

Biomedical Waste Management – A Review

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Abstract— Bio-medical waste is generated mainly by health care establishments. The management of Bio-medical waste is still infant all across the world. It consists of Bio-medical waste as well as chemical waste with a portion of solid waste. This is a review paper which is prepared from the surveys of various research papers on improper biomedical waste. This research article is to survey the practice of biomedical waste such as collection, storage, transportation and disposal along with the amount of generated biomedical waste in various hospitals. Biomedical waste management is one of the biggest challenges of the present day times. It has a direct impact on the health of the citizen of that city. It is hazardous in nature. It's safe and proper disposal is extremely important. As in many developing countries the generation of biomedical waste has increased significantly over the last few decades, management of this kind of waste continues to be a major challenge. Biomedical waste is generated in hospitals, research institutions, health care teaching institutes, clinics, laboratories, blood banks, animal houses and veterinary institutes. For proper management of bio-medical waste the Ministry of Environment and Forests has promulgated the Bio-Medical Waste (Management and Handling) Rules, 1998. Purpose of study was to highlight certain aspects of hospital waste management status. This paper will sensitize the reader about the impacts of improper waste management. Proper handling, treatment and disposal of the biomedical waste material are most important issue for the health of the human beings. The inadequate knowledge about the proper handling of biomedical waste can be dangerous to the health of common man as well as of health care personnel. This review discusses about various types of waste, its hazards and management.

Keywords- Bio-medical waste, hazardous, WHO, Segregation, recycling, disposal, Pathological, Radioactive Infectious, Pharmaceuticals, incineration

I. INTRODUCTION

Any solid, fluid or liquid waste, including its container and any intermediate product, which is generated during the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biological and the animal waste from slaughter houses or any other like establishments (Bio-medical waste rules 1998 of India) [1] is called as biomedical waste. Bio-medical waste is generated from health care establishments and also some small sources as blood banks, laboratories and research institutes. Hospital waste defined as all waste, biologic or non-biologic that is discarded and not intended for further use. Medical waste is a subset of hospital waste; it refers to the material generated as a result of diagnosis, treatment or immunization of patients and associated biomedical research [14]. Bio-medical waste contaminated by chemicals becomes hazardous these chemicals include formaldehydes and phenols (used as disinfectants), mercury etc.[12]. Proper management of hospital waste is essential to maintain hygiene, aesthetics, cleanliness and control of environmental pollution. The hospital waste like body parts, organs, tissues, blood and body fluids along with soiled linen, cotton, bandage and plaster casts from infected and contaminated areas are very essential to be properly collected, segregated, stored, transported, treated and disposed of in safe manner to prevent hospital acquired infection [22] [23] [24]. Various communicable diseases, which spread through water, sweat, blood, body fluids and contaminated organs, are important to be prevented. The Bio Medical Waste scattered in and around the hospitals invites flies, insects, rodents, cats and dogs that are responsible for the spread of communication disease like plague and rabies. Rag pickers in the hospital, sorting out the garbage are at a risk of getting tetanus and HIV infections. The recycling of disposable syringes, needles, IV sets and other article like glass bottles

without proper sterilization are responsible for Hepatitis, HIV, and other viral diseases. It becomes primary responsibility of Health administrators to manage hospital waste in most safe and eco-friendly manner. Hence, it is of prime importance to inculcate proper management and handling techniques of these wastes to eliminate any likely chances of proliferation of communicable disease or vectors, which includes proper training regarding the biomedical waste management and handling [21] [25].

II. CLASSIFICATIONS OF BIOMEDICAL WASTE

The wastes generated from health care units are generally classified as infectious and non-infectious. The infectious biomedical wastes are termed as hospital wastes and are considered to be potentially hazardous in nature. This waste is highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner [5].

a. Non-Hazardous Wastes: This includes wastes constituting remnants of food and peels of fruit; wash water as well as paper cartons; packaging materials etc. [7]

b. Hazardous Wastes: Potentially Infectious Wastes In the scientific documents as well as in the regulations and guidance various terms for infectious wastes have been used over the years. These include: infectious as well as infective; medical and biomedical; hazardous and red bag; contaminated; infectious medical wastes; along with regulated wastes in the medical profession. Basically all these terms indicate the similar types of wastes even though the terms involved in regulation are defined usually in more specific manner. Hospital, like any other center of man's activities, is a source for waste generation [7].

Biomedical wastes can be categorized based on their origin and physical, chemical or biological characteristics [10].

- General waste: Largely composed of domestic or household type waste. It is non-hazardous to human beings, e.g. kitchen waste, packaging material, paper, wrappers, and plastics.
- Pathological waste: Human body parts, tissues and organs.
- Infectious waste: The wastes which contain pathogens in sufficient concentration or quantity that could cause diseases. It includes cultures and stocks of infectious agents from laboratories, waste from surgery, waste originating from infectious patients.
- Sharps: Physically hazardous biomedical waste like needles, broken glass, saws, nail, blades, and scalpels.
- Pharmaceutical waste: Drugs and pharmaceutical products that are contaminated outdated or have been spilled.
- Chemical waste: chemicals disposed in cleaning, housekeeping, and disinfecting.
- Radioactive waste: It includes solid, liquid, and gaseous waste that is contaminated with radionuclides generated from in-vitro analysis of body tissues and fluid, in-vivo body organ imaging and tumor localization and therapeutic procedures

III. LITERATURE REVIEW

A survey by B. Ramesh Babu, A.K. Parande, R. Rajalakshmi, P. Suriyakala, M. Volga [18] 2001 was carried out to review biomedical waste management in India in order to improve waste management. The objective of study was to classify the characteristics of waste and create the implementation structures, different methods are used for the disposal of bio medical waste. The research was conducted to find proper management of Bio medical waste. They also survey for treatment technologies for medical wastes. Numerous factors such as type of hospital, specialization, proportion of reusable items, and waste management plan were investigated in waste generation assessment in India specially in Delhi.

Dr.C.Periya Ganesh 2015 [2] focuses various terminologies of biomedical waste management and disposal of clinical waste in private hospitals in India. This also includes waste transportation, waste accumulation and storage, waste minimization techniques. A major problem related to current Bio-Medical waste management in several hospitals is that the implementation of Bio-Waste regulation is disappointing as some hospitals are disposing of waste in a haphazard, improper and indiscriminate manner. Inadequate Bio-Medical waste, the recycling of throw away syringes, needles, IV sets and other article like glass bottles without proper sterilization are accountable for Hepatitis, HIV, and other viral diseases. He suggested need for education as to the hazards associated with improper waste disposal.

Zekieni R. Yelebe¹, Revelation J. Samuel² and Blessing Z. Yelebe [3] 2015, studied biomedical waste treatment, a case study of some selected hospitals in Bayelsa State, South-South, Nigeria. During this study, author observed that majority of the hospitals investigated had no waste

management department or plan. There is also no training programme for the sanitary workers. Only hospital C and E has a pit used for burning some waste. Also he suggested the segregation of bio-medical waste. Author collected the data about the average quantity of biomedical waste generated by all ten hospitals. The result shows that these ten hospitals cumulatively generate approximately 4330 kg of medical waste per month, of which only about 35% is non-infectious. 65% of biomedical waste generated by hospitals is infectious and harmful to humans and the environment.

S.B.Abitha, R.Dhanapal [5] 2014, published a paper ON Biomedical waste management in rural areas using solar powered thermal autoclave technique. Authors introduce a technique of bio-medical waste management, Solar thermal powered autoclave with EWS system. This system is suitable for wet sterilization of medical instruments in remote and rural areas of developing countries. This system acquires energy from sunlight collected through semi parabolic black mirrors. The extracted energy transferred to aluminum plate through forced transmission. The high pressurized autoclave in presence of water kills all microbes, spores and viruses. This technique utilizes solar energy directly. It can be highly utilized in areas of large rural population supporting small hospitals and clinics with lack of reliability to electricity. It is cost-effective sustainable way to minimize pollution in rural areas of developing nations.

Nosheen Arshad, Shamail Nayyar, Dr. Fatima Amin and Dr. Khawaja Tahir Mahmood conducted a survey on all existing methods for handling and management of medical waste disposal in Pakistan. A cross-sectional study was conducted in five hospitals (2 private and 3 governments) Children hospital, Sheikh Zayed hospital, Shaukat Khanum hospital, Mian Munshi hospital, Shalamar hospital of Lahore in July 2010. Different types of waste produced in hospitals including radioactive. Various methods of segregation of bio-medical wastes are surveyed and found the effective result like proper segregation with need for raising awareness about medical waste and its related issues.

Patan S, Mathur P [7] 2015, presents an overview of the current management practices of health care waste in the Janana Govt hospital of Ajmer city. Information regarding generation, segregation, transportation, and disposal of biomedical wastes is provided and discussed. The main treatment method used in the final disposal of infectious waste is incineration. Non-infectious waste is disposed of using land disposal method. The wastes are not properly segregated, collected and disposed in all the services of the hospital, which may lead to a negative impact on public health and on the environment. This paper presented an assessment of biomedical waste management. Authors suggested that comprehensive training programs regarding Bio-Medical waste management are highly recommended to all hospital staff.

In the study of Dr. D. Rama Mohan, Dr. M. Veera Prasad, Dr. Kanagaluru Sai Kumar [8] 2012, medical waste management status was analyzed. A survey was conducted to evaluate

medical waste management aspects in selected hospitals. The effectiveness of the training programme was also measured and rated by collecting the opinion of respondents. Nearly 33.33 percent of staff acquired knowledge on what is biomedical waste, 89.74 percent of the respondents acquired knowledge on the categories of biomedical waste management, 69.23 percent have acquired knowledge on categories of animal waste and 69.23 percent have acquired knowledge on category of human anatomical waste. Author recommended that the need for reinforcement with continuous nursing education programme on critical topics like generation, segregation is required, so that their behavior practices will change for better self-care as well as patient care and also to prevent transmission of diseases.

A study was conducted by Dr. Sushma Rudraswamy, Dr. Naganandini Sampath, Dr. Nagabhushana Doggalli [9] 2013, to determine the amount of different kinds of solid wastes and assess the obstacles in the existing hospital's solid waste management system in hospitals of various countries worldwide.. The waste generation rates depend on several factors such as established waste management methods, type of health-care establishment, hospital specializations, proportion of reusable items employed in health care and proportion of patients treated on a day-care basis. Solution lies in the proper training of the hospital staff to segregate the waste and by training the municipal staff regarding the disposal of such waste.

A research was carried out by Dhruv P. Hirani, Krish R. Villaitramani, Snehit J. Kumbhar [10] 2014, on management of biomedical waste. The objective of study was to classify the characteristics of waste and create the implementation structures at hospital. The research was conducted to find the average daily waste generated from hospital and clinics. Numerous factors such as type of hospital, specialization, proportion of reusable items, and waste. Biomedical waste should be safely and efficiently identified, segregated, stored, transported and disposed after appropriate treatment. Its effective implementation in our community is of prime importance to protect public health and environment.

Anurag V. Tiwari, Prashant A. Kadu [11] 2014, conducted a survey on biomedical waste in Amravati city. The objective of this study was Assessment Biomedical Waste Management in Amravati City. Data was recorded by visiting all possible areas and using an appropriately designed questionnaire containing 28 question regarding general information, handling, segregation, disposal and a health hazard of biomedical waste. This data was tabulated and analyzed by various statistical methods as per need and results were found out from the collected data. The study revealed that the system of biomedical waste management should be improved and there is lack of necessary knowledge and information regarding biomedical waste management system. During study it was observed that waste is not collected at regular interval. Proper segregation of this waste at hospitals is recommended. This paper carried out statistical methods to measure and analyze clinical waste generation rate at Amravati.

V.V. Prabhakar Rao , G. Uday Kiran, [13] 2014, determined that the segregation of waste at source is the key step and

reduction, reuse and recycling should be considered in proper perspectives The purpose of this article is to discuss about various types of biomedical waste produced in the hospitals, different waste management practices, the hazards of indiscriminate disposal of biomedical waste and to create awareness among the medical profession, regarding minimizing the production of biomedical waste and doctors are encouraged to follow the best management practices, while disposing hazardous wastes. The present study is to survey the practice of biomedical waste such as collection, storage, transportation and disposal along with the amount of generated biomedical waste in various healthcare units in Eluru city, and create awareness among the staff and patient about biomedical wastes.

In the study of Deborah, J. M., M.N. Dammo., Hanatu, J. T., Gambo, Zubairu., Fanna, Kyari and Zara, Kolo [15] 2014, Current Solid Waste Disposal Practice In University Of Maiduguri Teaching Hospital was analyzed in Nigeria. A survey was conducted to evaluate solid waste management aspects. This study aim to examine data on the hospital waste generated, collection system, process or form of treatment, transportation and disposal system. Several factors such as hospital size, hospital location, beds occupancy percentage, medical waste segregation program, type of hospital and type of services were investigated in order to calculate medical waste generation rate. The disposal option is open dump and burial in secured landfill which is safe and environmental friendly.

Amal Sarsour, Aaeid Ayoub, Ihab Lubbad, Abdelnaser Omran, Isam S, [17] 2014, conducted a assessment of Medical Waste Management within Selected Hospitals in Gaza Strip Palestine. In the study, statistical methods were used to develop mathematical models for prediction of hospital waste quantities. A pilot study was carried out in two hospitals in Gaza Strip after receiving the formal approval from the Director – General of the Ministry of Health. Al Shifa hospital in Gaza city represents governmental hospital and Al Awdah hospital in the north area represents nongovernmental hospital.

IV. RESULT AND DISCUSSION

Waste (glassware, plastic material dressing kits, surgical kits and other disposables) were observed to be minimized by recycling and reusable of items subject to proper cleaning and disinfection. Surgical department showed high rates of waste generation per day. The staff handling infectious waste, were limited to the rooms of patients with highly infectious disease to minimize exposure of infectious waste. The segregation of various types of waste into their different categories according to their treatment/disposal option was done at the point of generation in color coded plastic bags and containers, to Protect waste handlers and the public from possible injury and disease that could result from exposure to the waste and Avoid attraction to rodents and vermin. Hospital solid waste were observed to be collected in an open dumping site within the Hospital premises and burnt openly. Sorting of waste at source of generation with pretreatment in hospital only before disposal would be the best option.

Colour coding-biomedical waste (management and handling) rules, 1998

Color coding	Type of container	Waste categories
Yellow	Plastic bags	Category 1: Human anatomical Waste, Category 2: Animal waste, Category 3: Microbiology waste from pathological lab. Category 6: Soiled waste i.e. items contaminated with blood and body fluids
Red	Disinfected container Plastic bags	Category 3: Microbiological Category 6: Soiled waste Category 7: Solid waste (waste IV tubes) (catheter, etc)
Blue/white translucent	Plastic bag/puncture proof containers.	Category 4: Waste sharps Category 7: Plastic disposal tubings. etc
Black	Plastic bag/Puncture Proof Containers	Category 5: Discarded medicines Category 9: Incineration ash Category 10: Chemical waste

V. APPROACH

In India, the Bio Medical Waste Management Rules, 1998 and further amendments were passed for the regulation of bio medical waste management. Each state's Pollution Control Board or Pollution control Committee will be liable for implementing the new legislation in India. There are a number of special disposal methods, yet most are harmful rather than helpful. If body fluids are nearby, the substance desires to be incinerated or put into an autoclave. Although this is the appropriate method, most medical facilities fail to follow the system. It is often found that biomedical waste is put into the ocean, where it ultimately washes up on shore, or in landfills due to inappropriate sorting when in the medical facility. Improper disposal can lead to many diseases in animals as well as humans [2].

Rules and guidelines in opposition to Biomedical Waste Management System,

1. The Air (Preclusion and Organize of Pollution) Act 1981
2. The Environment (Security) Act 1986
3. The Dangerous Waste (Managing & Handling) Rules 1989
4. The National Environmental Tribunal Act 1995
5. The Biomedical Waste (Managing & Behavior) Rules 1998
6. The Municipal Solid Waste (Management & Handling) Rules 2000.

VI. CONCLUSION AND RECOMMENDATION

After surveying and review has been carried out on selected 20 research papers on biomedical and hospital / clinical waste in various cities of India and other countries, it is found that several factors such as reusable items, waste management plan, economic, social and cultural status of the patients etc. effect on quantity of waste generation. The disposal option is open dump and burial in secured landfill which is safe and environmental friendly. Awareness of biomedical waste management is required among the peoples and users to avoid hazardous effects of its inappropriate disposal. Proper management of biomedical waste should be maintained. Every concerned health personnel are expected to have proper knowledge, practice, and capacity to guide others for waste collection, proper handling techniques, and management. To achieve this all the health personnel as required to undergo continuing training programme on biomedical waste management and are encouraged to follow best management practices while disposing. Lastly, proper segregation of this waste at hospitals is recommended.

The waste may be temporarily stored at the central storage area of the hospital and from there it may be sent in bulk to the site of final disposal.

During transportation following points should be taken care of:

- Ensure that waste bags/containers are properly sealed and labeled.
 - Bags should not be filled completely, so that bags can be picked up by the neck again for further handling. Hand should not be put under the bag.
 - Manual handling of waste bags should be minimized to reduce the risk of needle prick injury and infection.
 - After removal of the bag, clean the container including the lid with an appropriate disinfectant.
 - Waste bags and containers should be removed daily from wards / OPDs or even more frequently if needed (as in Operation Theatres, ICUs, labour rooms).
- Waste bags should be transported in a covered wheeled containers or large bins in covered trolleys.

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