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Bio-Medical Waste Management

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Abstract

Biomedical waste hospital waste is any kind of waste containing infectious (or potentially infectious) materials. It may also include waste associated with the generation of biomedical waste that visually appears to be of medical or laboratory origin (e.g., packaging, unused bandages, infusion kits, etc.), as well as research laboratory waste containing biomolecules or organisms that are mainly restricted from environmental release. As detailed below, discarded sharps are considered biomedical waste whether they are contaminated or not, due to the possibility of being contaminated with blood and their propensity to cause injury when not properly contained and disposed of. Biomedical waste is a type of biowaste.

Biomedical waste may be of two types solid or liquid. Examples of infectious waste include discarded blood, sharps, unwanted microbiological cultures and stocks, identifiable body parts (including those as a result of amputation), other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in contact with blood and body fluids, and laboratory waste that exhibits the characteristics described above. Waste sharps include potentially contaminated used (and unused discarded) needles, scalpels, lancets and other devices capable of penetrating skin.

Sources of Bio-Medical Waste (BMW)

Biomedical waste is generated from biological and medical sources and activities, such as the diagnosis, prevention, or treatment of diseases. Common generators (or producers) of biomedical waste include hospitals, health clinics, nursing homes, emergency medical services, medical, and research laboratories,officesof physicians, dentists,and veterinarians, home health care, and morgues or funeral homes. In healthcare facilities (i.e., hospitals, clinics, doctor's offices, veterinary hospitals and clinical laboratories), waste with these characteristics may alternatively be called medical or clinical waste.

Management

Biomedical waste must be properly managed and disposed of to protect the environment, the general public and workers, especially healthcare and sanitation workers who are at risk of exposure to biomedical waste as an occupational hazard. Steps in the management of biomedical waste include.

- generation,
- accumulation,
- handling,
- storage,
- treatment,
- transport
- disposal.

The development and implementation of a national waste management policy can improve biomedical waste management in health facilities in a country.

Generation & Accumulation

Biomedical waste should be collected in containers that are leak-proof and sufficiently strong to prevent breakage during handling. Containers of biomedical waste are marked with a biohazard symbol. The container, marking, and labels are often red.

Discarded sharps are usually collected in specialized boxes, often called needle boxes.

Specialized equipment is required to meet standards of safety. Minimal recommended equipment includes a fume hood and primary and secondary waste containers to capture potential overflow. Even beneath the fume hood, containers containing chemical contaminants should remain closed when not in use. An open funnel placed in the mouth of a waste container has been shown to allow significant evaporation of chemicals into the surrounding atmosphere, which is then inhaled by laboratory personnel, and contributes a primary component to the threat of completing the fire triangle. To protect the health and safety of laboratory staff as well as neighboring civilians and the environment, proper waste management equipment, such as the Burkle funnel in Europe and the ECO Funnel in the U.S., should be utilized in any department which deals with chemical waste. It is to be dumped after treatment.

Handling

Handling is the act of moving biomedical waste between the point of generation, accumulation areas, storage locations and on-site treatment facilities. Workers who handle biomedical waste must observe standard precautions.

Storage

Storage refers to keeping the waste until it is treated on-site or transported off-site for treatment or disposal. There are many options and containers for storage. Regulatory agencies may limit the time for which waste can remain in storage.

Treatment

The goals of biomedical waste treatment are to reduce or eliminate the waste's hazards, and usually to make the waste unrecognizable. Treatment should render the waste safe for subsequent handling and disposal. There are several treatment methods that can accomplish these goals.

Biomedical waste is often incinerated. An efficient incinerator will destroy pathogens and sharps. Source materials are not recognizable in the resulting ash. Alternative thermal treatment can also include technologies such as gasificationand pyrolysis including energy recovery with similar waste volume reductions and pathogen destruction.

An autoclave may also be used to treat biomedical waste. An autoclave uses steam and pressure to sterilize the waste or reduce its microbiological load to a level at which it may be safely disposed of. Many healthcare facilities routinely use an autoclave to sterilize medical supplies. If the same autoclave is used to sterilize supplies and treat biomedical waste, administrative controls must be used to prevent the waste operations from contaminating the supplies. Effective administrative controls include operator training, strict procedures, and separate times and space for processing biomedical waste.

Incinerator and its Hazards

The first solution for the disposal of BMW was to burn the waste. India in the late 1990s after the first BMW rule was implemented, saw a boom in the number of incinerators being installed. It is based on the high temperature that kills pathogens and in the process destroys the material in which the microbes reside. However, a number of toxins are produced during its operation such as products of incomplete combustion (PIC) and dioxins. During incineration and post-combustion cooling, waste components dissociate and recombine forming new particles called PIC, which are toxic. Metals are not destroyed but are dispersed into the environment and these cause serious health issues. Dioxins are an unintentional by-product of waste combustion produced during incinerator operation. These are a group of 75 chemicals that coexist along with another group of toxins called furans. These toxins tend to accumulate in fatty tissues and travel up the food chain. Burning of medical devices made up of polyvinyl chloride (PVC) is the largest dioxin producer in the environment.In addition, metals present in the medical waste act as a catalyst for dioxin formation. These are very toxic, being known as carcinogenic, and cause damage to the immune and endocrine systems of humans. In India, to date, no study has been done by the Government of India to estimate the level of dioxin in the Indian population. In 2000, Subramanian have found high levels of dioxin in the human breast milk collected from New Delhi, Mumbai, and Kolkata.Recently, in January 2017 appreciating the importance of the presence of dioxins in the environment, a joint project by the Council of Scientific and Industrial Research and the National Institute for Interdisciplinary Science and Technology has started a study to analyze the presence of dioxins in Thiruvananthapuram.Moreover, the incinerator ash is also hazardous and needs to be checked for the level of toxin before being sent to a secured landfill. Therefore, keeping these points in consideration, most of the countries are shifting to alternative environmentally friendly methods of BMW disposal. The Philippines has banned incinerators and Denmark has banned construction of incinerators.

Benefits of the New Biomedical Waste Rules

The new rules are stringent and elaborate and should bring about a change in the way, the BMW is being managed in India. Under the new rules, coverage has increased to include various health-care-related camps such as vaccination camps, blood donation camps, and surgical camps.

Another distinction is in the segregation, packaging, transport, and storage of BMW waste. The categories have been reduced to four to bring about ease of segregation. One of the main principles of the disposal of BMW is that segregation has to be done at the source of generation of the waste. To overcome confusion created by large number of categories, this has been simplified to make it convenient and manageable for all HCWs. Now, the color coding (i.e., yellow, red, white, and blue) of the bags/containers is linked to a particular type of waste and its specific treatment option. For example, the disposal of chemical solid waste and cytotoxic waste is to be done in yellow bags which go for incineration/plasma pyrolysis/deep burial.

In addition, the HCF has to do pretreatment of various laboratory waste and blood bags according to guidelines of WHO and NACO, to decrease the chances of infections being transmitted to HCWs handling waste at the treatment stage. Within 2 years, plastic bags, gloves, and blood bags have to be phased out to eliminate emissions of dioxins and furans during their burning into the environment. The new rule also calls for a barcode system for all bags/containers used for BMW treatment and disposal. This step will help in tracking and identifying bags during inspection for quality control and also quality assurance.

The BMW in a red/blue bag or container which is for recycling will be sent only to an authorized recycler. This will keep the recycler in the realm and in control of various government agencies. Greater emphasis has been given to recycling of waste to conserve resources as well as decrease pollution.

The 2016 guidelines are more specific regarding the dependence of HCFs on CBMWTF and who will provide land for setting up CBMWTF. The state government or UT government will provide land for setting up CBMWTF and no occupier of an HCF shall establish an on-site treatment and disposal facility if a CBMWTF is available within 75 kms.This has several advantages as the installation and functioning of individual BMW treatment facilities as well as recruiting separate, dedicated, and skilled workforce require high capital investment. CBMWTF is a popular concept in developed countries because by operating it at its full potential, the cost of treatment/kg BMW gets significantly reduced. Further, this makes the control and checking of various waste disposal plants less tedious. Furthermore, maintaining records and logbooks will streamline the documentation.

The emission standards for incinerators have been made more stringent (acceptable SPM reduced to 50 mg/nm3, retention time in secondary chamber lowered to 2 s). This will reduce dioxins and furans release (which are produced at temperatures greater than 600°C) and lead to the production of carbon dioxide and water.

The new rules lay down new criteria for authorization of an HCF and have made the procedure for getting authorization very simple. Bedded hospitals will get automatic authorization and nonbedded HCFs will get a one-time authorization.

Another improvement in the new rules is in the monitoring sector. The MoEF (Ministry of Environment, Forest, and Climate Change) will review HCF once a year through state health secretaries and the SPCB (State Pollution Control Board). Moreover, according to the new rules, the advisory committee on BMWM is now mandated to meet every 6 months.

Challenges in the Implementation of New Biomedical Waste 2016 Rules

One of the biggest challenges the government hospitals will face, during the implementation of BMW 2016 rules will be due to the lack of funds. To phase out chlorinated plastic bags, gloves, and blood bags and to establish a bar code system for bags/containers the cost will be high and the time span for doing this i.e. two years is too short.

Currently, in India, there are in operation and 28 are under construction. There is a great need for rapid development of many more CBMWTFs to fulfill the need for treatment and disposal of all BMW generated in India. Incinerators emit toxic air pollutants, and incinerator ash is potentially hazardous.

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

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

Figure : Biomedical waste classification – categories, treatment, processing, and disposal options

Conclusion

In conclusion, the following points are stated as possible guidelines for the hospitals to bear in mind for future actions:-

1) The government authorities have to assume more responsibilities for regulating waste generated from health facilities. In addition to formulating guidelines and rules and regulations, the focus should be on enforcing the guidelines.
2) The health care facilities should increase cooperation with professional medical associations and the Ministry of Environment and Forests.
3) Encourage recycling efforts leading to the segregation of infectious and hazardous waste from the conventional waste streams to reduce the amount of medical waste that needs to be incinerated.
4) Consider the phasing out and elimination of medical supplies made of PVC plastics or containing mercury where alternatives are available.
5) Look into the possibilities of better product purchasing and substituting the hazardous materials that are currently used.

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