BIOMEDICAL WASTE GENERATION AND MANAGEMENT IN VARIOUS HOSPITALS IN ELURU CITY OF ANDHRA PRADESH, INDIA-CASE STUDY

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ABSTRACT

Our modern medical science has discovered many advanced treatment methods to save our lives. The indiscriminate disposal of untreated biomedical wastes is the cause of spread of infectious diseases. Apart from these, a good amount of biomedical wastes including disposable syringes, saline bottles, IV fluid bottles, etc. are picked up by the rag pickers, and are recycled back to the market without disinfection. It is imperative, therefore, to adopt appropriate system for the safe collection, storage, transport, treatment and disposal of biomedical wastes. Realizing the seriousness of the problems associated with the poor management of the biomedical wastes, the Ministry of Environment and Forest Government of India notified the Bio-Medical Wastes (Management & Handling) Rules, 1998 in order to regulate the environmental menace due to mismanagement of hospital waste. WHO estimated that, in 2000, injections with contaminated syringes caused 21 million hepatitis B virus infections. In literature, it is found that 15% to 35% of hospital waste is treated as infectious waste.

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 Eluru, nearly 71 hospitals and clinics were located in different parts of the city, generating large amounts of bio-medical waste. About one and a half kilograms waste are produced per day per bed, of which about 47 percent is only biomedical waste. It has been observed that many of them were not following proper disposal methods besides the invention of a new possible way of waste management; the present article intends to create awareness among the personnel involved in health care units, in their handlings and disposal of biomedical waste.

Key Words*: *Hazardous Waste, Biomedical Waste, Healthcare Units, Waste Management, Eluru.

I INTRODUCTION

According to Biomedical Waste (Management and Handling) Rules, 1998 of India, "Any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological. World Health Organization states that 85%of hospital wastes are actually non-hazardous, whereas 10% are infectious and 5% are noninfectious but they are included in hazardous wastes. About 15% to 35% of Hospital waste is regulated as infectious waste. This range is dependent on the total amount of waste generated (Glenn and Garwal, 1999).The Hospital waste management has been brought into focus in India recently, particularly with the notification of the Biomedical Waste (Management and Handling) rules, 1998, in which the rule makes it mandatory for the health care establishments to segregate, disinfect, and dispose of their waste in an eco-friendly manner. Center for Disease Control recommend that medical waste disposal must be carried out in accordance with regulations.

Biomedical waste is broadly classified into hazardous and non hazardous. Hazardous waste is the waste that is dangerous or potentially harmful to our health and the environment. Hazardous wastes are potentially infectious and potentially toxic such as radioactive waste chemical waste and pharmaceutical waste. Improper disposal of these materials can lead to unexpected releases of biomedical waste. This management has recently emerged as an issue of major concern not only to hospitals, and nursing home authorities but also to the environment. The bio-medical wastes generated from health care units depend upon a number of factors such as waste management methods, type of health care units, occupancy of healthcare units, specialization of healthcare units, ratio of reusable items in use, availability of infrastructure and resources. The proper management of biomedical waste has become a worldwide humanitarian topic today. Although hazards of poor management of biomedical waste have aroused the concern world over, especially in the light of its far-reaching effects on human, health and the environment. Now it is a well established fact that there are many adverse and harmful effects to the environment including human beings which are caused by the "Hospital waste" generated during the patient care. Hospital waste is a potential health hazard to the health care workers, public and flora and fauna of the area. The problems of the waste disposal in the hospitals and other health-care institutions have become issues of increasing concern.

There may be increased risk of infections in patients due to poor waste management. Improper waste management can lead to change in microbial ecology and spread of antibiotic resistance. The best disposal options are prevention or minimize the toxic substances from hospitals to the environment.

1.1 Objectives of Biomedical waste management:

- To prevent transmission of disease from patient to patient, from patient to health workers and to prevent injury to the health care workers in support services, while handling biomedical waste.
- To create awareness to general public and health professionals exposure about harmful effects of the cytotoxic, genotoxic and chemical biomedical waste.

1.2 Study area:

Eluru is located at 16.7°N 81.1°E. It has an average elevation of 22 meters (72 feet). Eluru is a city and one of the ten municipal corporations in the Indian state of Andhra Pradesh. It is also the headquarters of West Godavari district. As of 2011 census, the city had a population of 214,414 and an urban agglomeration population of 250,693.Eluru was earlier called Helapuri and has a rich cultural and political history. Eluru was upgraded from a municipality to corporation in April 2005 that eventually made it a well developed town.

Figure 1: Map showing study area

II CATEGORIES OF BIOMEDICAL WASTE

There are ten categories notified in The Government of India, "Biomedical Waste (Management and Handling) rules" 1998. They are:

SCHEDULE	TREATMENT & DISPOSAL	MANAGEMENT
Category No 1	Incineration/deep burial	Human Anamolical waste etc...
Category No 2	Incineration/deep burial	Animal Waste, Animal Tissues, Organs, Body parts carcasses, bleeding part, fluid, blood & experimental animals used in research, waste generated by veterinary hospitals / colleges, discharge from hospitals, animal houses)
Category No 3	Local autoclaving/micro waving/incineration	Microbiology & Biotechnology waste
Category No 4	Disinfections (chemical treatment/autoclaving/micro waving and mutation shredding	Waste sharps (needles, syringes, scalpels etc. This includes both used & unused sharps)
Category No 5	Incineration/destruction & drugs disposal in secured landfills	Discarded Medicines & Cyclotoxic drugs
Category No 6	Incineration, autoclaving/microwaving	Solid waste (items contaminated with blood & body fluids including cotton, dressings etc...)
Category No 7	Disinfections by chemical treatment and discharge into drain	Solid waste (waste generated from disposable items other than the waste sharp such as tubing, catheters etc…)
Category No 8	Disinfections by chemical treatment and discharge	Liquid waste (waste generated from laboratory & washing etc…)
Category No 9	Disposal in municipal landfill	Incineration Ash (ash from incineration of any bio-medical waste)
Category No 10	Chemical treatment & discharge into drain for liquid & secured landfill for solids	Chemical waste (chemicals used in production of biological, chemicals, used in disinfect ion, as insecticides, etc…)

Table-1: categories of biomedical waste

2.1 Classification of Bio-Medical Waste:

The World Health Organization (WHO) has classified medical waste into eight categories:

1. General Waste, 2.Pathological 3.Radioactive 4.Chemical
5. Infectious to potentially infectious waste 6.Sharps 7.Pharmaceuticals 8. Pressurized containers

2.1.1 Anatomic biomedical waste:

1. Pathologic waste: Blood, blood products, bodily fluids, and tissues.

2. Infectious waste: Culture infectious agents, associated biological (e.g., culture flasks, petri plates, specimens, vaccines, wastes from the production of biological, chemicals, disinfectants, sterilizing agents. Infectious waste is that part of medical that has been shown through controlled studies capable of transmitting an infectious disease.

2.1.2 Non anatomic biomedical waste:

Waste from medical materials/equipment/disposables that appear to be medical waste:

1. Mercury-containing: Elemental mercury, scrap amalgam.
2. Silver-containing: Spent X-ray fi xer, undeveloped film.
3. Lead-containing: Lead foils packets, lead aprons, broken thermometers, and blood pressure gauges.
4. Chemical or pharmaceutical waste: chemicals, disinfectants, sterilizing agents, expired drugs, waste-bearing cytotoxic/genotoxic properties.
5. Contaminated/uncontaminated sharps: syringes (with/without needles), broken glass, scalpels, specimen tubes, and slides.

2.1.3 Regulated waste:

Regulated waste includes all "sharps" such as disposable needles, scalpel blades, broken glass, burs, endodontic files and reamers, blood, and blood-soaked or blood-caked items, human tissue, extracted teeth, and waste from pathological procedures. Regulated waste requires special disposal in biohazard containers or bags. Since extracted teeth are potentially infectious, they are considered regulated waste. Only teeth without amalgam may be heat sterilized. Teeth containing amalgams can be placed in biohazard containers for pickup.

2.1.4 Non-regulated waste:

Includes items such as used patient bibs, barriers used during treatment, and saliva soaked gauze. If this waste contains potentially infectious materials, even if it is considered non-regulated, it should be labeled with a biohazard label. Any waste container that holds "potentially infectious" waste materials, whether regulated or non-regulated must be labeled with the biohazard symbol.

2.1.5 Hazardous waste:

Hazardous waste is a waste with properties that make it dangerous or potentially harmful to human health or the environment. Hazardous waste takes many physical forms and may be solid, semi-solid, liquid, or even contained gases. Any waste container that holds "potentially infectious "waste materials, whether regulated or non regulated must be labeled with a biohazard symbol.

III SOURCES OF BIOMEDICAL WASTE

Hospitals produce waste, which is increasing over the years in its amount and type. The hospital waste, in addition to the risk for patients and personnel who handle them also poses a threat to public health and environment.

3.1 Major Sources:

- Govt. hospitals/private hospitals/nursing homes/ dispensaries.
- Primary health centers.
- Medical colleges and research centers/paramedic services.
- Veterinary colleges and animal research centers.
- Blood banks/mortuaries/autopsy centers.
- Biotechnology institutions.
- Production units.

3.2 Minor Sources:

- Physicians/ dentists' clinics
- Animal houses/slaughter houses.
- Blood donation camps.
- Vaccination centers.
- Acupuncturists/Psychiatric clinics/cosmetic piercing.
- Funeral services.
- Institutions for disabled persons

IV BIOMEDICAL WASTE MANAGEMENT PROCESS

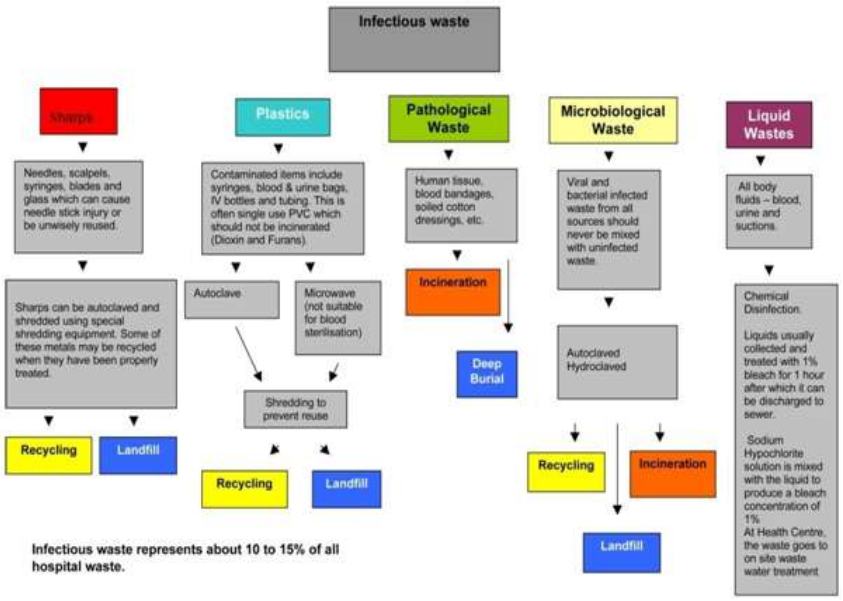

Figure 2-Waste Management Research-Bio-Medical Management

There is a big network of Health Care Institutions in India. 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 nosocomial or hospital acquired infection.

The following are the steps for biomedical waste management process

1. Collection of biomedical waste
2. Segregation
3. Handling and storage
4. Biomedical Waste Treatment and disposal

4.1 Collection of biomedical waste: Collection of biomedical waste should be done as per biomedical waste (management and handling) rules, at ordinary room temperature the collected waste should not be stored for >24 h.

4.2 Segregation: The "key for waste management" is waste segregation. Only a segregation system can ensure that the waste will be treated according to the hazards of the waste and that the correct disposal routes are taken, and the correct transportation equipment will be used. Recycling can be only carried out if recyclable materials are separated from the hazardous waste. Contaminated materials are excluded from any recycling activity, and they must be treated as mixed hazardous waste. Without effective segregation system, a complete waste stream must be considered as hazardous. The correct segregation is the clear responsibility of every waste generator. If the waste is unclear or not recognizable, then that waste must be classified in the highest to be expected risk group. Segregated waste should not be mixed during transport and storage. If hazardous and nonhazardous wastes are mixed, the entire mixture must be considered and treated as hazardous waste. Only a segregation system can ensure that the waste will be treated according to the hazards of the waste and that the disposal routes are taken.

4.3 Handling and storage:

Safe handling of regulated waste is essential. Involved personnel must be informed of the possible health hazards present and be trained in appropriate handling, storage, and disposal methods. In response to a continuing concern about exposure and the development of technological advances that increase employee protection. Generally, waste should not be stored for >30 days

4.4 Biomedical Waste Treatment and Disposal:

Health care waste is a heterogeneous mixture, which is very difficult to manage as such. But the problem can be simplified and its dimension reduced considerably if a proper management system is planned.

4.4.1 Incineration Technology

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. These are refractory lined.

4.4.2 Non-Incineration Technology

Non-incineration treatment includes four basic processes: thermal, chemical, irradiative, and biological. The majority of non-incineration technologies employ the thermal and chemical processes. The main purpose of the treatment technology is to decontaminate waste by destroying pathogens. Facilities should make certain that the technology could meet state criteria for disinfection.

Bag Colour	Description
Yellow	**Infectious waste contaminated with chemicals** Clinical waste, infectious, containing chemicals from healthcare For clinical waste incineration only Classed as Hazardous waste
Orange	**Infectious waste (not containing chemicals or medicinal contamination)** Clinical waste, infectious, containing chemicals from healthcare Suitable for alternative treatment or clinical waste incineration Classed as Hazardous waste
Purple	**Cytotoxic and cytostatic waste** Clinical waste, cytotoxic and cytostatic waste, infectious For incineration only Classed as Hazardous waste
Yellow &Black	**Offensive/hygiene waste** Offensive waste, municipal or from healthcare For incineration, landfill ,energy from waste or other authorised disposal/recovery Classed as Non-hazardous waste
Red	**Anatomical waste for incineration** Indicative treatment/disposal required is **incineration** in a suitably permitted facility. For clinical waste incineration only Classed as Hazardous waste
Blue	**Medicinal waste for incineration** Indicative treatment/disposal required is **incineration** in a suitably permitted facility. Can be classed as Hazardous waste
Black	**Domestic (municipal) waste** Mixed municipal waste Classed as Non-hazardous waste
White	**Dental Amalgam** Dental amalgam and mercury including spent and out-of-date capsules, excess mixed amalgam and contents of amalgam separators For recovery Classed as Hazardous waste

Figure 3: Color coding of the segregated waste

4.4.3 Autoclaving

The autoclave operates on the principle of the standard pressure cooker. The process involves using steam at high temperatures. The steam generated at high temperature penetrates waste material and kills all the micro organisms. These are also of three types: Gravity type, Pre-vacuum type and Retort type. In the first type (Gravity type), air is evacuated with the help of gravity alone. The system operates with temperature of 121 deg. C. and steam pressure of

15 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 about 132 deg. C.

Retort type autoclaves are designed much higher steam temperature and pressure. Autoclave treatment has been recommended for microbiology and biotechnology waste, waste sharps, soiled and solid wastes. This technology renders certain categories (mentioned in the rules) of bio-medical waste innocuous and unrecognizable so that the treated residue can be land filled.

4.4.4 Microwave Irradiation

The microwave is based on the principle of generation of high frequency waves. These waves cause the particles within the waste material to vibrate, generating heat. This heat generated from within kills all pathogens.

4.5 Chemical Methods

1 % hypochlorite solution can be used for chemical disinfection

4.5.1 Plasma Pyrolysis:

Plasma pyrolysis is a state-of-the-art technology for safe disposal of medical waste. It is an environment-friendly technology, which converts organic waste into commercially useful byproducts. The intense heat generated by the plasma enables it to dispose all types of waste including municipal solid waste, biomedical waste and hazardous waste in a safe and reliable manner. Medical waste is pyrolysed into CO, H2, and hydrocarbons when it comes in contact with the plasma-arc. These gases are burned and produce a high temperature (around 1200oC).

V DISCUSSION

The majority of soiled items are not regulated waste, for example, used gloves, masks, and gowns are not considered as regulated waste and thus can be added to the regular trash. With the exception of a relatively limited number of items, medical waste can be disposed of using regular waste removal and disposal schemes. In many hospitals the best biomedical waste management practices are not following meticulously by the Doctors, nurses and staff. There are many studies available on the improper disposal of biomedical waste. Punchanuwat *et al*. did a study to investigate and followed the disposal of clinical waste within dental surgeries in Bangkok and found that most wastes were disposed of into the domestic rubbish stream. It was found that in this study that many clinics were not following the proper disposal methods.

As per WHO; SEARO, the 11 South-East Asian countries together produce some 350,000 tons of health care waste per year, close to 1000 tons a day, which is both hazardous and nonhazardous, and it is unimaginable production from the entire world in a day and how much burden on the environment. Sharps are regarded as highly hazardous health care waste since they can cause injuries and puncture wounds. Because of exposure of the contaminated sharps, the risk of transmission of blood borne pathogens, such as HIV, hepatitis B and C is always possible. According to WHO many cases of infection with various pathogens due to exposure to improperly managed health care waste was documented. Reports from US EPA, the dentists are exposing to viral hepatitis B infections is <1%, whereas dental assistants 5-8% resulting from exposure to sharp injuries annually.

As per the BMW National Guidelines, 48 h is the maximum time limit for which biomedical waste can be stored before transporting to common waste treatment facility. Non-chlorinated and incurable plastic bags can be used for the collection of waste, to avoid release of "dioxins and furans" into the environment. It is required to disinfect the waste so that it is no longer a source of infection and reduces the volume of waste.

VI RECOMMENDATIONS

- Every hospital should have special boxes to use as dustbin for bio-medical waste.
- There is biomedical waste label on waste carry bags and waste carry trolley and also poster has put on the wall adjacent to the bins (waste) giving details about the type of waste that has to dispose in the baggage as per biomedical waste management rule.
- As provided by bio-medical waste rules, the whole of the waste should be fragmented into colours due to their hazardous nature.
- Special vehicle i.e. bio-medical waste vehicle should be started to collect waste from private hospitals and private medical clinics and carry it up to the main incinerator
- Housekeeping staff wear protective devices such as gloves, face masks, gowned, while handling the waste.
- Bio-medical waste should not be mixed with other waste of Municipal Corporation.
- Bio-medical waste Management Board can be established in each District.

VII CONCLUSION

The segregation of waste at source is the key step and reduction, reuse and recycling should be considered in proper perspectives. Medical wastes should be classified according to their source, typology and risk factors associated with their handling, storage and ultimate disposal. We need to consider innovative and radical measures to clean up the distressing picture of lack of civic concern on the part of hospitals and slackness in government implementation of bare minimum of rules, as waste generation particularly biomedical waste imposes increasing direct and indirect costs on society. 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.

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