International Journal of ChemTech Research
CODEN(USA): IJCRGG ISSN : 0974-4290
Vol.5, No.3, pp 1213-1221, April-June 2013

IPACT-2013[14th – 15th March 2013]
National Conference on Industrial Pollution And Control Technology-2013

Management Of Bio Medical Waste

A.S.Tanksali

BLDEA's V.P.P.G.H College Of Engineering And Technology, Bijapur, Karnataka,India.

Corres.author: anutanksali@gmail.com, Tel: 9449532917,

Abstract: Medical care is vital for our life and health, but the waste generated from medical activities represents a real problem of living nature and human world which includes the newly seen, "Hospital-inflicted diseases". All round technological progress has led to increased availability of health related consumer goods, which have the potentiality to produce more waste.

The bio-medical waste produced in the health care activities include wide variety of drugs, antibiotics, cytotoxic, corrosive chemicals, radioactive substances [(1)], which ultimately become part of hospital waste. This waste carries a higher potential for infection and injury than any other type of waste. Inappropriate handling of biomedical waste has led to serious public health consequences and a significant impact on the environment which is due to inappropriate recycling, unauthorised and illegal re-use and increase in the quantum of waste [(6)]. Public health is compromised due to lack of accountability in the handling of hospital waste; specifically body fluid contaminated equipment and containers as well as microbiological materials.

Though scientists and public authorities around the world are realizing that human actions have to be responsible regarding not only the social and economic matters but also protection of public health .The most important process to protect public health is establishment of a manifest system of cradle-to-grave accountability for the infectious portion of a hospital's waste. "Cleanliness is next to Godliness", this phrase is to be involved with the noble profession of medical science.

This paper represents the systematic management of the Bio-Medical Waste. It deals with proper handling, segregation according to the colour coding, mutilation, disinfection, storage, transportation and final effective disposal of bio-medical waste. It also states the difficulties being faced by the processor in effective disposal.

Keywords: *Bio-medical waste, Hospital waste, Public health, Colour coding, Segregation.*

Introduction

Biomedical waste, also known as infectious waste or medical waste is defined as waste generated during the diagnosis, testing, treatment, research or production of biological products for humans or animals [(1)]. In simple terms it is defined as *the health-care waste, which includes all the waste generated by healthcare* establishments, research facilities, and laboratories. It also includes the waste generated from health care undertaken in the home (dialysis, insulin injections, etc.).

The biomedical waste produced in the course of health care activities carries a higher potential for infection and injury than any other type of waste. Inappropriate handling of biomedical waste may have serious public health consequences and a significant impact on the living organisms (including humans) and environment.

Development of medical science is a must for mankind, but the waste generated from medical activities can be hazardous, toxic and even lethal because of their high potentiality for diseases transmission. Apart from these the unhealthy disposal methods such as terrestrial dumping, uncontrolled burning, and primitive land-filling have increased the risk.

Another major problem being faced is when the health care waste is mixed with municipal waste, it leads to numerous diseases which get passed to humans through insects, birds, rats and other animals. Illegal repacking and resale of contaminated needles led to the newly formed," Hospital inflicted diseases" which are more resistant than other diseases and which further might lead to HIV/AIDS, sepsis and hepatitis etc. But with a judicious planning and management, however, the risk can be considerably reduced. Studies have shown that health care waste consists of 5% hazardous waste and 10% infectious waste and the remaining 85% is non-infectious waste, hence if we handle the 15% waste properly most of the risks can be avoided[5].

Present Status

Rapid growth in population has resulted in the establishment of large number of Hospitals and Nursing Homes in all places. These Health Care Institutions are undoubtedly necessary for keeping up the well-being of our community, but there waste which is the neglected part needs to be handled carefully. To streamline the disposal of Bio–Medical Waste, Central Government has notified the Bio- Medical Waste (Management & Handling) Rules, 1998.

In Karnataka there are 12365 health care establishments, 7109 Government units (including 4116 Veterinary institutes) and 5256 private units and approximately these generate 62 tons of health care waste per day, and to manage this amount of waste there are 14 common bio-medical waste treatment facilities, still some districts need to establish the treatment facility. Most of the health care systems follow indiscriminate disposal, which leads to adverse effect both on life and environment.

Rules And Regulations

For safe disposal of health care wastes, the Central Government has notified the Bio- Medical Waste (Management & Handling) Rules, 1998 with effect from 20-7-1998[1].According to the Rules, It shall be the duty of the every occupier of an institution generating Bio- Medical Waste, to take all steps to ensure that such waste is handled without any adverse effect to human health and environment. It also states that Bio-Medical Waste shouldn't be mixed with any other waste. It should be segregated at the point of generation and stored in containers labeled (as per the Rules) and need to be transported only in authorized vehicles. The waste shouldn't be stored beyond 48 hours.

On failure to comply with the Rules, the occupier shall be punishable under Section 15 of EP (Act) 1986 which includes penal action, imprisonment, fine of rupees one lakh, imprisonment and fine of rupees one lakh and closure of the unit.It is however not necessary that every health care establishment should have its own waste treatment facility, it can co-relate with any common facility or any other facilities for waste treatment. However it is necessary that the occupier ensure that the waste is treated within a period of 48hours. Hospital is one of the complex institutions, which is frequented by people from every walk of life in the society without any distinction between age, sex, race and religion. The waste generated from these sections is increasing in its amount and type due to advances in scientific knowledge. But in reality, a law will remain ineffective if sources (finance, material and knowledge) are not available in the hospitals or health care sectors to implement it and or if enforcement is weak.

Management Of Bio-Medical Waste[4]

A perfect management of bio-medical waste can be stated as a path between two words i.e. cradle to grave, which can be bifurcated into following steps[7],

1. Waste Survey-Identification of areas of waste generation, quantification of waste.
2. Waste Segregation-Categorization and bifurcation.

3. Waste Storage.
4. Waste Transportation.
5. Waste Treatment.
6. Waste Disposal.

Waste Survey

The foremost point in management of bio-medical waste is to identify the areas of waste generation. Bio-Medical waste is generated in hospitals, research institutions, health care teaching institutes, clinics, laboratories, blood banks, animal houses and veterinary institutes. In each health care establishment the waste generation points can be identified as follows [(3),(5)],

SN	**Unit**	**Waste Generated**
1	Out Patient	S oiled Waste,(gauze, bandages etc.), Solid Waste (Plastic)and sharps.
2	Injection Room	Soiled Waste, Sharps and Solid waste.
3	General Ward	Sharps waste, Solid waste and Soiled waste.
4	Labour Room	Body part (placenta etc.),Sharps waste, Solid waste and Soiled waste.
5	Operation Theatre	Body parts, Sharps waste, Solid waste and Soiled waste.
6	Intensive Care Unit /Casualty/Emergency	Sharps waste, Solid waste and Soiled waste
7	Laboratory	Sharps waste, Solid waste, Soiled waste, Biological (culture media)
8	Pharmacy	Discarded medicines

And for quantification the wastes need to be segregated at the source according to the colour codings and weighed separately (category wise).

Waste Segregation[1]

Waste identification is an important tool of waste control programme. Segregation of Bio-Medical waste is the key to successful Bio- Medical waste management. The use of colour coding and labelling of hazardous waste containers provides great assistance in waste separation. Without opening a container one can easily know about the contents. In India, MoEF, GoI (1998) has notified Bio-medical Waste (management & Handling) Rules -1998[(1)],which describes ten categories viz., Human Anatomical Waste; Animal Waste; Microbiology &Biotechnology Waste; Waste Sharps; Discarded Medicines and Cytotoxic Drugs; Solid Waste; Liquid Waste; Incineration Ash and Chemical Waste.

Category 1: Human Anatomical Waste (body parts, organs, human tissues etc.)

Category 2: Animal Waste (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals, colleges, discharge from hospitals, animal houses).

Category 3: Microbiology & Biotechnology Waste (Wastes from laboratory cultures, stocks or micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures).

Category 4: Waste Sharps (needles, syringes, scalpels, blade, glass, etc. that maycause puncture and cuts. This includes both used and unused sharps).

Category 5: Discarded Medicines and Cytotoxic drugs (Waste comprising of outdated, contaminated and discarded medicines).

Category 6: Soiled Waste (items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood).

Category 7: Solid Waste (Waste generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets etc.).

Category 8: Liquid Waste (Waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities).

Category 9: Incineration Ash (Ash from incineration of any bio-medical waste).

Category 10: Chemical Waste (Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.).

Colour coding, type of container and disposal method[(1)],

COLOUR CODING	WASTE CATEGORY	TREATMENT AS PER SCHEDULE-I
Yellow	Plastic bag Cat 1, Cat 2, Cat 3, Cat 6.	Incineration/deep burial.
Red	Disinfected container/Plastic bag Cat 3, Cat 6 and Cat 7.	Autoclaving/ microvaing/ chemical treatment.
Blue/White translucent	Plastic bag/puncture proof Cat 4, Cat 7.	Autoclaving/Microwaving/ Chemical Treatment and destruction/shredding.
Black	Plastic bag Cat 5 and Cat 9 andCat 10. (solid)	Disposal in secured landfill.

Notes:

- Colour coding of waste categories with treatment options as defined in Schedule 1, shall be selected depending on treatment optionchosen, which shall be as specified in Schedule 1.
- Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
- Category 8 does not require containers/bags.
- Category 3 if disinfected locally need not be put in Containers/bags.

Waste Storage[6]

Storage of waste is necessary at two points:

(i) at the point of generation and

(ii) Common storage for the total waste inside a health care organisation.

Each category of waste (according to treatment options mentioned in Schedule I of the rules) has to be kept segregated in a proper container or bag as the case may be. The bags being used for storage needs to be sturdy enough to contain the designed maximum volume and weight of the waste without any damage. It should be without any puncture/leakage. The container should have a cover, preferably operated by foot. The sharps must be stored in puncture proof sharps containers. But before putting them in the containers, they must be mutilated by a needle cutter, placed in the department/ward itself. The bags/containers should not be filled more than 3/4thcapacity. Attempts should be made to designate fixed places for each container so that it becomes a part of regular scenario and practice for the concerned persons.

When a bag or container is sealed, appropriate label is to be provided on it. The container should bear 'Biohazard' or 'cyto-toxic' symbol, the name of the department/laboratory from where the waste has been generated so that in case of a problem or accident, the nature of the waste can be traced back quickly. The containers should also be labelled with the date, name and signature of the person responsible. The label should

contain the name, address, phone/fax nos. of the sender as well as the receiver. It should also contain name, address and phone/fax nos. of the person who is to be contacted in case of an emergency.

Collection room/intermediate storage area where the waste packets/bags are collected before they are finally taken/transported to the treatment/disposal site are necessary for large hospitals having a number of departments, laboratories, OTs, wards etc.

But it is to be noted that no untreated Bio-Medical waste is to be kept stored beyond a period of 48 hours.

Waste Transportation[6]

Biomedical waste should be transported within the hospital by means of wheeled trolleys, containers or carts that are not used for any other purpose. The trolleys have to be cleaned daily. All attempts should be made to provide separate service corridors for taking waste matter from the storage area to the collection room. Preferably these corridors should not cross the paths used by patients and visitors. The waste has to be taken to

the common storage area first, from where it is to be taken to the treatment/disposal facility. Off-site transportation vehicle should be marked with the name and address of carrier. Biohazard symbol should be painted on it. Suitable system for securing the load during transport should be ensured. The vehicle should be easily cleanable with rounded corners. The transportation of waste should be as per a defined path.

Waste Treatment

The 'Bio-Medical Waste(Management & Handling) Rules, 1998' has elaborately mentioned the recommended treatment and disposal options according to the 10 different categories of waste generated in health care establishments in Schedule I of the rules. A review of the above schedule shows that there is no single technology, which can take care of all categories of biomedical waste. A judicious package has to be evolved for this purpose. For example, small and medium hospitals can opt for local (in house) disinfection, mutilation / shredding and dedicated autoclaving plus off-site incineration at a common treatment/disposal facility followed by disposal in sanitary and secured landfills [(1)].

Waste Disposal[1]

Incineration

This is a high temperature thermal process employing combustion of the waste under controlled condition for converting them into inert material and gases. Incinerators can be oil fired or electrically powered or a combination thereof. Broadly, three types of incinerators are used for hospital waste: multiple hearth type, rotary kiln and controlled air types. All the types can have primary and secondary combustion chambers to ensure optimal combustion. Both the chambers are refractory lined. The primary chamber has pyrolytic conditions with at temperature range of about 800 (+/-) 50 deg. C and is used for solid phase combustion. The secondary chamber operates under excess air conditions at about 1050 (+/-)50 deg. C and is used for gas phase combustion. These incinerators use excess air hence are known as excess air incinerators. These incinerators are connected to air pollution control devices and further to a chimney with a minimum height 30 meters above ground level. Installation of incinerators in congested area is not desirable.

In the Bio-medical Waste (Management and Handling)Rules, Incineration has been recommended for human anatomical waste, animal waste, cyto-toxic drugs, discarded medicines and soiled waste.

Autoclave Treatment

This is a process of steam sterilisation under pressure. It is a low heat process in which steam is brought into direct contact with the waste material for duration sufficient to disinfect the material. There are three types of autoclaves, Gravity type, Pre-vacuum type and Retort type. In Gravity type, air is evacuated with the help of gravity alone. The system operates with temperature of 121deg.C. and steam pressure of15 psi. for 60-90 minutes. Vacuum pumps are used to evacuate air from the Pre-vacuum autoclave system so that the time cycle is reduced to 30-60 minutes. It operates at about132 deg. C. Retort type autoclaves are designed to handle much larger volumes and operate at much higher steam temperature and pressure.

Autoclave treatment has been recommended for microbiology and biotechnology waste, waste sharps, soiled and solid wastes. Autoclave sterilises and disfigures the waste.

Hydroclave Treatment

Hydroclave is another innovative system for steam sterilisation similar to autoclave. It is a double walled container, in which the steam is injected into the outer jacket to heat the inner chamber containing the waste. Moisture in the waste evaporates and steam builds up the steam pressure to 35-36psi. The chamber is slowly rotated by a strong shaft connected to a paddle which turns the waste continuously against the hot wall which mixes and as well as fragments the same. In the absence of enough moisture, additional steam is injected. The system operates at 132deg.C. and 36 psi steam pressure for sterilisation time of 20minutes. The total time for a cycle is about50 minutes, which includes start-up, heat-up, sterilisation, venting

and depressurisation and dehydration. The treated material can further be shredded before disposal. The expected volume and weight reductions are up-to 85% and 70% respectively

The hydroclave can treat the same waste as the autoclave plus the waste sharps. The sharps are also fragmented. This technology has certain benefits, such as, absence of harmful air emissions, absence of liquid discharges, non-requirement of chemicals, substantial reduction of volume and weight of waste.

Microwave Treatment

It is a wet thermal disinfection technology , this process heats the waste from inside out and provides a high level of disinfection. In this method initially the waste is shredded and allowed to enter conventional microwave generators, which heat the material to95-100deg.C.and uniformly disinfect the material during a minimum residence time of30 minutes and further it is again shredded and then disposed.

This technology has certain benefits such as absence of harmful air emissions, absence of liquid discharges, non-requirement of chemicals, reduced volume of waste, operator safety. But the main drawback of this system is it's high investment cost.

According to the Cat 3, Cat 6 and Cat 7 are treated by microwave.

Chemical Disinfection

Chemical treatment is done by using at least 1%hypochlorite solution and a minimum contact period of 30 minutes is to be maintained. Apart from hypochlorite solution other equivalent chemical reagents such as phenolic compounds, iodine, hexachlorophene, iodine-alcohol or formaldehyde-alcohol combination can be used.

Sanitary Landfill

Sanitary and secured land filling is required for human anatomical waste when the incineration facility is not available (for towns having population less than 5lakhsand rural areas)/ under repair. It is also used for autoclaved/hydroclaved/microwaved waste. Incineration ash is also landfilled. A separate sharp pit is devised for sharps and is usually available in common treatment facilities.

Advanced Technologies[8]

Plasma Pyrolysis Technology

This method is another type of thermal disintegration of carbonaceous materials in oxygen starved environment. It converts electric energy to heat energy. Here also two chambers are installed but in primary chamber pyrolysis takes place at a high temperature of 1100 deg. C. and secondary chamber combustion takes place at 950 to 1000 deg. C.

Plasma pyrolysis has an advantage of formation of lesser POPs (Persistent Organic Pollutants), is a compact smoke free technology (does not require chimney) and consumes less space but only disadvantage is it's cost and it requires technical persons to handle it.

Treatment For Mercury Containng (Elemental Mercury) Waste[7,8]

Mercury containing wastes are part of bio-medical wastes, these are to be handled separately and with care. Highly sealed resistant container are used to store such type of wastes and is allowed to react with silver alloy to form scrap amalgam and is stored till a certified waste carrier or recycler is allowed to handle it. The same procedure is followed for lead containing wastes.

Case Study- Bijapur City

Bijapur city situated in southern India is the district headquarters of Bijapur District of Karnataka state with co-ordinates 16.82^0 N 75.72^0 E. Bijapur city is well known for monuments of architectural importance built during the rule of AdilShahi dynasty. It has a population of 3.26 lakhs as per the 2011 census. Bijapur city consists of 120 hospitals and 111 OPDs(including Labs and Dental OPDs).Bijapur Municipality has allotted 3 acre area for Karnataka Private Medical Association, Bijapur chapter, which is establishing a Common Bio Medical Waste Treatment Facility(CBMWTF) is being established. The CBMWTF has 2 Tata ace vehicles which are used to collect the waste from the hospitals. A two wheeler with bins arranged in the back is run in the evening to collect the waste from the OPDs. The hospital wastes are bifurcated category wise, tied in respective coloured bags and brought to the site in large bins placed inside the vehicle. The hospitals are visited on daily basis whereas the OPDs are visited twice in a week in the evening hours. The wastes collected in a month category wise can be stated

as follows,

Category 1,2,3 & 6 - 120 to 140 kgs per day

Category 7 & 4 - 43 to 45 kgs per day

Category 5 & 10 - 26 to 30 kgs per day

All the wastes are handled and treated according to the rules and regulations by chemical treatment, autoclaving, shredding and incineration process and finally disposed in the secured sanitary landfill existing the treatment facility premises.

Occupational Hazards And Safety Measures[1,2,9]

The staff of the health care establishments, who are either in contact with the patient or the infectious waste generated, are continuously at risk during their working hours. There are chances of accidental injuries, infections, hospital inflicted diseases or there might be chances of illegal repacking/ resale of used/expired drugs. Hence adequate safety measures are to be provided.

Safety Measures:

For the Medical and Para-Medical Staff [1,2,9]

1. Clear directives in the form of notice are to be displayed in the concerned areas.
2. Protective clothes such as gloves, aprons, masks etc are to be provided.
3. Proper sterilization of all surgical equipments and tools should be done.
4. Disinfectant, soap, clean towels etc are to be provided.
5. Regular medical check-up (half-early) is to be done.

For the cleaning and transportation staff[(1,2,9]

1. Display of do's and don'ts in local language.
2. Protective clothes such as gloves, aprons, masks etc are to be provided.
3. Provision of proper wash area with disinfectant and soaps.
4. Always cleaning the vehicles and bins after every trip.

Practical Difficulties

In practical field we come across lot of difficulties which make the situation difficult to manage. The issues leading to mismanagement can be stated as no segregation at source, non-compliance with colour coding,

lack of interest from senior management, no ownership, inaccurate quantification, no monitoring, inadequate safety measures etc[3].

There is a need to bring awareness among the occupiers to pay equal importance to the management of bio-medical waste. Which might reduce the impact to certain extend.

Important Points To Be Noted[6]

1. Segregate waste into different categories as soon it is generated.
2. Collect waste in specific colour code and covered bins.
3. Disinfect the bins and clean them regularly with soap and water.
4. Domestic waste such as eatables , wrappers ,paper , fruit peel etc are to be collected separately and sent to Municipal waste disposal facility.
5. Identity a particular place in the hospital for the bins.
6. Use dedicated waste collection bins/ trolleys for transporting waste.
7. Transport waste through a pre-defined route within the hospital.
8. Mutilate the needle after injection.
9. Never mix infectious waste with other waste.
10. Never mix chlorinated wastes with the waste which goes for incineration
11. Don't mix Municipal Solid Waste with Bio-Medical Waste.
12. Never store waste beyond 48 hours.
13. Never overfill the bins.
14. Don't dispose waste sharps with other wastes.
15. Don't Consider Bio-Medical Waste Casually.
16. Don't Encourage Reuse Of Disposables.

Conclusion

Bio-Medical waste is an ever generating waste and the quantity is increasing with increase in population and variation of living standards of India. We need to accept that the quantity of hospital waste and proportion of infection waste is definitely higher than one would expect in India. Hence the need of the hour is proper management of the bio-medical waste. There are many alternative methods but the final choice of treatment system should be made carefully, on the basis of various factors, such as local conditions, fund & space availability, composition of waste generated, regulatory approval and public acceptance.

But to bring about a proper management of bio-medical waste and reduction in hazards, we need to bring awareness in the Government, Medical staff and waste handlers. Effective disposal of the waste can be achieved by proper training to the persons who handle the waste. The entire waste management system is a collective effort to be done by both generator and regulatory body.

References

1. http://www.nihfw.org/ndc-nihfw/html/legislations/biomedical waste.
2. Environmental Protection training and Research (EPTRI) Bio-medical Waste Management, *Self learning Document for Dayas, Aayas & ClassIV employees*, 2009.
3. Carmen Aurora.V.Bulucea, Aida.V.Bulucea, Maricus.C.Popescu, Anca.F.Patrascu, *Assessment of Biomedical Waste situation in Hospitals of DoljDistrict*, International Journal of Biology & Biomedical Engineering, Issue 1, Vol 12, 2008.
4. PritiRazdan, Amarjeet Singh Cheema, *Biomedical Waste Management System,* Proceedings of ASCNT-2009, CDAC, Noida, India, pp.26-31.
5. Surjit Katoch, *Bio-medical waste classification and Prevailing Management strategies*,Proceedings of the International Conference on Sustainable Solid Waste Management-5-7 September 2007, Chennai, India, pp 169-175.

6. Palanisamy Pasupathi , Sivaraman Sindhu , Babu Shankar Ponnusha, Athimoolam Ambika, *Bio-Medical Waste Management for Health Care Industry*, International Journal of Biological and Medical Research, 2011;2(1): 472-486.
7. SandhyaArunkumar, R.SatishMuthukumar, *Bio-Medical waste disposal in Dental clinics*, SRM University Journal of Dental Science, Vol 2, Issue 2, April-June 2011.
8. Dr.D.Vyas, Mr Urvij.B.Dave, Ms Hemal.B.Parekh, *The Safe Disposal of Bio-Medical Waste(Case study of a Rural Medical Hospital)*, National Conference on recent trends in Engineering & Technology, May 2011.
9. Shalini Sharma, *Awarness about Bio-Medical Waste Management among Health Care Personnel of some important medical centers in Agra*, International Journal of Environmental Science and Development, Vol 1, No 3, August 2010.

* * * * *