Bio-Medical Waste Management Practices in India – A Review

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Abstract : Economic development of India in last two decades has resulted in environmental pollution and waste generation in huge quantity in India. Today Waste Management is a very big headache problem even for developed countries like USA, Japan, and Canada. Biomedical Waste Management has become one of major issue of concern in India taking into account the rate of growth of population. Biomedical Waste Management is receiving greater attention due to recent regulations of the Biomedical Wastes (Management & Handling Rules, 1998). Inadequate management of Bio-Medical Waste can be associated with risks to healthcare workers, patients, communities and their environment. The present paper is review of Bio-Medical Waste Management Practices in India and recommended few measures to minimize the impacts of Hospital Waste on people and surrounding environment.

IndexTerms - **Bio-Medical Waste, MoEF, Treatment Methods**

I. INTRODUCTION

Due to economic development in industrial, infrastructure, medical, information technology and agriculture sector of India in last two decades life of human being has become more content, lavish and comfortable. On the other hand due to this economic development the environment is badly affecting by Pollution, industrialization, urbanization, deforestation etc. In India huge amount of medical facility is available which are producing the Biomedical waste such as body parts, organs, tissues, blood and body fluids along with soiled linen, cotton, bandage and plaster. This waste is very infected and contaminated.

In developing countries such as India, the international policy that the generator of waste is responsible for the proper management, treatment and disposal of waste has remained on paper and is yet to be implemented. The notion that waste is the responsibility of the government authorities has not enabled waste generators to appreciate the negative impact of improper waste disposal. Although waste is generated from anywhere such as the home, office, industry, agriculture, school, living things and healthcare establishments, of more concern is that of healthcare waste due to its hazardous nature and disease transmission characteristics of some of the wastes.

Bio-medical waste is defined as waste that is generated during the diagnosis, treatment or immunization of human beings and are contaminated with patients' body fluids (such as syringes, needles, ampoules, organs and body parts, placenta, dressings, disposables plastics and microbiological wastes) (Das et al., 2001). Healthcare establishments generate wastes, byproducts of health care which can be classified into infectious and non-infectious wastes (Patil and Shekdar, 2001). Infectious wastes contain pathogens in quantities sufficient to transmit infectious diseases on exposure to them. A hazardous waste is one which may be toxic, genotoxic, corrosive, shocksensitive, flammable, reactive, explosive, radioactive, containing infectious agents and/or sharps (Pruss et al, 1999).

The hospital waste, in addition to the risk for patients and personnel who handle these wastes, poses a threat to public health and environment (Singh et al, 1996). Keeping in view inappropriate biomedical waste management, the Ministry of Environment and Forests notified the Bio-medical Waste (Management & Handling) Rules, 1998. In accordance with these Rules (Rule 4), it is the duty of every "occupier" i.e. a person who has the control over the institution and or its premises, to take all steps to ensure that waste generated is

handled without any adverse effect to human health and environment (Notification: BMWM Rules, 1998). Hospitals, nursing homes, clinic, dispensary, animal house, pathological lab etc., are therefore required to set in place biological waste treatment facilities. It is however not incumbent that every institution has its own waste treatment facility. The rules also envisage that common facility or any other facilities can be used for waste treatment. However it is incumbent on the occupier to ensure that the waste is treated within a period of 48 hours (Manohar et al., 1998; Baveja et al., 2000; Rao et al., 2004 Verma et al., 2008).

1.1. BIO-MEDICAL WASTE

Hospitals, clinics, research centers and health care centers use wide variety of drugs including antibiotics, radioactive substances, corrosive chemicals, which ultimately contribute in Bio medical waste. In the country like India the total amount of municipal waste a city generates, only 1 to 1.5% is Bio medical waste, of which 10-15% is considered infectious. Whereas, In developed countries due to increased use of disposables the waste produced has been up to 5.24 Kgs per bed per day. Most hospitals in India generate 1-2 Kgs per bed per day, except the tertiary care hospital (e.g. AIIMS and SKIMS) which produce waste on higher side. According to World Health Organization (WHO) estimates 85% of Bio medical waste is actually non-hazardous and around 10% is infectious while the remaining 5% is non-infectious but consists of hazardous chemicals like methyl chloride and formaldehyde and this range is dependent on the total amount of waste generated (Glenn and Garwal, 1999). The disposal of Bio medical waste can be very hazardous particularly when it gets mixed with municipal solid waste and is dumped in uncontrolled or illegal landfills such as vacant lots in neighboring residential areas and slums. This can lead to a higher degree of environmental pollution, apart from posing serious public health risks such as AIDS, Hepatitis, plague, cholera, etc.

Health and environmental effects, uncertainty regarding regulations and negative perceptions by waste handles are some important concerns in health care waste management in a country (Freeman, 1998). At present, there is no available information that describes the actual practice of handling the health care waste products. The proposed hospital waste management plan is consistent with the biomedical waste (management and handling) (second Amendment) Rules, 2000, Ministry of environment and forests. Johannessen et al (2000) opine that proper management of medical waste can minimize the risk both within and outside healthcare facilities. The first priority is to segregate wastes, preferable at the point of generation into reusable and non-reusable, hazardous and nonhazardous components. There are generally four key steps to medical waste management: (1) segregation into various components, including reusable and safe storage in appropriate containers; (2) transportation to waste treatment and disposal sites, (3) treatment and (4) final disposal.

1.2. SOURCES OF BIO-MEDICAL WASTE GENERATION:

Although the solid waste management has become one of the major topic of importance but still local bodies are unable to give the proper attention towards some special sources of wastes out of which biomedical waste is one. Primary sources are Hospital, Medical College, Nursing Home, Immunization centers, Dispensaries, Nursing Homes, Maternity home, Animal research centers, Dialysis center, Blood bank, Research lab, Industries etc. Secondary Sources are Clinics, Ambulance Service, Home treatment, Slaughter houses, Funeral Service, Educational institutes etc.

II. PRESENT SCENARIO:

Normally the waste is collected in open containers without disinfection. Bandages, cotton and other items used to absorb body fluids are collected in plastic or other non-specified containers. Waste is collected in mixed form. Some hospitals in the country have developed their own system of color coding. Waste sharps are discarded without disinfection and mutilation, which may result in their being, re-used thus spreading an infection. The waste collection and transportation workers in the hospital segregate the recyclable material for sale. In a similar way, all disposable plastic items are segregated by the waste pickers, from where the

waste is deposited either inside the hospital grounds, or outside in the community bin for further transportation and disposal along with municipal solid waste. Since the infectious waste gets mixed with municipal solid waste, it has potential to make the whole lot infectious in adverse environmental conditions (Info Nugget, 1996).

III.THREATS IN BIO-MEDICAL WASTE MANAGEMENT:

The status of poor waste management currently practiced in the country poses a huge risk towards the health of the general people, patients, and professionals, directly and indirectly through environmental degradation. Communicable diseases like gastro-enteritis, hepatitis - A and B, respiratory infections and skin diseases are associated with hospital waste either directly as a result of waste sharp injuries or through other transmission channels. The hosts of microorganisms responsible for infection are enterococci, non-hemolytic streptococci, anaerobic cocci, clostridium tetani, klebsiella, HIV and HBV (Blenkharn, 1995). The potential risk to health care workers comes from the handling of infected sharps; 60 percent of them sustain an injury from sharps knowingly or unknowingly during various procedures. The practice of reheating the needle after use is the major factor for needle stick injuries. Through poor waste management practices, all health care workers (nurses, doctors, lab technicians), service personnel, rag pickers and the general public are at risk of contracting infections while handling, storage, and treatment. Incinerators operating at sub-optimal conditions are an added environmental and health hazard.

IV.SEGREGATION:

Wastes should be segregated at the point of generation before treatment and disposal to protect both humans and the environment. Segregation of wastes would result in a clean solid waste stream which could be easily, safely and cost effectively managed through recycling, composting and land filling (NIHE, 2006). The different categories of healthcare hazardous waste should be segregated, collected in different and suitable containers, appro destination. Removed containers or bags should be replaced with new ones of the same type and appropriate colour (Pruss et al., 1999). The transportation of wastes should also be well documented, and all vehicles involved should carry a consignment note from the point of collection to the incinerator or landfill or other final disposal facility; and these vehicles should be cleaned and disinfected regularly.

The segregation of waste in almost all hospitals is not satisfactory.

- Color-coding for various categories of waste is not followed.
- The storage of bio-medical waste is not in isolated area and proper hygiene is not maintained.
- Personal protective equipment and accessories are not provided.
- Most of the hospitals do not have proper waste treatment and disposal facilities. In the cities where common treatment facilities have come up, many medical establishments are yet to join the common facility.
- Most of the incinerators are not properly operated and maintained, resulting in poor performance.
- Sometimes plastics are also incinerated leading to possible emission of harmful gases.
- General awareness among the hospital staff regarding bio-medical waste is lacking.

V.WASTE TREATMENT:

The hospitals in this study, which are the leading ones in Jos city, carry out open burning at temperatures below the recommended temperature of 1000ºC. Since there was no segregation, pharmaceutical and cytotoxic wastes that should not be burnt at temperatures below 1000ºC, were being burnt together with the subsequent release of toxic emissions into the air. Such toxic emissions may include dioxins, furans and heavy metals emitted as fumes or vapours (Lee et al., 2004; Lee and Huffman, 1996). However, the benefits of incineration include reduced volume of waste, the unrecognizable end product in form of ash and destruction of pathogens (Lee and Huffman 1996). Burning of pharmaceuticals and cytotoxic drugs should be

done in well constructed incinerators at recommended temperatures with facilities to control emissions. For cytotoxic drugs and large pharmaceuticals, rotary kilns designed for industrial waste and operated at temperatures greater than 1200°C should be used (Pruss et al, 1999).

VI. TRAINING OF WASTE HANDLERS:

The establishments claimed that the waste handlers were trained but the outcome of the survey indicated otherwise. If indeed they were being trained, then the training was inappropriate and had not been impacted on their skills and knowledge of the recommended measures for hazardous waste management. It was also not possible to obtain the materials used for the training. Training and re-training programmes should be instituted for all workers (with no exceptions) in the hospitals thereby creating awareness of waste, its effects, importance of guidelines and the implementation of the waste management options for the different categories of waste.

Common Regional Facility for Final Disposal of Infectious Biomedical waste Hospitals, private practitioners, emergency care centers though aware of the rules do not have the time or resources to arrange satisfactory disposal of biomedical waste. Self contained on site treatment methods may be desirable and feasible for large healthcare facilities. They will not be practical or economical for smaller institutes. An acceptable common system should be in place which will provide free supply of colour coded bags, daily collection of infectious waste, and safe transportation of waste to offsite treatment facility and final disposal with suitable technology.

Operating parameters Handling, segregation, mutilation, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management of biomedical waste. The key to minimisation and effective management of biomedical waste is segregation (separation) with identification of the category of waste. The most appropriate way of identifying the categories of biomedical waste is by sorting the waste into colour coded plastic bags or containers. Biomedical waste should be segregated into containers/ bags at the point of generation in accordance with Schedule II of Biomedical Waste (management and handling) Rules 1998 (Notification: BMWM Rules, 1998).

VII. IMPLEMENTATION:

Implementation of rules and regulation of the biomedical waste management systems in India is major drawback of the whole system. The doctors, nurses, technicians, sweepers, hospital visitors, patients, rag pickers and their relatives are exposed routinely to Bio-Medical Waste and are at more risk from the many fatal infections due to indiscriminate management. Due to improper management of the biomedical waste this infectious waste gets mixed with solid waste. During the rainy season infectious substance may get added to the ground water and spreads hazardous diseases.

The Government has formulated the Bio-Medical Waste (Handling and Management) Rules in 1998 (hereafter referred to as the Bio-Medical Waste Rules) in order to specify procedures that have to be followed in the management and disposal of waste.4 The rules regulate the disposal of bio-medical waste including human anatomical waste, blood, body fluids, medicines, glassware, soiled, liquid & biotechnology waste and animal waste. The rules have been formulated as framework for handling & management of biomedical wastes. The rules are applicable to all hospitals, nursing homes etc in the country and also apply to all persons who generate, collect, receive, store, transport, treat, dispose or handle biomedical waste in any form.

Health care wastes are categorized into two types such as infectious and non-infectious (Saini and Dadhwal, 1995).Infectious wasteincludes all those medical wastes, which have the potential to transmit viral,

bacterial or parasitic diseases. It includes both human and animal infectious wastes and waste generated in laboratories and veterinary practice. These wastes are hazardous in nature. Non infectious wastes are generated from packaging, food preparations and visitors activities. This waste is large compared to infectious waste. A large fraction is potentially recyclable but may be contaminated with infectious agents. This has to be separately stored and sterilized before sending for recycling (Sandhu and Singh, 2003).

VIII. DISCUSSION:

The recent developments in healthcare units are precisely made for the prevention and protection of community health. Sophisticated instruments have come into existence in various operations for disease treatment. Such improvement and advances in scientific knowledge has resulted in per capita per patient generation of wastes in health care units. Waste generated in the process of health care are composed of variety of wastes including hypodermic needles, scalpels, blades, surgical cottons, gloves, bandages, clothes, discarded medicine and body fluids, human tissues and organs, chemicals etc., Other wastes generated in healthcare settings include radioactive wastes, mercury containing instruments, PVC plastics etc., These are the most environmentally sensitive healthcare by products and needs a greater attention which has to be monitored (Remy, 2001).

Handling, segregation, mutilation, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management of biomedical waste in any establishment (Acharya and Singh Meeta, 2000). The key to minimization and effective management of biomedical waste is segregation (separation) and identification of the waste. The most appropriate way of identifying the categories of biomedical waste is by sorting the waste based on color. This has to be segregated into containers/ bags at the point of generation in accordance with Schedule II of Biomedical Waste (management and handling) Rules 1998 as given in Table I.

Category	Waste Category	Treatment & Disposal
1	**Human Anatomical Waste** (human tissues, organs, body parts)	Incineration /deep burial
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)	Incineration/ deep burial
3	**Microbiology & Biotechnology Waste** (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures)	Local autoclaving / microwaving / incineration
4	**Waste Sharps** (needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	Disinfection (chemical treatment 01/autoclaving / micro-waving and mutilation/ shredding
5	**Discarded Medicines and Cytotoxic Drugs** (wastes comprising of outdated, contaminated and discarded medicines)	Incineration /destruct ion and drugs disposal in secured landfills drugs disposal in secured
6	**Soiled Waste** (Items contaminated with blood, and body fluids including cotton dressings, soiled	Incineration autoclaving / micro-waving

	plaster casts, lines, beddings, other material contaminated with blood)	
7	**Solid Waste** (wastes generated from disposable items other than the waste shapers such as tubings, catheters, intravenous sets etc)	Disinfection by chemical treatment autoclaving/microwaving and mutilation
8	**Liquid Waste** (waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities)	Disinfection by chemical treatment and discharge into drains.
9	**Incineration Ash** (ash from incineration of any bio-medical waste)	Disposal in municipal landfill
10	**Chemical Waste** (chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.)	Chemical treatment and discharge into drains for liquids and secured land filled for solids

Handling, segregation, mutilation, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management of biomedical waste in any establishment. The key to minimisation and effective management of biomedical waste is segregation (separation) and identification of the waste as shown in Table 1. The most appropriate way of identifying the categories of biomedical waste is by sorting the waste into colour coded plastic bags or containers. The details are given in Table 2. Biomedical wastes should be segregated into containers/ bags at the point of generation in accordance with Schedule II of Biomedical Waste (management and handling) Rules 1998 (Notification: BMWM Rules, 1998).

Colour Coding	**Type of Container - I**	**Waste Category**	**Treatment options as per Schedule I**
Yellow	Plastic bag	Cat. 1, Cat. 2, and Cat. 3, Cat. 6.	Incineration/deep burial
Red	Disinfected container/plastic bag	Cat. 3, Cat. 6, Cat.7.	Autoclaving/Microwaving/ Chemical Treatment
Blue/White Translucent	Plastic bag/puncture proof Container	Cat. 4, Cat. 7.	Autoclaving/Microwaving/ Chemical Treatment and destruction/shredding
Black	Plastic bag	Cat. 5 and Cat. 9 and Cat. 10.	(solid) Disposal in secured landfill

When hazardous health care wastes are not properly managed, exposure to them could lead to infections, infertility, genital deformities, hormonally triggered cancers, mutagenicity, dermatitis, asthma and neurological disorders in children; typhoid, cholera, hepatitis, AIDS and other viral infections through sharps contaminated with blood (Johannessen et al., 2000; Smith, 2002; NIOSH, 2004; Askarian et al., 2004; Blenkharn, 2006a, b). The effect of the exposure may not be felt in some cases, until some years after. For instance a pharmacist who had worked full time for 20 months in a hospital intravenous preparation area where she routinely prepared cytotoxic drugs, was found with grade II papillary transitional cell carcinoma twelve years after she started the job (NIOSH, 2004). The full environmental effects of dumping of hazardous waste in unrestricted areas that contaminate soils and waters, with their consequent effects on plants, aquatic and wild lives, may take a long time to be appreciated. Hence, the health risks, the increased workload for healthcare workers and its damage to the environment beg for a collective commitment to waste management. Healthcare establishments owe it as a duty to the environment and public health to abide by agreement by Member States to the Basel convention (Basel Declaration, 1999). The agreement clearly stated that it remains the responsibility of healthcare establishments to treat and dispose wastes generated by them in such a manner as to ensure that there would be no adverse health or environmental effects. Management of healthcare waste

is not strictly about data compilation and technologies of waste treatment and disposal but it also involves training, commitment, management, leadership and effective legislation (Patil and Shekdar 2001).

General waste like garbage, garden refuse etc. should join the stream of domestic refuse. Sharps should be collected in puncture proof containers. Bags and containers for infectious waste should be marked with Biohazard symbol. Highly infectious waste should be sterilized by autoclaving. Cytotoxic wastes are to be collected in leak proof containers clearly labeled as cytotoxic waste (Acharya and Singh Meeta, 2000). Needles and syringes should be destroyed with the help of needle destroyer and syringe cutters provided at the point of generation. Infusion sets, bottles and gloves should be cut with curved scissors.

Disinfection of sharps soiled linen, plastic and rubber goods are to be achieved at point of generation by usage of sodium hypochlorite with minimum contact of one hour. Fresh solution should be made in each shift. On site collection requires staff to close the waste bags when they are three quarters full either by tying the neck or by sealing the bag. Kerb side storage area needs to be impermeable and hard standing with good drainage. It should provide an easy access to waste collection vehicle (Srivastava, 2000).

Effective waste management activities include waste segregation, collection, transportation, storage, disposal, minimization, and reuse (Rao et al., 2004). Even though it is becoming well recognized that for proper waste management, waste should be segregated right from the point of generation. Waste collection points become easy breeding sites for rodents, cockroaches, etc; and even domestic animals and humans visit to scavenge. Sometimes these wastes are left for days and weeks and are subjected to the direct effects of weather. These untreated wastes when beaten by rain are washed into the drainages, rivers, streams and other waters endangering human and aquatic lives. It was also not uncommon to find hospitals with overflowing open and shallow drainages that contain chemical waste from diagnostic laboratories, pharmaceutical waste from in-patient wards, human waste from theatres and mortuaries which may eventually end up in rivers and streams from which public water supplies are sourced and also used for agricultural irrigation.

It is very essential to properly collect, segregate, store, transport, treat and dispose this waste in safe manner. Incineration of biomedical waste is one of the most commonly adopted methods of treatment in India because of its low cost but Incineration causes bad environmental effects. Other than incineration the methods such as autoclave treatment, microwave treatment, dielectric heating, Depolymerization, Pyrolysis-Oxidation, etc are used in some places in India.

IX. RECOMMENDATIONS AND CONCLUSION:

- All health care facilities generating Bio-medical waste shall strictly ensure segregation, color coding and other provisions of Bio-medical waste (Management & Handling) rules, 1998 and amendments thereof.
- Incinerators, which do not confirm to the design and emission norms as per rules, must be modified and air pollution control system may be retrofitted to minimize the emission level.
- The operator should ensure proper operation and management (O&M) of incinerator through attainment of required temperature in both the chambers, regular operation of the incinerator, proper maintenance of the logbook and storage of the waste in isolated area, plastic incineration should not be undertaken.
- Proper training and personal safety equipment / accessories should be provided to waste handling staff.
- Records of waste generation, treatment and disposal should be maintained by the hospital.
- Various regulatory agencies, Hospitals, Medical Association & Municipal Corporation should work together for proper management of Bio-medical waste in the cities/towns.
- Common bio waste treatment facility in each city/town with strict monitoring of these facilities by regulatory agency should be implemented. Environmental agencies visit to the particular treatment plants can be made more mandatory and the management are highly possible in common facilities

only. Individual and local arrangements for the same should be discouraged. This is on account of the fact that improper operation may lead to increase in air pollution and other annoyance problem.

The development of waste management policies, plans, and protocols are recommended, in addition to establishing training programs on proper waste management for all healthcare workers.

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