Section 3{ii), dated 27th July. pp. 10-20. 460. Ministry of Environment and Forests. Notification N. S.O.630 (E)

Anonymous. (1997) World Health Organization, Regional Office of South East Asia. Safe Management of Wastes from Health Care Activities

Anonymous. (2000) Guide lines for common hazardous waste incineratio11 Central Pollution Control Board Ministry of Environment & Forests Hazardous Waste Management Series HAZW AMSi30/2005-06

Askarian M. Vakili M. Kabir G. (2004) Hospital waste management status in university hospitals of the Fars province. Iran. Int. J. Environ. Health Res. 14. 295-305

Askarian M . Yakili M. Kabir G (2004b) Results of n hospirnl waste survey in private hospitals in Fars province. Iran. Wa.,te Manage. 24. 347-352.

Baccini P. Brunner P. (1991) The Meraboli.,m of th,· A11thrupmphere, Springer Vcrlug. Berlin. 1991 Baveja. G .• Muralidhar, S. & Aggarwal, P.(2000) Hospital waste management- 11n overview. Hospital Today , 5, 9 485-486.

Bdour A. (2004) Guideline for the Safe Management of Medical. Chemical. and Pharmaceutical Waste. National Institute for E11viro11111enta/ Training, Riyadh. Saudi Arabia

Burd M. (2005) Reducing the risks related to the hnndling 1111d disp<>6111 of healthcare waste. Prof. Nurses 20. 40--42.

Chitnis V, Chilnis S. Patil S. Chitnis OS. (2002) Is Inefficient In Decontaminating Blood Containing Hypodermic Needles. /11ditm J Med Miaohiol; 20, 215-218

Chitnis V, Chitnis S, Patil S, Chitnis DS. (2003) Tremment of discarded blood units: disinfection with hypochlorite/formalin verses ste11m sterili1.ution. /11di,111 J Med Micmbiol 21, 265-267.

Chitnis V. Patil S. Chitnis OS. (2000) Ravikant Hospital Effluent: A Source of Multi drug Resistant Bacteria. Current Sciences 79, 535-540.

Chitnis V. Vaidya K, Chitnis OS, (2005) Biomedical waste in laboratory medicine: Audit and management. Indian Jo11mal of Medical Microbiology. 23 (I):6-13 ·

Code A. Christen J. (1999) How are we managing our healthcare wastes'? St. Gallen, Switzerland: SKAT.

CPHEEO (1998) Hospital medical waste management practices in ')1umbai. hulustrial Safety Chronicle. Oct-Dec. pp 77.

Da Silva. CE. Hoppe AE, Ravanello MM. Mello N. (2005) Medical wastes management in the south of Brazil. Waste Manage. 25, 600-605

Das NK. Sushant P. Jayaram K. (2001) A TQM Approach to Implementation of Handling and Management of Hospital Waste in Tata Main Hospitals. The official Journal of the Indian Society of Health Administrator. 11. ·15-78.

Gayathri VP, Kamala P, (2005) Biomedical solid waste management in an Indian hospital: a case study. Waste Management. 25, 6, pp.592-599.

Glenn McR, Garwal R, (1999) Clinical waste;,, Developing Co1111tries. An analysis with a Case Study of India. and a Critique of the Basie- TWG Guidelines

Gupta SP, (1998) Statistical Methotls. Revised & Enlarged. S. Chand & Sons. New Delhi, India.

http://health.delhigov1.nic.in/Health/files/bio .html

http://isebindia.com/95-99/99-07-2.html

http://kspcb.kar.nic.in/BMW

http://mpcb.mah.nic.in

http://www.ipaiindia.org/files/2007.pdf

Info Nugget. (2003) Hospital Waste Managemem and Bio-degradable Waste. Government of India. Press Infonnation Bureau. (http://www.sciencedirect.com/science)

Jaswal PS. Jaswal N. (2000) Environment Law, Allahabad Law Agency, Harayana, India

Kela M. Nazareth S, Goel A, Agarwal R, (2000) Managing Hospital Waste A G11ide for Health-Care Facilities. New Delhi

Kelkar R. (1998) A practical approach to hospital waste management in India. Industrial Safety Chronicle. Oct-Dec. pp. 67-70

Machala Z. Janda M, Hensel Kl, Jedlovsky, Lestinska L, Follin, V, Martisovits. V. Morvova M. (2007) Emission spectroscopy of atmospheric pressure plasmas for bio-medical and environmental applications. J. of Molecular Spectroscopy, 24:l. 194-201

Malviga K. (1999). Existing Solid Waste Management from Hospitah. MSc Dissertation. Devi Alivya University, Indore, India

Management and Handling Rules (1998) Notification: Bio-medical Waste Ministry of Environment and Forests, GOI (E), part 3(ii), New Delhi.

Manohar D. Reddy PR. Kotaih B. (1998) Charm:terization of solid waste of a super speciality hospital - a case study. hut. J. Environ. H(!(i/th, 40, 319-326

Marinkovic N. Vitale K, Afric I, Janev HN, (2005) Hazardous medical waste management as a public health issue. Arh Hig Rada Toksikol. 56, 21-32.

Mehta. G. (1998) Hospital Waste Management. National Guidelines (Draft) prepared for GOUWHO project IND EHH DOI.Lady Hardinge Medical College and Associated Hospitals, New Delhi.

Ministry of Health and Family Welfare. Government of India (1998) Health Information of India (1995 &1996) 131-136. New Delhi: Central Bureau of Health Intelligence Directorate General of Health Services, Ministry of Heahh and Family Welfare, Governlllent of India.

Ndiaye P. Fall, C. Diedhiou A. Tai-Dial A. Diedhiou O. (2003) Biomedical waste management in the Regional Hospital Center of Ziguinchor. S1111te. 13, 171-176.

Neema SK. Garcshprasad KS. (2002) Plusma pyrolysis of medical waste. C.'htre/11 Science, 83. 3

CERTIFICATE

This is to certify that Mrs. Ankita Chaturvedi D/O Mr. Radhe shyam Chatuevedi has conducted her M.Sc. Dissertation work titled"**A case study on bio-medical waste management**" at Girraj ji children hospital Gurugram (Haryana)under my supervision.

This is being submitted to fulfill the partial requirement for the award of degree of M.Sc. Environmental Science, under the Department of Environmental science of St. Wilfred PG College, affiliated to University of Rajasthan ,Jaipur (Rajasthan**)**

Date:

Jaipur **(Dr. Prerna Sharma)**

DECLARATION

This is to certify that the Dissertation work entitled "**A case study on bio-medical waste management**" at Girraj ji children hospital Gurugram (Haryana) submitted by me. to fulfill the partial requirement for the award of degree of M.Sc. Environmental Science, under the Department of Environmental science of St. Wilfred PG College, affiliated to University of Rajasthan ,Jaipur (Rajasthan**)** is a record of original work carried out by me .

The matter embodied in this dissertation has not been submitted for the award of any other degree or diploma.

Date:

Jaipur

Ankita Chaturvedi
MSc. Environmental Science
(**Ankita Chaturvedi**)

ACKNOWLEDGEMENT

I express my deep gratitude and appreciation to my college guiding staff and Girraj ji Children Hospital gurugram Hariyana officials, who assisted guided and shared their insight in the dissertation work. I am indebted and hope that the product of our collaboration benefits one as much as I got benefitted from the process.

I had been immeasurably enriched by working under the supervision of Dr. Prerna Sharma ,Asst. Professor ,who has great level of knowledge ,which has enabled me to complete the dissertation. I also thank Mr. Sudhir Verma, Asst. Professor and HOD of environmental science Deptt. For the support in this process.

I am extremely thankful to the entire Girraj Ji Children Hospital Gurugram Haryana team for providing me the platform , assisted me at each step and clarified the queries and doubts in reference to this case study .at times ,my studies carried out at great cost to unnoticed fellows . Ithank my family and my fellow students support.

(**Ankita Chaturvedi)**

A **CASE STUNDY O BIO-MEDICAL WASTE MANAGEMENT**

AT GIRRAJ JI CHILDREN HOSPITAL

GURUGRAM(HARYANA)

A

DISSERTATION

Submitted in partial fulfillment for the award of degree of

Master of science

In

ENVIRONMENTAL SCIENCE

(2022-23)

Ankita Chaturvedi

MSc. Environmental Science

Submitted to:-

Dr. Prerna Sharma

(Assistant professor)

Submitted b:-

AnkitaChaturvedi

M.SC.(FINAL YEAR)

DEPARTMEN OF ENVIRONMENTAL SCIENCE

ST.WILFRED'S P.G. COLLEGE JAIPUR

UNIVERSITY OF RAJASTHAN