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THEORTICAL STUDIES OF BIOMEDICAL WASTE AND ITS MANAGEMENT

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ABSTRACT
With the growth of healthcare facilities, the amount of biomedical waste produced every day is growing. If biomedical waste management is done correctly, many of the problems can be avoided. Segregation, storage, processing, transportation, and disposal of biomedical waste are all common practices undertaken as part of health care waste management. It involves interdisciplinary relationships in organizational, planning, administrative, financial, engineering, legal, and human resource creation. Biomedical waste management necessitates dedication from healthcare providers at all levels. The risks and value of their "contribution" are feared in a system run by reckless and untrained personnel. The importance of biomedical waste, its interaction with the ecosystem, the environmental pollutants used in the health care industry, and the effect of callousness on public health are all topics that are still largely unknown. To achieve better results, we must raise the level of training and education in biomedical waste and environmentally sustainable health care as quickly as possible, while adhering to all applicable rules and regulations. This study also focused on the problems associated with Biomedical waste. In the past, medical waste was often mixed with municipal solid waste and disposed in nearby landfills. In recent years, many efforts have been made by environmental regulatory agencies to bettermanage the biomedical waste.

Keywords: *Healthcare, biomedical waste*

INTRODUCTION
Many waste are produced as a result of human activities. Such waste may be dangerous and therefore need safe disposal. Industrial waste, sewage and agricultural waste pollute water, soil and air and it can also be dangerous to human beings and environment. Solid waste can be classified into different types depending on their source. It includes (a) House hold waste (b) Industrial waste (c) Biomedical waste or hospital waste or infectious waste. Hospital waste is considered as hazardous because they contain toxic substances. This waste is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities in these fields. Liquid waste can be divided into two components (a) Liquid reagents/ chemicals discarded and (b) the cleaning and washing water channeled into the drain. Until recently, medical waste management was not generally considered an issue. In the 1980s and 1990s, concerns about exposure to human immunodeficiency virus (HIV) and hepatitis B virus (HBV) led to questions about potential risks inherent in medical waste. Thus, hospital waste generation has become a prime concern due to its multidimensional ramifications as a risk factor to the health of patients, hospital staff and extending beyond the boundaries of the medical establishment to the general population. Hospital waste refers to all waste, biologic or non biologic that is discarded and not intended for further use. Medical waste is asubset of hospital waste; it refers to the material generated as a result of diagnosis, treatment or immunization of patients and associated biomedical research. Biomedical waste (BMW) is generated in hospitals, research institutions, health care teaching institutes, clinics, laboratories, blood banks, animal houses and veterinary institutes 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.

Biomedical waste includes syringes, live vaccines, laboratory samples, body parts, bodily fluids and waste, sharp needles, cultures and lancets.

Improper management of waste generated in health care facilities causes a direct health impact on the community, the health care workers and on the environment. The waste generated in these institutions essentially consists of solids and liquid, which may be hazardous, infectious and non-infectious. It has been estimated that up to 85% to 90% of the waste generated in hospitals is non-infectious (free with any body fluids, which is similar to domestic waste). It is the remaining 10% to 20% of waste that is of concern because it is hazardous and infectious. In addition, waste that is un-segregated and not treated in the right manner would cause environmental pollution affecting the health of the community. From waste audits done at several hospitals by a few NGOs, arrived at some figures, which can now be used and extrapolated for the whole country. These audits must be conducted only after adequate training on waste segregation is given to health care institutions.

Proper handling, treatment and disposal of biomedical wastes are important elements of health care office infection control programme. Correct procedure will help protect health care workers, patients and the local community. If properly designed and applied, waste management can be a relatively effective and an efficient compliance-related practice.

Proper collection and segregation of biomedical waste are important. At the same time, the quantity of waste generated is equally important. A lesser amount of biomedical waste means a lesser burden on waste disposal work, cost saving and a more efficient waste disposal system. Hence, health care providers should always try to reduce the waste generation in day-to-day work in the clinic or at the hospital.

To protect the environment and community health, the Ministry of Environment and Forest has notified, "Biomedical waste (Management and Handling) Rules 1998/ 2000 under the Environment (Protection) Act, 1986 that compel all hospitals, clinics, nursing homes, slaughter houses and laboratories to ensure safe and environmentally sound management of waste produced by them.

Safe and effective management of waste is not only a legal necessity but also a social responsibility. Lack of concern, motivation, awareness and cost factor are some of the problems faced in the proper hospital waste management. Clearly, there is a need for education as to the hazards associated with improper waste disposal. Lack of apathy to the concept of waste management is a major stymie to the practice of waste disposal. An effective communication strategy is imperative keeping in view the low awareness level among different category of staff in the health care establishments regarding biomedical waste management

Review of Literature

The UNEP reports, (2009) state that daily global generation of waste in 2006 was reported as 2.02 billion tonnes. At the global level, 18% – 64% health care facilities have unsatisfactory BMWM facilities, which include lack of awareness, inadequate resources and poor disposal mechanisms. In South-East Asian countries, 56% of medical facilities lack proper waste disposal and treatment (WHO, 2011). Similar situation existed in several other developing countries such as Senegal, Iran, Nigeria and Pakistan and the authors reported lack of infrastructure, state of collection, transportation, disposal, training, capacity building, PPEs and resource constraints in BMWM (Abah and Ohimain, 2011; Ali et al.,2015; Askarian et al., 2004). Pollution has also increased, because the rapid increase of waste generation has exceeded the earth‟s carrying capacity by 30 percent (Odum and Odum, 2006). A major concern for many fast growing cities in developing countries is the lack of proper planning, inadequate governance, resource constraint and ineffective management, solid waste, especially inadequate collection and improper disposal of the same (Pek and Othman, 2010; Medina, 2010).

The important steps identified are as follows: the institution of a sharp management system, avoidance of hazardous substances wherever possible, waste reduction, ensuring worker safety, providing appropriate methods of waste collection and transportation and installing safe treatment and disposal mechanisms (Abor and Bouer, 2008). It is estimated that some 5.2 million people (including 4 million children) die each year from waste-related diseases. Globally, the amount of hospital waste generated will be doubled by the year 2000 and quadruple in the year 2025 (Haque, 1994; Akter et al., 1999). A study in Bangladesh about BMW

in different health care centres reported the absence of appropriate policy and laws, awareness and willingness responsible for the improper management of BMW (Hassan, 2008). A study of BMW in low level health facilities of Tanzania reported that the medical waste management is still very poor and awareness and training should be provided to the staffs of the health care settings (Manyele, 2010).

Sources of biomedical waste:

Although the solid waste management has become one of the major topics 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. The sources of biomedical waste can be categorized as primary and secondary sources according to the quantities produced. While minor and scattered sources may produce some biomedical waste in categories similar to Bio medical waste, their composition will be different. The fig 1 and fig 2 illustrates the major and minor sources of biomedical medical waste.

Fig.1 The major sources of Biomedical waste

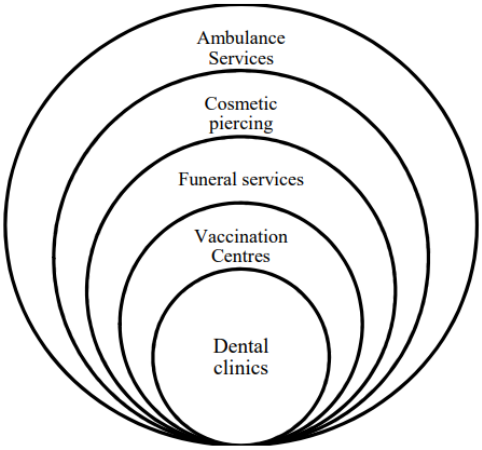

Fig.2. The Minor sources of Biomedical waste

Classification of biomedical waste

Approximately 75-90% of the biomedical waste is nonhazardous and as harmless as any other municipal waste. The remaining 10-25% is hazardous and can be injurious to humans or animals and deleterious to environment (fig.3).

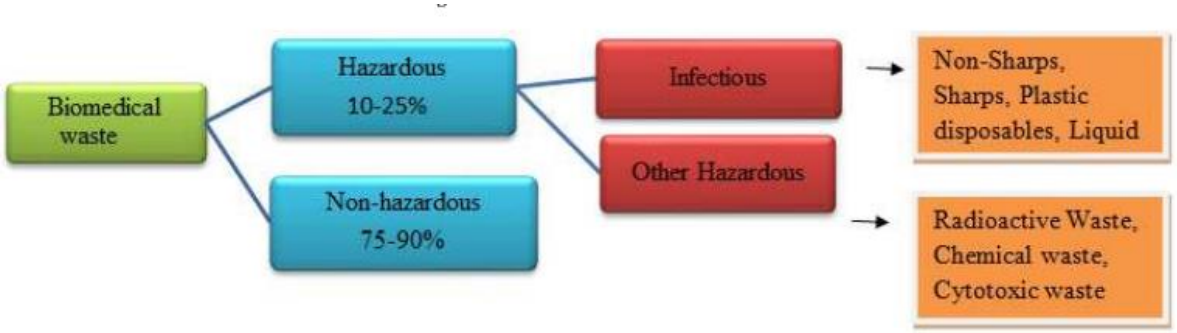

Fig.3 Classification of Biomedical waste

It is important to realize that if both these types are mixed together then the whole waste becomes harmful. Apart from these the WHO classified medical waste into 8 categories such as General Waste, Pathological, Radioactive, Chemical, Infectious to potentially infectious waste, Sharps, Pharmaceuticals, Pressurized containers. Whereas, In India, Ministry of Environment and Forest, Government of India (1998) has notified Bio-medical Waste (Management & Handling) Rules -1998, which describes ten categories shown in table 1.

Table.1: Categories and types of Biomedical waste

Category	Type
1	Human anatomical waste
2	Animal waste
3	Microbiology waste and laboratory waste
4	Waste sharps
5	Discarded medicines
6	Solid waste
7	Infectious solid waste
8	Chemical waste
9	Liquid waste
10	Incineration ash

Problems associated with biomedical waste

Biomedical waste is produced in all conventional medical units where treatment of (human or animal) patients is provided, such as hospitals, clinics, dental offices, dialysis facilities, as well as analytical laboratories, blood banks, university laboratories. Health care waste refers to all materials, biological or non biological, that is discarded in any health care facility and is not intended for any other use.

Within a health care facility or hospital, the main groups submitted to risks are:

Doctors, medical nurses, Patients, Visitors, Workers in ancillary services, Service workers dealing with waste treatment and disposal of health unit. Regarding the health care workers, three infections are most commonly transmitted: hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency (HIV) virus. Among the 35 million health care workers worldwide, the estimations show that each year about 3 million receive hard exposures to blood borne pathogens, 2 million of those to HBV, 0.9 million to HCV, and 170,000 to HIV. Also, the workers involved in the collection and treatment of the biomedical waste are exposed to a certain risk.

Treatment and disposal techniques for biomedical waste

There are several methods that have been successful in the treatment of infectious waste. The following are the methods that will show the treatment that may be available at your facility. The methods are: Autoclaving, Incineration, Thermal inactivation, Gas/Vapor Sterilization, Chemical Disinfection etc.

Autoclave

Autoclaves are closed chambers that apply both heat and pressure, and sometimes steam, over a period of time to sterilize medical equipment. Autoclaves have been used for nearly a century to sterilize medical instruments for reuse . Autoclaves are used to destroy microorganisms that may be present in medical waste before disposal in a traditional landfill. Autoclaves can be used to process up to 90% of medical waste, and

are easily scaled to meet the needs of any medical organization. Small counter-top autoclaves are often used for sterilizing reusable medical instruments while large autoclaves are used to treat large volumes of medical waste. Steam sterilization is most effective with low-density material such as plastics, metal pans, bottles, and flask. High-density polyethylene and polypropylene plastic should not be used in this process because they do not facilitate steam penetration to the waste load. Plastic bags should be placed in a rigid container before steam treatment to prevent spillage and drain clogging. Bags should be opened and caps and stoppers should be loosened immediately before they are place in the steam sterilizer. Care should be taken to separate infectious wastes from other hazardous wastes. Infectiouswaste that contains noninfectious hazards should not be steam-sterilized.

Waste that contains anti neoplastic drugs, toxic chemicals, or chemicals that would be volatilized by steam shouldnot be steam-sterilized.

Incineration

This is proved in which there is increase temperature causes dry oxidation. To reduce organic & combustible waste to inorganic incombustible to reduce volume & weight that cannot be reveled, reused or disposed in outer land fields. The drawbacks to incineration include the large capital and operating costs for modern technologies. The advantage of incineration is no Pretreatment is required and suitable for low heating volume above 2000 Kcal/Kg for single chamber & 3500 Kcal/Kg for double-chamber. The waste should be less moistured as less than 30% and also combustible.

Thermal inactivation

Thermal inactivation involves the treatment of waste with high temperatures to eliminate infectious agents. This method is usually used for large volumes. Liquid waste is collected in vessel and heated by heat exchangers or a steam jacket surround the vessel. The types of pathogens in the waste determine the temperature and duration of treatment. After treatment, the contents can be discharged into the sanitary sewer in a manner that complies with State, Federal, and local requirements. This method requires higher temperatures and longer treatment cyclesthan steam treatment.

Gas/vapor sterilization

Gas/vapor sterilization uses gaseous or vaporized chemicals as the sterilizing agents. Ethylene oxide is the most commonly used agent, but should be used with caution since it is a suspected human carcinogen. Because ethylene oxide may be adsorbed on the surface of treated materials, the potential exists for worker exposure when sterilized materials are handled.

Chemical disinfection

Chemical disinfection is the preferred treatment for liquid infectious wastes. Consider the following: Type of microorganism**,** Degree of contamination **,** Amount of proteinaceous material present, Type of disinfectant, Contact time **,** Other relevant factors such as temperature, pH, mixing requirements, and the biology of the microorganism**.** Ultimate disposal of chemically treated waste should be in accordance with State and local requirements.

Disposal of treated waste:

Infectious waste that has been effectively treated is no longer biologically hazardous and may be mixed with the disposed of as ordinary solid waste, provided the waste does not pose other hazards that are subject to federal or state regulations..

EPA recommends:

- Contacting state and local governments to identify approved disposal options.
- Discharge of treated liquids and pathological wastes (after grinding) to the sanitary sewer system.
- Approval of the local sewer authority must be obtained.

Health hazard from biomedical waste

The improper management of bio-medical waste causes serious environmental problems in terms of air, water and land pollution. The nature of pollutants can be classified into biological, chemical and radioactive. Environment problems can arise due to the mere generation of bio-medical waste and from the process of handling, treatment and disposal.

Air Pollution can be caused in both indoors and outdoors. Bio-Medical Waste that generates air pollution is of three types - Biological, Chemical and Radioactive. Indoor air pollutants like pathogens present in the waste can enter and remain in the air in an institution for a long period in the form of spores or as pathogens itself. 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 and should be strictly avoided. Water Pollution is another major threat from Bio-medical waste. If the waste is dumped in low-lying areas, or into lakes and water bodies, can cause severe water pollution. Water pollution can either be caused due to biological, chemicals or radioactive substances [22]. The pathogens present in the waste can leach out and contaminate the ground water or surface water. Harmful chemicals present in bio-medical waste such as heavy metals can also cause water pollution.

Land Pollution is caused by the final disposal of all bio-medical waste. Even liquid effluent after treatment is spread on land. Hence, pollution caused to land is inevitable. Open dumping of bio-medical waste is the greatest cause for land pollution [22]

Challenges of biomedical waste in India

- To treat 420561 kg per day of bio medical waste in accordance with Bio-Medical Waste Rules.
- Number of Common Bio Medical Wastes Treatment Facility (CBMWTF) to be increased manifold. Presently there are 157 facilities which are not adequate to handle all the bio medical wastes generated
- CBMWTF is to be set up under public private partnership mode.
- New technologies to be promoted for destruction of toxic bio medical wastes.

CONCLUSION

Hospital Management must understand the gravity of the issue and they must be able to differentiate between hospital waste and general waste. They must ensure proper identification, segregation at the source of generation, collection in prescribed colored containers, safe transportation, appropriate treatment and environmentally sound disposal of Bio-Medical Waste. They should also provide health education and training of everyone involved in the management and handling of Bio-Medical Waste. Last but not the least is effective implementation of rules by surprise visits and inspection by appropriate authorities and fixing the accountability of each and every person involved in management of Bio-Medical Waste. If Hospital Management wants to protect our environment and health of community Hospital Management must sense ourselves to this important issue not only in the interest of health managers but also in the interest of community.

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