BIOMEDICAL WASTE MANAGEMENT IN DELHI HOSPITALS-A CASE STUDY

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE
OF

MASTER OF TECHNOLOGY
IN
ENVIRONMENTAL ENGINEERING

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CERTIFICATE

This is to certify that Major project entitled, "***Biomedical Waste Management In Delhi Hospitals-A Case Study***" submitted by MADHU BALA **(2K12/ENE/18)** in partial requirements for the award Degree of Master of Technology (Environmental Engineering) at Delhi Technological University. During the academic year 2015 is an own work carried out by the student under my supervision, and this work has not formed the basis for the award of any Degree, Diploma or such other titles.

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CANDIDATES'S DECLARATION

I hereby declare that the work which is being presented in this project report entitled "***Biomedical Waste Management In Delhi Hospitals-A Case Study***"submitted as Major Project towards the fulfillment of the requirements for the award of the Degree of Master of Technology with Specialization in Environmental Engineering, Delhi Technological University, Delhi, is an authentic record of my own work carried out under the supervision of **Prof. Dr. (Mrs.) Anubha Mandal**, **Asst. Prof. Anunay Gour** Environmental Engineering Department, at Delhi Technological University, Delhi and **Dr. Chandra Prakash** (Incharge CMC), Delhi Pollution Control Committee.

The matter embodied in this dissertation report has not submitted by me for the award of any other degree.

Madhu Bala

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Madhu Bala

Abstract

The high generation rate of medical waste in Delhi is a proof that medical waste management in Delhi is problematic.Environmental education of healthcare professionals can help in developing the right kind of attitude and behavior towards healthcare services particularly the management of the Bio Medical Waste (BMW).The objective of the study focuses on four hospitals of Delhi with different bed capacityundertaken in the Hospitals & Common Bio-Medical Waste Treatment facility.The research explores the staff's perception towards the medical waste management. The study aims to examine the knowledge level, attitude and role of health care workers towards the medical waste management and highlights current practices and strategies for biomedical waste management in Delhi. The present study focuses on BMW management system in the hospitals with special reference to environment education.The study was conducted through field visits, questionnaire, surveys, and interviews with the hospital administration, doctors, nurses, technicians and other personnel involved in the management of generated waste.Sample of waste water from the ETP of the hospital &ETP of the Common Bio-Medical Waste Treatment Facility (CBWTF) were alsobeing taken for analysis. The resultrevealed that 58.3% respondents were aware of the legislation applicable to BMW management and had attended training program.Majority of respondents (91.6%) including doctors, paramedical, and auxiliary staff believed that the proper management of BMW was a team work and the safe management efforts by hospital would increase the financial burden, while 16.6% of them felt that it was an extra burden on their work.The study also examines whether the hospital could help in reduction of carbon foot print by improving the medical waste management in the hospitals.The study states that the health care workers have a critical role in achieving efficient medical waste management. The doctors were observed to be good in theoretical knowledge related to the BMW management in private hospitals. The need of comprehensive training programs regarding Bio-Medical waste management is highly recommended to all hospital staff.There should be a provision of organization advanced training programme to the staff at various levels time to time prevent and minimize the waste production and treat the waste by safe and environmental friendly methods.

Chapter-1

INTRODUCTION

1.1 Overview

Many steps have been taken in the field of health care system over the several years. Strongly, along with restoring and maintaining society , health care surroundings also threaten their well-being. The hospital staff of government, private patients and professionals alike are affected by poor waste management practices. In the practice of health care, bio medical waste is generated which usually includes sharps, human tissues and other infectious resources.

Hospital is a inhabited establishment which provides the short term and long term health care medical care consisting of observational, investigative, curative and rehabilitative services for a human being suffering or person suffering from disease or injury and for parturient. In Delhi, there are various hospitals under government sectors& private sectors, 2,740 are required to take authorization from Delhi pollution Control Committee and 746 are having granted authorization in the year 2014. In addition to this there are 07 Health Care Establishment which are having their own Bio-Medical Treatment plant. About 44995 beds are available in the private and government hospitals in Delhi.

1.2 Definition and Classification of Medical Waste

All the wastes generated from the medical actions come under bio medical waste category. The activity involved in diagnostic procedure and protective, healing treatments in together the human and veterinary fields of medication. In short, waste from the health care activities or produced by a medical institute , a medical study facility or a laboratory.

1.3 Bio Medical Waste Consists of:

- Human anatomical waste like tissues, organs and body parts
- Animal wastes generated during research from veterinary hospitals
- Microbiology and biotechnology wastes
- Waste sharps like hypodermic needles, syringes, scalpels and broken glass
- Discarded medicines and cytotoxic drugs

- Soiled waste such as dressing, bandages, plaster casts, material contaminated with blood, tubes and catheters
- Liquid waste from any of the infected areas
- Incineration ash and other chemical wastes

1.4 Classification

Approximately 75-90% of the biomedical waste is non-hazardous 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. It is important to realize that if both these types are mixed together then the whole waste becomes harmful. In addition, medical wastes include those wastes from animals intentionally exposed to pathogens; bulk human blood and blood products.

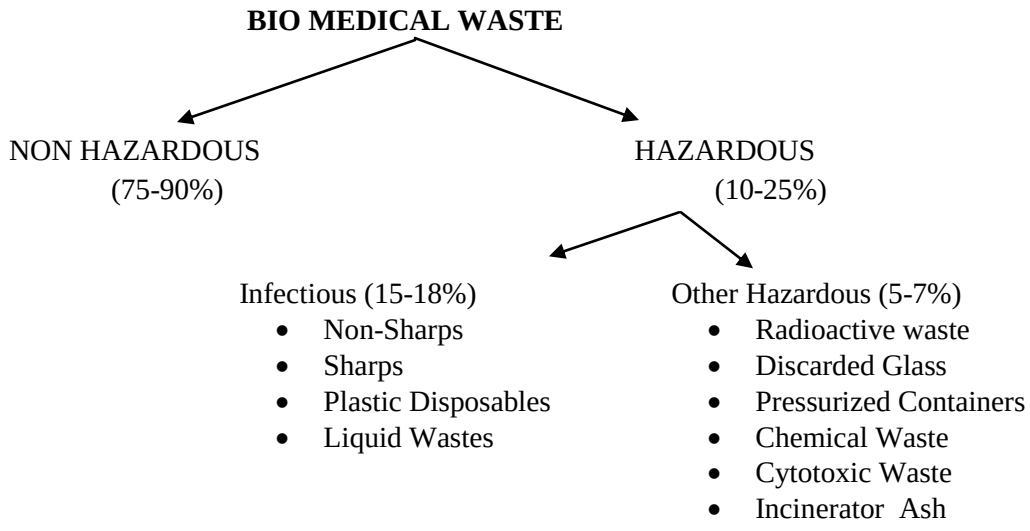


Figure 1.1 Classification of Bio-Medical Waste

1.5 Need of Biomedical Waste Management (BMW) in Health Care Establishment

The reason due to which there is huge need of management in the health care establishment waste such as:

- Preclusion of injuries, which could direct to infections and spreading of various diseases among hospital staff due to infected sharps.
- Prevention of health servicing infections among patients due to poor management of BMW and infection manage practices.
- Prevention of risk of spreading of diseases among sweepers, rag pickers and scavengers, who are in close contact with hospital's surroundings.
- Prevention of spreading of risk due to hazardous chemicals, drugs and other infectious materials.
- Prevention of such unscrupulous practices, where illegal people re-pack the mis-disposed material and re-sell the infected material to hospitals at lower rates.
- Prevention of disposed off and expired medicines being re-used medicine suppliers. Prevention of risk arises to air, water and soil by directly disposing off the bio medical waste.

Hence, there is an urgent need in hospital to manage the bio medical waste to help in the reduction of carbon emissions.

1.6 Project Focus

The topic chosen for study is ***"Biomedical Waste Management in Delhi Hospitals-A Case Study".*** The study is based on hospitals located in Delhi (Capital of India) and treatment for bio-medical waste by CBWTF. Though, there are many hospitals/nursing homes/clinics operating in Delhi and collecting data for each and every hospital/nursing homes/clinics is not possible, so five hospitals were identified of Delhi according to the bed strength which included Government as well as private sector hospitals and the study report formed on them. The selected hospitals are based on the bed strength.

1.7 Study Area

As it has already been discussed that, this project report is about the bio medical waste production in Hospitals of Delhi NCR and as there are uncountable hospitals in Delhi, so five hospitals have been taken.

1.10.1 All India Institute of Medical Science

All India Institute of Medical Sciences Delhi (AIIMS) is a medical college and medical research government university based in New Delhi, India. The hospital was established in 1956 and operates autonomously under the Ministry of Health and Family Welfare. AIIMS Delhi was ranked at third place in the first list of the Times Higher Education India Reputation Rankings, published alongside the Times Higher Education World Reputation Rankings in 2013. AIIMS is one of the big hospitals in Delhi having 1650 .bed. AIIMS attends to more than 8,000 patients every day in its OPDs.

1.10.2 Safdarjung Hospital

Safdarjung Hospital is a 1531 bed multi-specialty hospital, one of the largest government hospitals in India. It is located in New Delhi on the Ring Road, right opposite the All India Institute of Medical Sciences (AIIMS). Until the inception of All India Institute of Medical Science in 1956, Safdarjung Hospital was the only tertiary care hospital in South Delhi region. It became a center of training and teaching of PG students of the DU in 1962. This hospital and its faculty were associated with UCMS in 1973 to 1990.

1.10.3 Hindu Rao Hospital

Delhi State Government converted this Nursing Home into a General hospital in 1951. It offers basic preventive and curative Out Patient Department services. It has 127 beds for in-patients. The MCD took over the hospital in 1958. In 1963Ministry of Health and Government of India, designated this hospital as a referral hospital. Hindu Rao Hospital is a modern care modern multi-specialty hospital catering to all sections of the society. The strategic location of the hospital, its size and the breadth of preventive and curative services and the easy and cost-effective accessibility to specialized services that it offers has succeeded in creating a large and regular clientele for the hospital.

The hospital also caters to the medical and health needs of a number of referred patients from the dispensaries and colony hospitals managed by MCD, the nearby government hospitals managed by Delhi administration and many charitable and private institutions. The hospital attempts to fulfil all criteria of a “Health Promoting Hospital” and has a healthy initiative of community mobilization in addition to numerous employee welfare schemes.

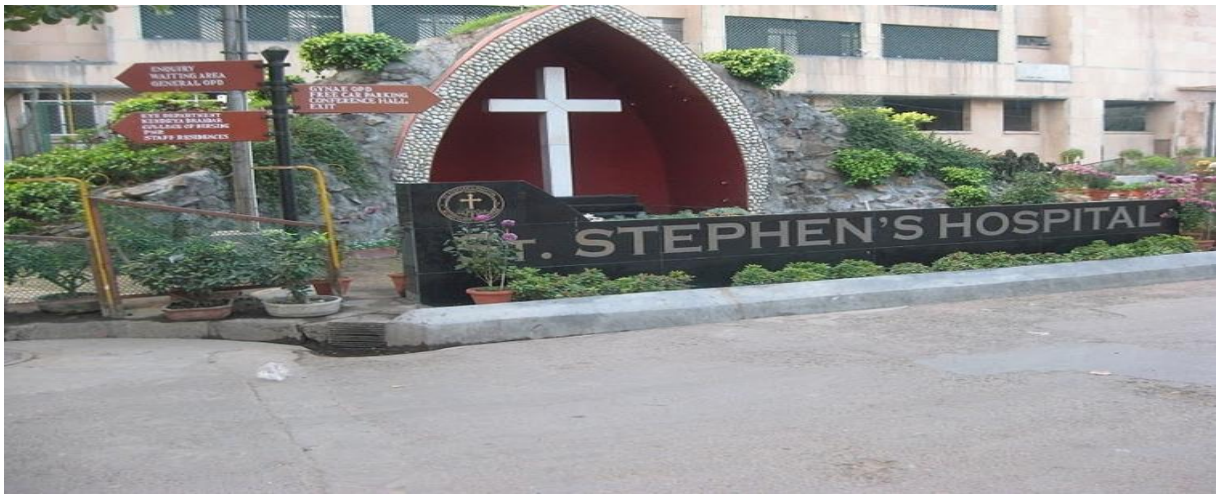
In 2012 the erstwhile Municipal Corporation of Delhi has been trifurcated into three separate corporations and Hindu Rao Hospital is now a part of North Delhi Municipal Corporation. A new Medical College has been started in July / August 2013 in Hindu Rao Hospital and has been named as North Delhi Municipal Corporation Medical College. 50 students have been admitted this year as 1st year MBBS candidates it has been affiliated to IP University

1.10.4 Indraprastha Medical Corporation Ltd. (Apollo Hospital Enterprises Ltd.)

Indraprastha Apollo Hospital is owned by Apollo Hospital group. It is the India's largest healthcare chain. It is also second largest hospital in Delhi region. Indraprastha Apollo Hospital has recently been recognized by Joint Commission International (JCI) USA. It is first internationally recognized Hospital in India and South Asia by Joint Commission International (JCI) USA. It is the third super specialty tertiary care hospital set by the Apollo Hospitals Group. Jointly with the Government of Delhi. It is a 615-bed hospital, with the provision for expansion to 1000 beds in future.

1.10.5 St. Stephen's Hospital

St Stephen's Hospital is the one of the largest private and oldest Hospitals in Delhi region. Established in 1885, it has a capacity of approx. 600 beds, and is a super speciality tertiary care Hospital offering care in all Specialties and most super specialties. Apart from treating patients, the Hospital is running training program in various Specialty and Super specialty courses affiliated to the National Board of Examinations and recognized by the Medical Council of India. In addition, many young aspirants are trained each year in General Nursing and Midwifery and in Allied health professional Courses. B.Sc. Nursing has been recently introduced. The Hospital is equipped with modern Imaging modalities, Operation theatres, ICUs and Laboratories providing 24 hours emergency services.



Motto states.” In Love Serve One Another" we at St. Stephen's Hospital strive to provide

healthcare with Christ-like compassion. And in doing so, St. Stephen's Hospital has become a part of the lives of the people of Delhi.

1.8 Centralized Treatment Facility

As per Biomedical Waste (Management & Handling) Rules 1998, all HCEs are required to handle biomedical waste in a particular manner. Delhi is generating approx. 7000 metric tons of hospital waste out of which 15 tons are Biomedical Waste. The Govt. hospitals and major private (pvt.) hospitals have their own deal for treatment of BMW. Total number of beds in Delhi govt. hospitals are approx. 6500. The lesser Nursing Homes/Clinics, which can't make their own preparations due to high rate involved in treatment facility, require some option modalities. Keeping in view the difficulty faced by small Nursing Homes /Diagnostic Laboratories/Clinics/Blood Banks etc., Govt. is taking initiative to establish central waste treatment facilities. The Govt. of NCT of Delhi has been selected land by Delhi Development Authority for establishment of Central Biomedical Waste treatment facility 1000 sq. meter each at Okhla and Gazipur in Delhi. The tender for central facility at Okhla had already been finalized and awarded to M/s Synergy Waste Management Private Ltd. and as the custody of land at Gazipur has been taken over by Government and the tenders for the same will be invited soon. The facility at Okhla started or operational by November 2005. The Govt. of NCT of Delhi has planned to utilize the above two sites for establishing Centralized Bio-Medical Waste Treatment facilities as a joint venture with the private sector/NGO etc. to be identified and selected through a transparent process.

There are 32 Health care establishment under Govt. of Delhi region. 4 Hospitals are having Incinerators and nine hospitals are having Shredders & Autoclaves for Scientific Management of BMW. Biomedical waste from these health care facilities, where such services are not offered are segregate and transported in special vahicle to Hospitals where such services exists.

Table1.2 No. of Government & Private Hospital/Clincs/ Nursing homes in Delhi

Bed Strength	Government Sectors	Private Sectors
0-10	903	2275
011-50	766	856
51-100	68	134
101-500	34	60
501-1000	15	8
1001-2000	7	2

Source:Delhi Polution Control Committee[12]

During the future year plan special vehicles will be purchase to monitor BMW in Delhi Government as well private hospitals. All hospitals which come under GNCT Delhi have already been requested to have take apart budget head in their hospitals for BMW management.

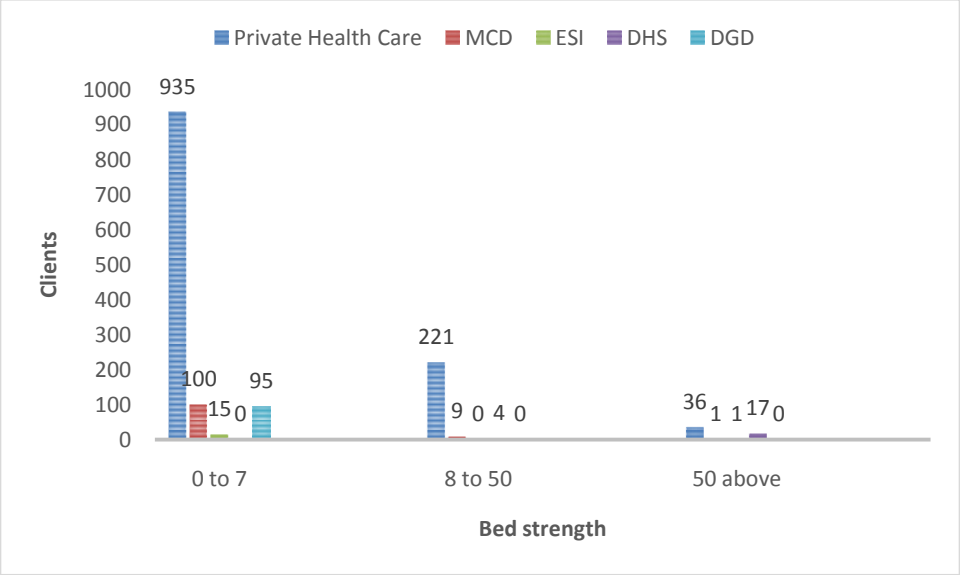


Figure 1.2 No. of Clients cover by the Biotic Waste Solution for year 2014

1.9 Introduction of the Common Bio-Medical Waste Treatment Facilities (CBWTFs) in Delhi:

There are two operators of CBWTFs in Delhi:

1. M/s Biotic Waste Solutions Private limited, 46 SSI Industrial Area, G.T.Karnal Road, Delhi-33
2. M/s SMS Water Grace BMW Private limited, Nilothi Sewage Treatment Plant Complex of DJB, Nilothi, Delhi-41

M/S Biotic Waste Solutions, it is a common bio medical waste treatment facility (CBWTF) which is certified by Delhi Pollution Control Committee (DPCC) for BMW (collection, transportation, treatment and disposal). It is a group of professionals with the vision of entering into socially relevant and environmentally awareness areas. They joined hands to encourage Biotic Waste Solutions to arrange a Common Bio Medical Waste Treatment Facility (CBWTF) underneath the BMW Rules. Biotic Solutions is a Common Bio Medical Waste Treatment Facility authorized by DPCC for BMW (collection, transportations, treatment and disposal) generated by different healthcare units in the National Capital Territory of Delhi. The team and promoters have vast experience of 10 years in the field of BMW treatment. They also have more than 6 years experience in other waste management companies like e-waste, slaughterhouse waste, plastic and rubber waste, etc.

BWS is providing services to more than 1000 healthcare units which include major Hospitals (AIIMS, Apollo Hospital, Sir Ganga Ram Hospital, St. Stephens Hospital, Moolchand Hospital, Rajiv Gandhi Cancer Institute, GM Modi Hospital, ESI Hospital etc). BWS is providing a complete BMW disposal solution to its clients by using the best technology methods.

BWS has its own ultra-modern handling facility in Confirmed Ind. Area of Delhi region. It has a team of Highly qualified, experienced and renowned environmentalists to manage. The convenience has installed two incinerators which have capacity of handling 500 kg of biomedical waste/ hour. They also have other requisite facilities like Autoclave and shredder. Autoclave has capacity of 2100 lit/batch. Shredder have capacity to shred 350kg of waste/ hour. Company has installed well-designed pollution control systems to control pollution within the prescribed standards

1.10 Objective and Aim of the project

The objective of this study is to perform a research on the current bio medical waste management in the Health Care Establishment and to aim to find out how hospital can profit from improving biomedical waste management practices. The different aspects of biomedical waste management are as follows:

- To understand the current medical waste management legislations, policies and practices at the study areas adopted by the hospitals staff.
- To study the perception of staffs at Hospital towards the medical waste management and to study how it affect the waste generation at hospital.
- To investigate the reasons behind higher generation of medical waste at hospital
- To understand the government perception towards various waste management technologies.
- Analyze the prevention of infection and control programs in hospitals
- Analyze of Ministry of Health EHS Policies in the hospital.
- Study of hospitals waste treatment and disposal methods.

Chapter-2

LITERATURE REVIEW

2.1 History of Biomedical Waste Management

Waste management is one of the important government health measures. If we go into the historical background, before discovery of bacteria as cause of disease, the principle focus of preventive medicine and government health has been on sanitation. The provision of potable water, disposal of odour from sewage and refuse were considered the important factors in causing epidemics. The invention of water closet by John Harrington (1561-1612)[1] facilitated flushing away human waste and helped to keep some dwellings clean, but flow from those indoor privies ran into cesspools and ultimately into waterways and wells. In 1848, the description by Edwin Chadwick of the sanitary conditions and health of English workers however had a great impact on the upper class and the governing bodies. His standard for proper removal of sewage and the protection of water supply was a stimulus to the govt. of Britain as was Rudolph Virchow's militant advocacy of government health measures in Germany. The great glories of Roman hygiene were the water supply and the sanitation system. In several areas of Europe, government health remains primarily the responsibility of the inhabitant (for example—street cleaning and drainage) but laws were created and inspectors were assigned for enforcement. 'Scavengers' were appointed to collect the garbage and space outside was assigned for dumping.

Biomedical waste is a small percentage of the total waste generated by hospitals. However this waste stream has the greatest health risk to workers and the general government. In recent years there is increasing demand for more healthcare facilities (nursing/retirement homes, hospitals), the used injections at home, and medical research, the generation of biomedical waste has increased significantly. Biomedical waste is not only being generated at designated healthcare facilities such as hospitals but also within private homes, schools, and workplace, nursing homes and children homes. Wastes generated in these smaller facilities including homes are not managed according to regulations to which hospitals are held for compliance.

For developed nations of the world, biomedical waste management is at an advanced

stage regarding technology, management systems, regulations, education and training. The healthcare industries in these nations are generally operated under strict licenses and code of practices, along with environment health and safety regulations. The world health organization also have figurers and codes to which these nations are signatory. Not with standing there exist within these nations continued challenges to improve biomedical waste management practices to lower health risk associated with the management of biomedical waste in the entire industry. This includes ensuring that all small healthcare facilities, home treatments practices and schools are in compliance with laws, codes and regulations. It involves the prevention of biomedical waste mixed with municipal solid waste and the disposal of biomedical waste at unauthorized landfills. There are specific health and safety standards and regulations for the healthcare industry to prevent and control of injuries and illnesses.

For developing nation's biomedical waste management have significant challenges ranging from lack of and inadequate laws and regulations, weak healthcare industry operating codes and practices, inadequate financial resources, lower education of citizens and a general lower level of environmental health and safety awareness.

2.2 Categorization of Biomedical

As per the Bio Medical Waste Rules, 1998 there are 7 categories introduced in India according to the type of waste generated in the hospital i.e. sharps, discarded medicines, soiled waste, solid waste etc. Further waste categorization at the International level & at the Indian level as below:

2.2.1 Waste Categorization at International Level

In the United States infectious waste is categorized as follows:

- Isolation waste
- Cultural and stocks and associated biological Human blood and blood products
- Pathological waste Used sharps contaminated animal carcasses
- Unused sharps

2.2.2 Waste categorization in India

Classification according to the biomedical waste (management and handling) rules, 1998, Waste divided into three major categories.

- General waste
- Infectious waste
- Hazardous waste

2.2.3 General Waste

- (75-90 per cent) of waste of a medical facility
- Comprises newspapers, letters, documents, packing material, cardboard

Containers, plastic bags / films, food wrapping, metal cans, food containers, flowers, floor sweepings and kitchen waste.

- General waste may be sorted out further for partial recycle / reuse purposes and the rest disposed of a municipal solid waste.

2.2.4 Infectious Waste or Pathological or Bio-Medical, or Bio- Hazards, Toxic OR Medically Hazardous Waste

a. About 15 per cent waste consists of infectious waste.
b. Originates in many hospital departments, wards, and laboratories

2.2.5 Hazardous Waste

Hazardous chemicals such as the listed below are generally found in any medical facility.

- Cytotoxic chemicals (chemotherapy and antineoplastic chemicals)
- Formaldehyde
- Photographic chemicals Radio nuclides
- Solvents
- Mercury
- Anesthetic gases
- Cleaning and maintenance chemicals

2.3 Source of Bio Medical 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 government health and environment.

2.3.1 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.

2.3.2 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

2.4 Research work on BMW management

In view of the above Society for Direct Initiative for Social and Health Action (DISHA) has been assigned with the task of Developing a Strategy for Health-Care Waste Management for Primary Level Health Care in West Bengal. Literature review of models and practices for health-care waste management at both national and international levels with special focus on primary health care along with review of Government orders, regulations, rules and models developed

and promoted by Government of India and the states with regard to health care waste management is an essential component of the strategy development. The present study endeavors to accomplish the same.

Sudeshna Chatterjee and Jyoti Shelar[2]reported that 80% of Mumbai hospitals flout bio-waste disposal norms and hazardous waste which is very dangerous and which needs to be incinerated at 900 degrees Celsius and is not segregated at source, moreover the disposal agency official have also reported that they hardly receive used syringes and saline bottles which further raises fears that this bio-waste is recycled in the market.

Chetan Bora [3],Director of SMS Envoclean has mentioned that eighty percent of government and private hospitals do not segregate medical waste at source, thus to raise awareness, SMS Envoclean regularly send posters on the right disposal method to all healthcare units and the bio-degradable bags which SMS Envoclean sells also carry information about how used medical items can be separated, but all these efforts have proved to be futile.

Dr. Jitendra Sangewar [4],Regional Officer at Maharashtra pollution control board reported that Maharashtra pollution control board is considering steps to ensure that hospitals are encouraged to maintain hygiene during waste disposal and this includes making the hospital sign bank guarantee over 1 lakh and if the hospitals fails to meet any of norms, then Maharashtra pollution control board will encash the bank guarantee.

Sandipan Mukherjee [5],Member Secretary West Bengal Pollution Control Board has mentioned in the report that total biomedical waste generated in the state of West Bengal is around12000 MT per year and with a rate of increase of 1% per year, the annual generation of biomedical waste in the state has been estimated to be nearly 13500 MT in the year 2020. At present 5 large and 2 small Common biomedical waste Treatment Facilities and 14 Stand-Alone Treatment Facilities are functioning in the state, but as a whole only 28% of biomedical waste is being treated as most of the health care units are yet to be incorporated in the management regime.

Veda Hegde et al [6]reported the opinion that proper handling, treatment and disposal of biomedical wastes are important elements of health care office infection control programe and correct procedure will help protect health care workers, patients and the local community.

Tamplin et al[7] reported that the re-use of syringes can cause the spread of infections such as HIV and hepatitis. This poses obvious health risks, both in terms of direct exposure and environmental contamination. This study of issues and options for the safe destruction and disposal of used injection materials was undertaken using document analysis and summarize approaches to the inter-related issues of syringe reuse and clinical waste disposal. The authors suggest that holistic approaches to syringe use and clinical waste disposal need to be utilized. The Health Care Without Harm publication Non-Incineration Medical Waste Treatment Technologies (August 2001) and the WHO draft Guidance for the Development of National Action Plans (2002) provide a sound framework for addressing issues of healthcare waste management and used injection materials disposal. This framework needs to be field tested in selected countries. The focus is on technology and procedures that may be adaptable to rural areas in developing countries.

Chandira boss et al [8] studied the character and quantity of BMW generation in Government General Hospital (GH) Pondicherry. Unhygienic disposal of non-segregated BMW in Pondicherry poses a serious health hazard to the population and to scavengers. The current practices of handling, transportation, storage, and disposal of BMW generated at GH need to be strict. Of late, more and more patients from abroad are opting to undergo advanced medical treatment in India, because they can be carried out at a fraction of the cost in India. With this "medical tourism" expanding (Connell 2006, Lee 2007), hospitals need to manage their BMW properly, to minimize risks to the public and to the environment (Mudur 2004). After the BMW guidelines were explained, observations indicate that proper management of BMW has improved and that the segregation of BMW is much better than before (Agrawal and Singh 2005).

Muhlich et al[9]conducted a research project sponsored by the EC-LIFE program to compare waste management in five different European hospitals. A comparison of the regulations governing current waste management revealed different strategies for defining infectious hospital waste. The differences in the infrastructure were examined and the consequences for waste segregation and disposal were discussed under economic and ecological aspects.

Mehrdad Askarian et al[10] surveyed 15 hospitals in Iran. The results indicated that the waste generation rate is 4.45kg/bed/day, which includes 1830kg (71.44%) of domestic waste, 712kg (27.8%) of infectious waste and 19.6kg (0.76%) of sharps. Segregation of different types

of waste is not carried out perfectly. Two (13.3%) of the hospitals uses containers without lids for transportation of wastes. Nine (60%) of the hospitals are equipped with an incinerator and six of them (40%) have operational problems with incinerators. They concluded that the hospitals under study aren't providing any effective training courses about hospital waste management and the hazards associated with them. The training courses that are provided are either ineffective or unsuitable.

Jayanthi et al [11] reported the quantity and quality of waste arising from different wards and units of Indian government hospital with a capacity of 360 beds. The quantity of waste arising from the hospital is about 285kg/day. 59% of total waste is general waste and rest 41% is biomedical waste. It was concluded that proper segregation at source is not practiced in the study area, which paved the way for increased medical waste stream due to mixing of general and mixed wastes at the collection points.

Gayathri Patil et al [13**]** assessed the waste handling and treatment system of hospital bio-medical solid waste and its mandatory compliance with regulation of Bio-medical Waste (Management and Handling) Rules, 1998, under the Environment (Protection Act 1986), Ministry of Environment and Forestry, Govt. of India, at the chosen KLE Society's J. N. Hospital and Medical Research Center, Belgaum, India to 53 estimate the amount of non-infectious and infectious waste generated in different wards/sections and reported as an average about 520 kg of noninfectious and 101 kg of infectious waste is generated per day (about 2.31 kg per day per bed, gross weight comprising both infectious and noninfectious waste).

Saurabh Gupta et al[14] studied to the biomedical waste management practices at Balrampur Hospital, a premier healthcare establishment in Lucknow, in North India. The study shows that infectious and non-infectious wastes are dumped together within the hospital premises, resulting in a mixing of the two, which are then disposed of with municipal waste at the dumping sites in the city. Lucknow Municipal Corporation generally collect it every 2 or 3 days. The hospital does not have any treatment facility for infectious waste. The laboratory waste materials, which are disposed of directly into the municipal sewer without proper disinfection of pathogens, ultimately reach the Gomti River. All disposable plastic items are segregated by the rag pickers from the hospital as well as municipal bins and dumps. The open dumping of the waste makes it freely accessible to rag pickers who become exposed to serious health hazards due to injuries from sharps, needles and other types of material used when giving injections.

2.5.1 Standards for Waste Autoclaving:

Autoclaving of hospitals are a per-Vacuum autoclave with temperature more than 121°C and pressure of 15 psi per an autoclave residence time of 45 minutes cycle. They are doing the validation test as well as the routine test at regular intervals. Autoclave should completely and consistently kill the approved bio indicator at the maximum design capacity of each autoclave unit. Biology indicator for autoclave shall be bacillus strearothermophil us spores using spore strips; with at least 1×10^{4} spores per milliliter.

A chemical indicator strip/tape the changes colour when a certain temp reached can be used to verify that a specific temperature has been achieve may be necessary to use more than one strip over the waste package at location to ensure that the inner content of the package has been autoclaved.

These limits are applicable to those, hospitals which are either connect sewers without terminal sewage treatment plant or not connected to kike for discharge into government sewers with terminals facilities, the general solid notified under the environment (protection) Act, 1986 shall be applicable.

2.5.2 Standards of Microwaving

a. Microwave treatment shall not be used for cytotoxic, hazarding waste, contaminated animal car cases, body parts and large metal.
b. The Microwave system shall comply with the efficacy test/routine performance guarantee may be provided by the supplier before operation limit.
c. The Microwave should completely and consistently kill the bacteria pathogenic organisms. That is ensured by approved biological indicator maximum design capacity of each microwave unit. Biological indicator microwave shall be bacillus subtitles spores using vials or spore strips with at least 1× 101 spores per milliliter.

2.5.3 Shredder

Shredder is installed for shredding of sterilized i.e., autoclaved regulated medical waste in the package before disposal. The shredder is designed for shredding of sterilized waste.

a. High infections waste, gloves, blood bags, lab cultures, bio-technology waste isolated

waste.

b. Disposable PVC/Plastic! Card Board! Thermo Cole! All catheters, any other sterilized waste receive from autoclave.2.5.4 Standards for Deep Burial

1. A pit or trench should he dug about 2 meters deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.
2. It must be ensured that animals do not have any access to burial sites. Covers of galvanised iron/wire meshes may be used.
3. On each occasion, when wastes are added to the pit, a layer of 10 m of soil shall be added to cover the wastes.
4. Burial must be performed under close and dedicated supervision.
5. The deep burial site should be relatively impermeable and no shallow well should be close to the site.
6. The pits should be distant from habitation, and sited so as to ensure that no contamination occurs of any surface water or ground water. The area should not be prone to flooding or erosion.
7. The location of the deep burial site will be authorised by the prescribed authority.
8. The institution shall maintain a record of all pits for deep burial.

2.5.5 Standard for Liquid Waste:

Treated effluent limits are applicable to those, hospitals which are either connected with sewers without terminal sewage treatment plant or not connected to government sewers. For discharge into government sewers with terminal facilities, the general standards as notified under the Environment (Protection) Act, 1986 shall be applicable shown in Table 2.4 Liquid Waste Standards shown in an Annexure-VI.

2.6 Waste Treatment Practices

As color-coded bins are missing in the majority of them were well on ward off fitting covers are placed on the stand. The Central Pollution Control Board strictly specified isolation of infectious waste, infectious waste, for this is yellow, black for normal garbage bag strictly observed only 43% of the sites had not been followed as guidelines despite the presence of the

different waste bag had, but insufficient knowledge about the isolation, the majority of biomedical wastes pose a major threat to the society in general, was treated as waste, which is disposed in the black bag was. Although the cans were labeled accordingly as Schedule III? Only 5 (5%) are placed in bins operation theater and gynecology ward 1% hypochlorite solution and disinfected daily disinfection of cans in the rest of the kids were out 3-4 times a day.

Generate biomedical waste treatment contract for the agency workers waste was transported by lift operators manual. Usually taken in the morning hours neither was useless, even for the proper transport of waste transport trolleys separately nor was there any way.

Every day, they come to collect bio-medical waste incinerator, incinerator, where it was stored in the open space of a pass on a dumping site. The yellow color of the bag had been left behind burnt out and incinerated ash pit in the remote medical college in itself, was thrown into a black bag. For biomedical waste collection rudimentary safety practices were adopted by sanitation workers. While only 30% of waste management, clean apron, the long boots, eye-shield was worn by anyone, gloves were used. This is attributed to the non-availability of adequate personal protection measures, as well as while dealing with personal protection equipment such waste is exposed to, which is basically unconscious of health hazards had gone. Only three (5%) workers were immunized for Hepatitis B. Biomedical waste management methods trained for only 14% of cleaning and waste handling waste management practices were aware of the risks involved in the sensitization. Rapid urbanization and industrial diversification, municipal plastic, hazardous and biomedical waste has led to the generation of significant amounts of. Government human diagnosis, treatment or immunization of any waste generated during research activities defined as biomedical waste. Biomedical waste producers general hospitals, health clinics, nursing homes, medical research laboratories, physicians, dentists offices, and veterinarians, home health care, and are involved in funeral homes. In Asian countries, the World Health Organization reported in 1999 on health care waste composition 0.33 million tons per year in India is causing biomedical waste, 1-2 kg per bed per day means that information.

2.7 Research work

The study area was selected for the research because these hospitals are the major hospitals in Delhi as they generated large amount of different categories of waste. Medical care

is vital for our life and health, but the waste generated from medical activities represents a real problem of living nature and human world. Improper management of waste generated in health care facilities causes a direct health impact on the society, the health care workers and on the environment Every day, relatively large amount of potentially infectious and hazardous waste are generated in the health care hospitals and facilities around the world. Indiscriminate disposal of bio-medical waste or hospital waste and exposure to such waste possess serious threat to environment and to human health that requires specific treatment and management prior to its final disposal.

Chapter-3

TREATMENT TECHNIQUES FOR BIOMEDICAL WASTE BY CBWTF

3.1 General Overview

The centralized system of waste management is the best method in terms of cost reduction and minimizes legal and ethical hassles of health care staff & authority. Through centralized system, the hospital the hospital would feel less burden of waste management and might devote more time on development of quality hospital.

3.2 Introduction of Common Bio Medical Waste Treatment Facilities

A CBWTF is set up where biomedical waste, generated from a several of health care facilities, is impacted required to treat and reduce all unfavorable effect of such waste may create. Installation of every treatment facilities by small healthcare establishment requires comparatively high capital venture. It requires reserve manpower and infrastructure development for the proper operations and maintenance of treatment system. A concept of centralized facilities emerged as a necessity since having individual treatment technology requires space, huge investment, high operation and maintenance charges, technically qualified staff, waste to maximum capacity of the machine to bring down the per kg treatment cost, etc. in comparison, if the waste from a number of healthcare establishments is brought at a centralized facility, all the above problems get scaled down. The concept of CBWTF addresses these problems and also prevents diffusion of treatment equipment in NCR Delhi region. Moreover, monitoring these facilities is much easier and one can ensure that the best and cleanest technologies with adequate pollution control devices are installed. In last year various centralized facilities have come up all around the country.

M/s Biotic Waste Solution Pvt. Ltd., common bio medical waste treatment facilities (CBWTF), one of the authorized service providers of Delhi Pollution Control Committee Department of Environment Govt. of Delhi. It is located at SSI Industrial area, G.T Karnal Road, New Delhi occupying the total area of 1012 km^2.

Our CBWTF has a set up for bio-medical waste treatment and disposal facility (incinerator, autoclave& shredder) in accordance to the BMW (M&H) Rules 1998. Our CBWTF is serving

850 Health Care Facilities of Delhi including Govt. as Pvt. Hospital, diagnostic, labs, clinics & nursing home, etc. following stringently the bio-medical waste rules with rapid commercialization Health Care Sectors have emerged out as one of the leading business opportunities therefore there is an increase in the no. of HCF in the national capital Territory of Delhi leading to an increase in the large volume of bio-medical waste generated per day.

3.3 Service Offered by CBWTF

Bio medical waste is a heterogeneous mixture. It is very difficult to manage as such. However, the difficulty can be cut down and its measurement diminished significantly if a proper management system is planned. Company can deliver the following services for better management of BMW:

1. Management and training of personnel and agencies, generating BMW.
2. Collection, reception, storage, shipping, storage area, treatment and disposal of BMW generated from hospital nursing homes, diagnostic centers, clinics, dispensaries etc.

Transportation:	Mobile van as per guidelines for transportation of Bio-Medical Waste.
Incineration	Dual chamber Incinerator (oil fired), with air pollution control device.
Autoclaving Chemical:	Chemical treatment system with Effluent Treatment Plant.

3.4 List of Raw Material & Products

Raw Materials

Items	Quality
Diesel	200-225 Lit./day

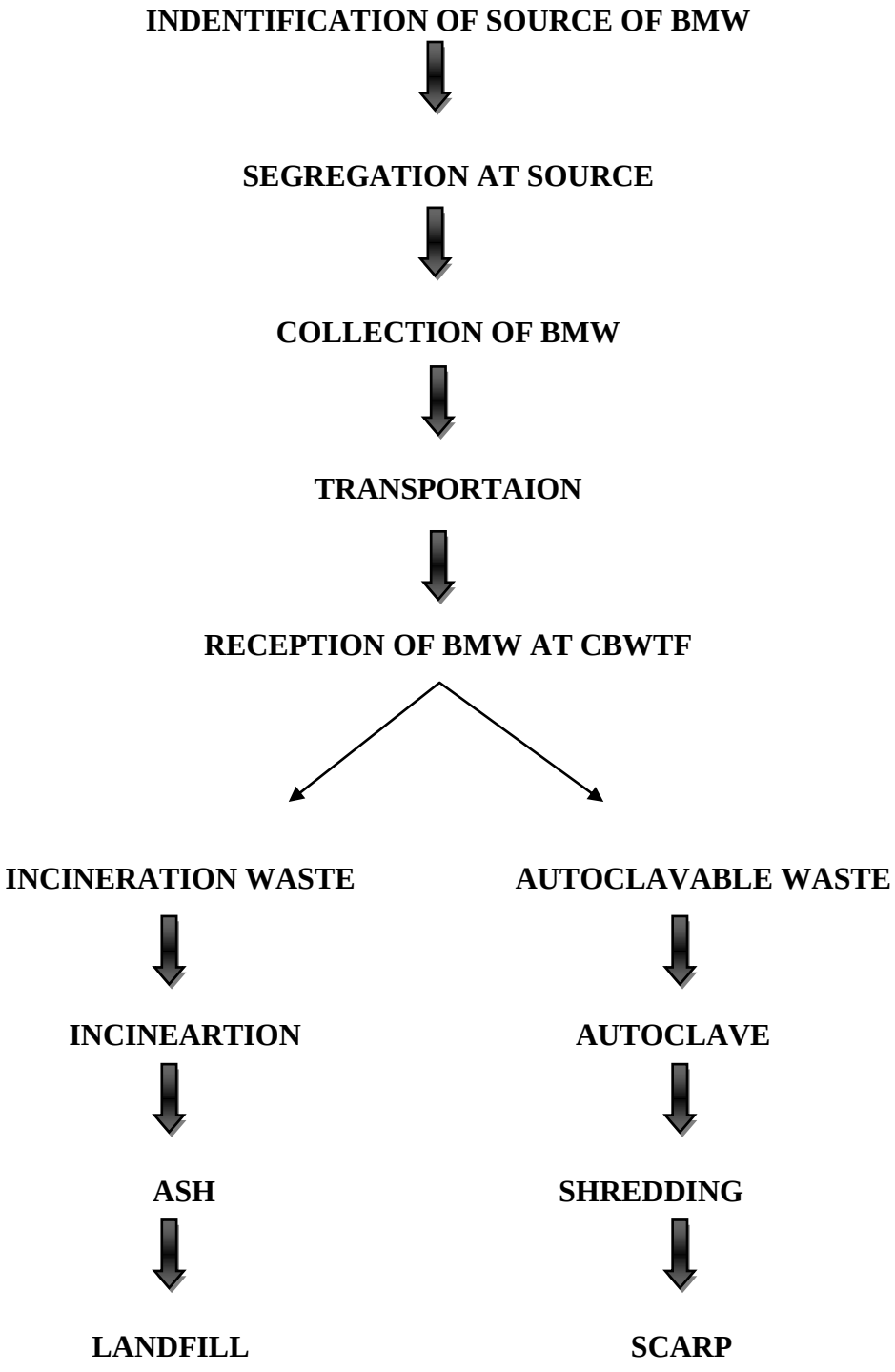


Figure 3.1: Flow chart of Handling of BMW

Table.3.1 Infrastructure & facilities

S. No.	Facilities	Details
1	Area	2420 Sq.Mt
2	Incinerator	250kg/hr (2 no.)
3	Boiler	Oil Fired Baby Boiler
4	Autoclave	200 kg. batch (2100 Lt.)
5	Shredder	350 Kg/hr
6	Air Pollution Control System	Venture Scrubber with droplet separator & ID Fan
7	Effluent Treatment Plant	Physio Chemical Treatment Plant
8	D.G. Set	82 KVA with Acoustic enclose
9	Transportation	Closed body pick vans as per CPCB Guidelines
10	Safety gadgets	Gloves, Mask, Apron, Gumboots

3.5 Treatment process in Biotic Waste Solution

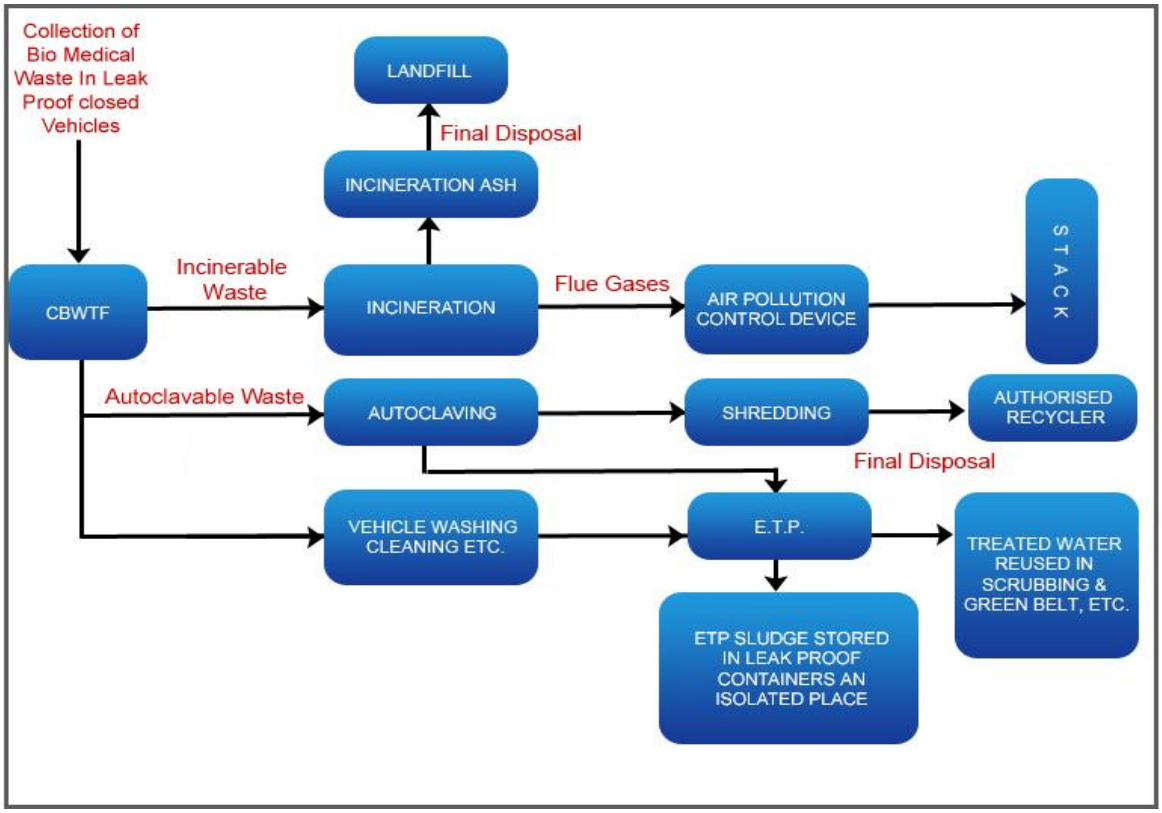


Figure 3.2: Flow chart of Treatment process in Biotic Waste Solution

3.5 .1 Incinerator

The incinerator is equipped with PLC for automatic controlled operation of all motors, burners, Air Pollution Control Device fitted with the incinerator. It gives computer print with date & time of the temperature of primary chamber, secondary chamber of the incinerator as well as inlet & outlet temperature of the venture scrubber to monitor the proper operation of the APCM. Incinerator is fitted with hour meter to be record the time of its running.

Figure 3.3 Incinerator

Table 3.2: Incinerator Specification

S.No.	Items	Specification
1	Incinerator	One (Oil Fired)
2	Make	Thermax Ltd. & Alfa Therm Ltd.
3	Burning Capacity	250 Kg/hr each
4	Operating system	PLC Controlled (with auto record & print of operational data)
5	Mode of waste handling	Autofeed
6	Combustion chamber	Primary& Secondary
7	Burner	2 Nos. (Primary & Secondary)
8	Operation Hours	20 hr. per day (Maximum)
9	Type of Burner Operation	Automatic controlled by PLC
10	Sight Glass (toughened)	Provided in the Combustion chamber
11	Emission control system	Venture scrubber followed by DropletSeparator
12	Designed Cal. Value of waste	1950 K. cal/kg of BMW
13	Combustion Efficiency	99.0%
14	Temperature of Burner operation 1. Primary Chamber 2. Secondary Chamber	 800 ± 50 ^{o} C 1050 ± 50 ^{o} C

3.5.2 PLC Panel

Duct and Vermi proof panel along with instruments, safety devices, indicators, hooters, digital display of parameters etc. the incinerator is equipped with PLC for automatic controlled operation of all motors, burners, Air Pollution Control Device fitted with the incinerate. It gives computer print with date & time of temperature of primary chamber, secondary chamber of the incinerator as well as inlet temperature of the venture scrubber to monitor the proper operation of the APCM. Incinerator fitted with hour meter to record the time of its running.

3.5.3 Autoclave

The medical waste materials which are not incinerated are sterilized by heating with steam at high pressure and temperature. The company will install an autoclave with a volume of about 2000 liter, sufficient to handle more than 100 kg of waste per batch. The autoclave is designed to operate at a high pressure of about 2.1 kg/cm2 and corresponding to saturated steam temperature of 134 ^{o}C. the process conditions are quite adequate for the sterilization of the waste materials particularly the used syringes, plastic tubes etc.

Figure 3.4:Autoclave

The solids after sterilization are taken out and cooled. These are then chipped into small pieces so that these cannot be reused for any purpose.

3.5.4 Shredder

A rotary Shredder to shred the Autoclaved treated plastic waste. It help in avoidance of reuse the biomedical waste and also acts as identifier that the waste has been sanitized and is safe to dispose off. The brief details of proposed shredder are as under:

No. of Shredder : one

Capacity : 350 kg/hr

Motor Capacity : 15.0KW

3.5.5 Microwaving

- Microwave treatment would not be used for cytotoxic, radioactive wastes or hazardous , contaminated animal corpses, body parts and metal items.
- The microwave system should obey with the effective tests / routine tests.
- The microwave should completely and consistently kill bacteria and other pathogenic microorganism that is ascertained by the approved biological indicator at the maximum design capability of every microwave unit.

3.5.6 Deep Burial

- A trench should be dug about 2 meters deep. It should be half filled with waste and other half should be covered with lime within 50 centimeters of the surface before filling the rest of the trench with soil.
- It must be ensured that these burial sites should be out of reach from animals.
- Covers of galvanized iron/wire meshes should be used.
- On every occasion, when wastes are added to the trench, a layer of 10 centimeters of soil should be added to cover these wastes.
- Deep Burial must be performed under close and keen supervision.
- The burial site should be comparatively impermeable and there should be no shallow well close to these sites.

- The trench should be far from habitation and sited, make sure that no contamination occurs of any surface water and ground water.
- The area should not be inclined to flooding and erosion.
- The location of the site will be approved by the prescribed authority.
- The authorities should maintain a record of all trenches for deep burial.

Chapter-4

MATERIALS &METHODS

4.1 INTRODUCTION

The purpose of this project is to examine and evaluation the existing management practice of biomedical waste management at the selected hospitals in Delhi. Here, the study focused on what are the all method of BMW generation in five hospitals and how, these hospitals manage their waste and treatment process. The study is in the form of comparative explanation, where, the waste generation and management processes would be compared from different angles. Biomedical waste is one of many waste streams from a hospital and one that may not be recognize as requiring special management, due to the lack of regulations and risks impacts.

4.2 Methodology

The goal of the project was met through a detail investigation and review of biomedical waste management in the hospitals & in the CBWTF. Information from the hospitals & CBWTF including the following:

- Study area selection
- Questionnaire preparation
- Data collection by distribution of questionnaires to key persons within the healthcare sector and conducting interviews in person ad through email.
- Research design.

4.3 Study Area

The study was operated in 5 major private/government hospitals. The study started in the area of "Bio medical waste management in All India Medical Science, Safdarjung Hospital, Hindu Rao Hospital, Indraprastha Medical Corporation Ltd. (Apollo Hospital Enterprises Ltd.) & St. Stephen's Hospital located in Delhi NCR and treatment facility for BMW by CBWTF

4.4 DATA ANALYSIS

The data was collected by using a questionnaire included information regarding the waste generation, management of BMW, handling/treatment of BMW at the study area from designated authority/staff in the researched hospitals and at later stage has been analyzed and presented in form tabular and graphical format. The information has been segregated as per below:

Primary Data – Primary data is considered as fresh data which hasbeen collected on first hand basis. The information has been collected from the designated authority related to hospitals, which we are researching. The information has been collected with help of questionnaire which was distributed in the hospital's staff and self-observatory skills.

Secondary Data – Secondary data is considered as second hand data,which are usually collected by any other researcher/organization and used for his or her study.

4.5 Interview with the Waste Management Officer (Nodal Officer) In Hospital

The reason of the interview with the waste management officer in hospitals was to gather the primary data and background information regarding to the waste management practices in the hospitals. The data and information collected is the root for this research. An interview etiquette was initially developed to cover qualitative data collection which includes interview etiquette, sampling, ethical issues and data analysis.

Semi structured interview - Semi structured interview approach is to assure that the some common areas of information are collected from every interviewee. This give us more focus than the conversational perspective, but still allows some freedom and adaptability in gathering the information.

The interviews were scheduled according to the time appropriate for the interviewee (nodal officer in Hospital) and the interviews were undertaken in the nodal office. Interviewer

4.6 Participant Observations

The site visited or participant examination enabled us to understand the exact nature of activities and allied activity with a process. It also helped in making good relationships with staff and make easy the release of internal credentials during the research period.

4.7 Research Design

4.7.1 Phase I- Exploratory work

Exploratory study refers to explore the idea and topic of study on first hand basis and here, we have identified our respondent group and have decided to collect information from them in form of short interviews & questioner. The respondents are designated authority of hospitals, who are into dealing of bio medical waste.

4.7.2 Phase II- Descriptive researches

Descriptive study refers to collecting information from the other studies on the related topic itself. Here, information gathered by exploring various journals, websites and books, where extensive information about bio medical waste is available.

Chapter-5

RESULT&DISCUSSION

5.1 Introduction

Out of 5,185 Health Care Facilities (HCFs) in Delhi, only 746 HCFs granted Authorization during 01.01.2014 to 31.12.2014. Out of these hospitals five major hospitals were inspected/ studied about their waste management and handling process within the hospital. It is approximately estimated that 0.4 to 1.5 kg/bed/day is the biomedical waste generation and 450-600 liters per bed/day is the waste water generation from hospitals/ health care establishment.

5.2 Quantity of waste generated at study areas

The results of questionnaire analysis show that about majority of respondents 81.6% including doctors, nurses, paramedical, and supplementary staff believed that the proper management of BMW was a group/team work and the secure management pains by hospital would increase the economic burden, while 26.6% of them felt that it was an additional burden on their work, 41.7% of the workers were aware and 25% had no knowledge about BMW management. On observation, it was found that 21.7% hospital staff in AIIMS hospital and 26.8% in Hindu Rao staffs did not have knowledge about segregation of BMW. Practices of biomedical waste management in these hospitals of Delhi were poor. Relation between increase quantity of bio-medical waste and beds of the hospitals shown in Figure -5.1. Different kind of waste generated in these hospitals as shown in an annexure-II

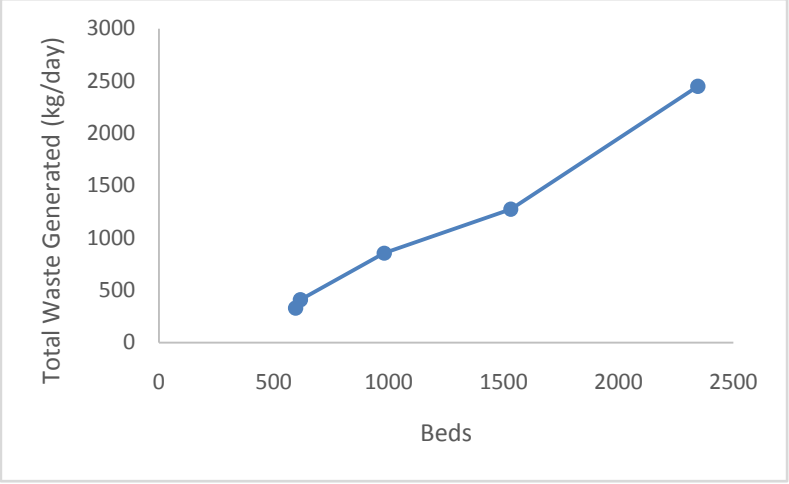


Figure-5.1 Relation b/w Beds & Waste generated in the hospitals

All government hospitals and health centers are managed by regional health departments, namely:

1. Health & Family Welfare Department.
2. Ministry of Environment & Forest.
3. Delhi Pollution Control Committee.

Each regional health authority is responsible for the operations of all government hospitals and health centers within the region. The Ministry of Health directly manages all regional health authorities. Private& Government hospitals are licensed by the Delhi pollution Control Committee for managing their Bio-Medical Waste. There is a documented operating standard and guideline manual governing government hospitals and health centers. This manual has limited instructions and procedures for the management of biomedical waste, personnel training and personal.

5.3 Generation of Bio-Medical Waste

BMW is segregated at the site of generation from each ward of the hospital. Biomedical waste segregation at the source might be achieved due to required number of bins in the hospital and due to required number of hospital staff. Waste segregated word wise at their collection point in the hospital and quantified in two or three shifts. The total average waste generation in AIIMS hospital, waste from the all wards was 2450 kg/day and overall waste generated 1.04kg/bed/day, waste from the Safdarjung hospital was 1275 kg/day and waste generated 0.832 kg/bed/day, waste the various wards of Hindu Rao Hospital from was 410 kg/day (including general waste) and overall waste generated is 0.41kg/bed/day.Different kind of waste generated in these hospitals shown Figure 5.2

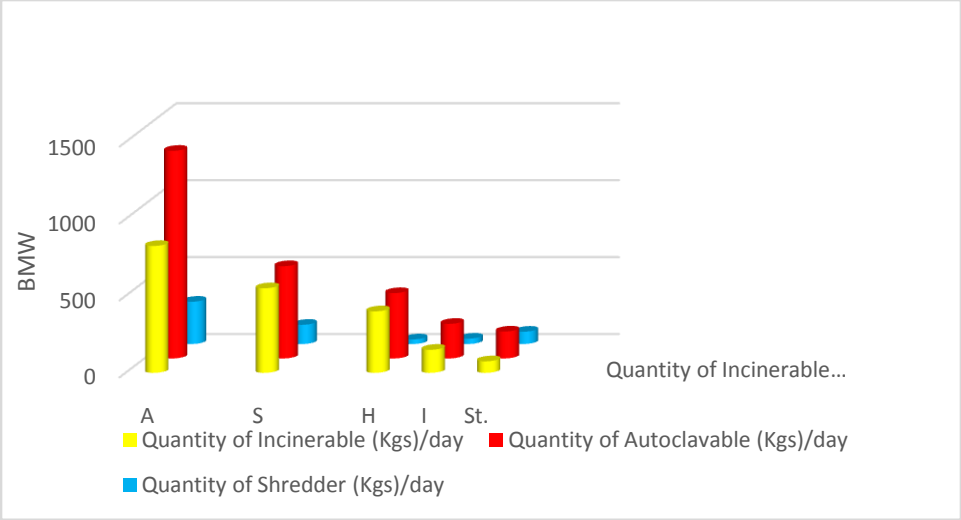


Figure 5.2 Quantity of different type of waste generated

The total no. of incinerable bags is 840 and autoclavable bags is 250 generated in AIIMS hospital, incinerable bags from the all wards was 518 and autoclavable bags were 198 from the Safdarjung hospital, red bags waste the various wards was 79 and yellow bags was 72 from the Hindu Rao Hospital, In Apollo Hospital, red bags was 69 and yellow bags were 65 from various wards (including general and kitchen waste) and incinerable waste bags was 58 and 55 autoclavable waste bags from St. Stephan Hospital. Different category of bags shown in the Figure 5.3

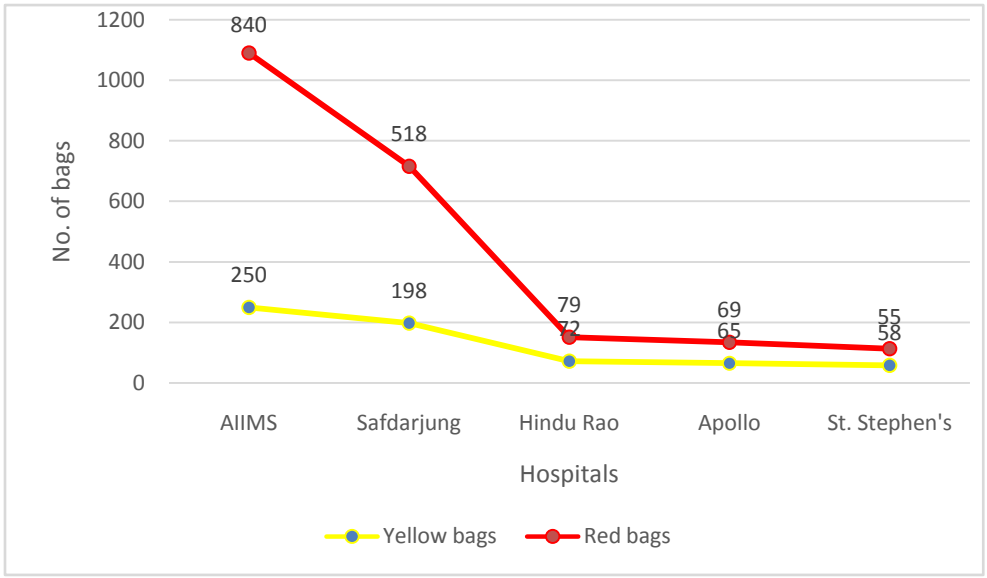


Figure 5.3No. of bags of different category used in the hospitals

In Apollo Hospital, 855 kg/day waste generated from various wards (including general

and kitchen waste), per bed waste generated is 1.39 kg/day & waste from St. Stephan Hospital was 330 kg/day and overall waste generated .55 kg/bed/day. Per bed waste generation shown in the Figure-5.4

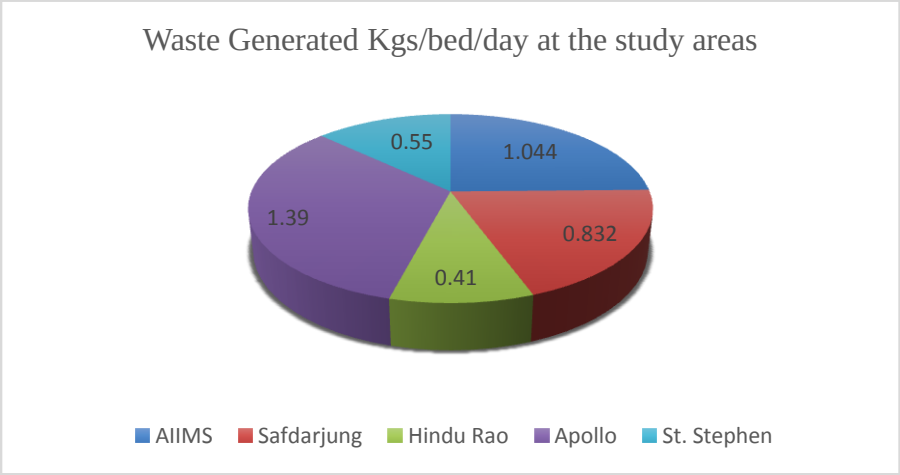


Figure-5.4 Total waste generated at study areas kg/bed/day

5.4 Perception of hospital staff about waste management

Majority of the nursing staff, chief lab technician in both government and private hospitals stressed that there was strict implementation of BMW management in the hospital area but labeling the name of the hospital area was usually not done. The nursing in charges said that 83-86 % of yellow, 82-86 % of red, 55-60 %of blue and 82-85% of black bags in the government hospitals were correct positioned. In all the private hospital areas, the waste bags were correctly positioned. This also revealed that guidelines regarding BMW management were not displayed in proper manner.

Table 5.1 Component of segregation and collection

Ward sisters	Government Hospitals %	Government Hospitals %	Total %
Labeled and signed			
Yes	66.7	87.5	75
No	33.4	12.5	25
Strict implementation			
Yes	83.3	100	90
No	16.7	0.00	16.7

5.4.1 Segregation of the BMW in the hospitals

There was significant difference in segregation of wastes in government and private hospitals with private hospitals showing results better in terms of segregation of wastes according to the guidelines, segregation of wastes at the site of generation and collection of plastic waste unmixed in red bags. It was revealed that in nearly half the hospital areas of the hospitals, containers with colored bags were not located at the site of generation in the government hospitals. There was a significant difference in government and private hospitals as far as the position of containers with colored bags at the site of generation was concerned. Observational survey revealed that only 65% of the hospital areas had guidelines/Figures displayed.

5.4.2 BMW handling in the Hospitals

All the housekeeping staff interviewed in the various hospitals told that they closed the waste bags by tying the knot and carried them to the central waste storage facility in hands. According to Hospital superintendents, all the hospitals except one were having separate/specific time schedule to remove infectious waste and general wastes from the wards. BMW was being removed from the hospital areas for storage/treatment and final disposal in more than once a day, and the remaining hospitals were removing it as and when sufficient quantity of BMW accumulated. A dedicated waste route selected to avoid the way of wastes through hospital areas was only in two of the hospitals one in a private and government sector each.

It revealed that none of the hospital areas had designated waste route inside the hospital. Even the time of removal of infectious waste from non-infectious waste was different in the hospitals areas and those hospital areas belonged to government hospitals. In private hospitals areas small buckets were being used to carry the wastes to the central storage facility but they were not labeled with the biohazard symbol.

5.4.3 BMW storage within the hospitals

Storage areas were secured by lock and key in the hospitals. Proper log book was not maintained for receipt and register of the BMW at any of the hospitals although a designated person was there for the storage area. It was observed that the waste bags were not labeled at the site of generation and were stored together except in two private hospitals where they were stored separately. The study exposed that biomedical waste generated in each department was collected by sanitation staff . The collection rotation occurred two times in a day. The BMW was collected manual/trolleys and temporarily stored in plastic bins of colors other than those prescribed by BMW rules, 1998 shown in figure 5.5. It was experiential that staff was mixing noninfectious and infectious waste and hospital did not segregate bio medical waste properly in accordance with the prescribed rules.

Figure-5.5 Bins located inside the hospital

Functional facility to weigh the waste was there in 4 of the hospitals with the one government hospital having it. The state of cleanliness in the central storage facilities in all the government hospitals was poor. The private hospitals fared better in this aspect as they had central storage facility in a relatively better condition compared to the government hospitals.

5.4.4 Sharps management in the hospitals

Totally, 60% of the nursing staff said that in their hospital areas sharps were destroyed individually. The major reason behind the destruction of sharps in bulk was found to be excess

workload. Though sufficient disinfectant was available of 72 % of the hospital areas and the disinfectant solution was being replaced in each shift as per the guidelines.

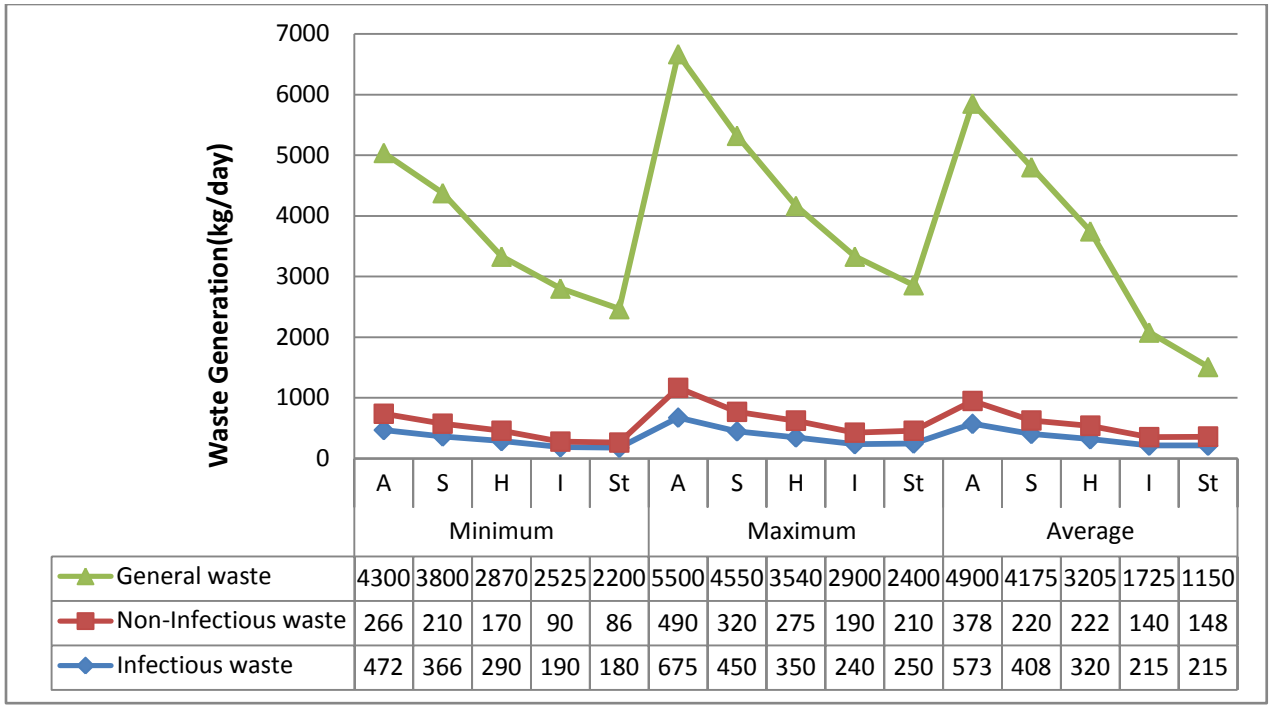
In 70 % of the hospital areas of the private hospitals supervised by nursing staff sharps were destroyed individually whereas it was seen in 60 % of the hospital areas of government hospitals according to the interview of the nursing in charge disinfectant solution for treating the plastic wastes was replaced as per guidelines. There was no significant association with various aspects of sharps treatment with type of hospitals in relation to ward sisters/ nursing in charge.

Totally, 64 % of the hospital areas had a functional needle destroyer easily available and 36 % of the hospital areas were destroying the needles after every injection. Higher proportion of the government hospitals areas were performing better regarding sharps management.

5.5 Quantification of Infectious, Non-Infectious and General Waste

The generation of waste is about 0.5-1.5 kg/ bed per day from hospitals of revealed by the study in hospitals. According to JICA (1982), the generation of infectious solid waste alone in the order of 0.43 kg per day per bed in many hospitals in Bangkok. Infectious wastes are highly hazardous and careful disposal practice, in order to eliminate the transmission of diseases either by itself or through vectors.

The results Indicate large variation on the generation of infectious and non-infectious and general wastes show the Figure 5.6



A-AIIM**S, S**-Safdarjung**, H**-Hindu Rao**, I-** Inderprastha**& St**-St Stephen

Figure 5.6Quantification of Infectious, Non-Infectious and General Waste

5.6 Quantification of Non-Infectious Waste Blue Bag &Yellow Bag

Non-infectious but hazardous products are collected in blue bag. Their uncontrolled dumping poses a threat not only to the surrounding, but also to some medical items which are accessible to the rag pickers. The characterization of non- infectious waste i.e. Glover, Syringes, Needle, Tubes, Blood and urine bags, Glass bottle, Needle cap and other generated kg/day and characterization of infectious waste i.e. Bandages, Moist clothe, Plastics, Cotton. Papers, cardboard Glass, Sharps, etc generated kg/day along with their percentage are as given in Figure 5.7

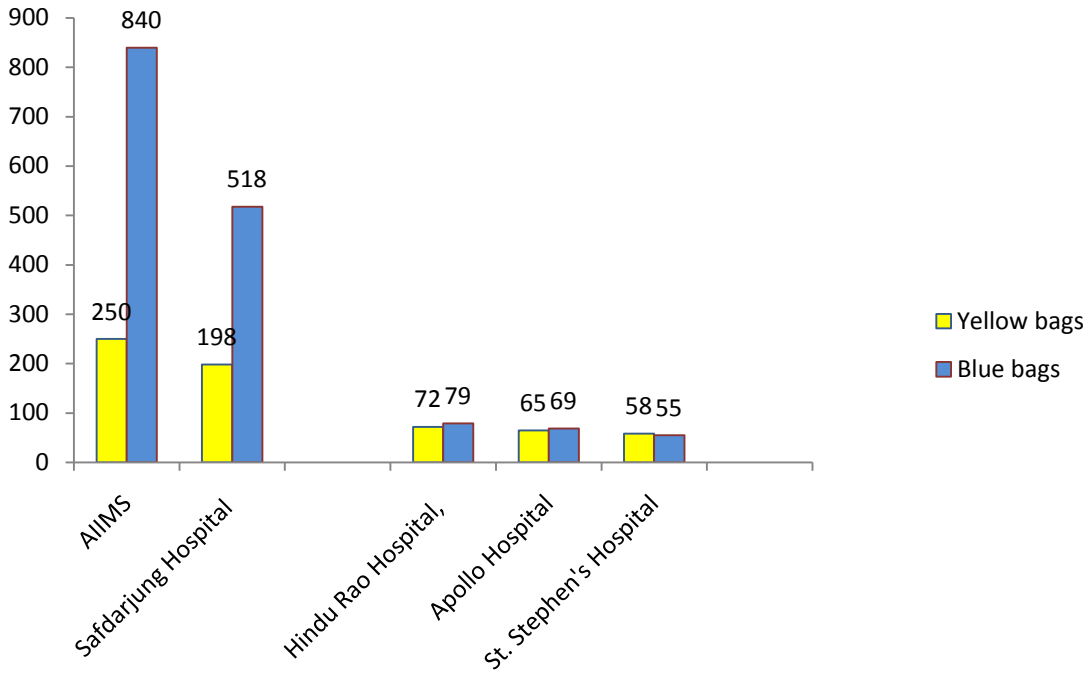


Figure 5.7: No. of waste generation begs

5.7 Identification of Plastics

Characterization of plastics waste has been done as a part of total waste characterization. In last two decades, the plastic content in the Bio-medical waste has increased from 10% to more than 30%. Based on the resin type plastic content in the Bio-Medical Waste is characterized into seven categories. These six categories are given below:

- High density polyethylene.
- Low density polyethylene.
- Polyethylene Terephthalate.
- Poly vinyl chloride.
- Polypropylene
- Polystyrene

Therefore information was gathered about their resin type. Plastics have been characterized according to following six standard categories and each product is quantified as mentioned in an Annexure-III

5.9 Standard for liquid waste

The effluent generated from the health care establishment should conform to the following limit

These limits are appropriate to those hospitals which are either linked with sewers without terminal Sewage Treatment Plant or not connected to government sewers. For release into government sewers with terminal services, the common standard as notify under the Environment (Protection) Act, 1986, shall be applicable. Waste Water Parameters shown in Annexure-VI

Delhi Pollution Control Committee has taken decision that HCE having 50 beds or more shall establish Effluent Treatment Plant for the treatment of waste water generated from the medical activities and for recycling of treated water for use in horticulture, air cooling /conditioning plants and flushing of toilet etc.

5.8 Level of knowledge of Hospital staff about biomedical waste generation

Table 5.2 Level of knowledge of biomedical waste generation, hazards and legislation among health care personnel

Hospital Staff/Health care personnel	Scoring criteria		
	Excellent	Good to average	Poor
Doctors/Dentist	25%	40%	35%
Head Nurses/Nurses	18%	47%	37%
Lab technicians	7%	59%	37%
House keeping staff	17%	50%	33%

The interview with the nodal officer was focused on questions connected to various aspect of medical waste management (Annexure-I) exposed in this research. They are:

- The general facts about the health care establishment trust
- Bio medical waste management plan/policies in the hospital.
- The organizational structure of the waste management at the hospital
- Classification of medical waste
- Segregation of medical waste and color coding system

- Storage, transportation and current disposal method of the medical waste.
- All records of medical waste generated

The direct or face to face interview help in gather data about the interior waste management policy at the hospitals and the BMW generation data. The suitable date & time for the study area visits were fixed during the questioner/interview. The data about the waste transportation & the offsite treatment plant was also composed. A copy of the biomedical waste management policies in the hospitals were collected and other data were record for the analysis. A request to visit the offsite treatment plant and the emissions data from biomedical waste was placed to the respective company through the nodal officer in the hospital.

5.9 Analysis Report of STP in Selected Hospitals

The treated waste water samples from S.T.P located at the Hospital were collected and the results obtained by analyzing are shown In Table 5.3

Table 5.3 Parameters analyzed

S.No	Hospitals Name	Beds	Date of Sample Taken	Parameters analyzed				
				Discharge BOD3 at 27°C	Suspended Solids	Oil and Grease	pH	Bio-Assay
1	All India Institute of Medical Sciences, Gautam Nagar, Ansari Nagar East, New Delhi	2345	14.02.15	15	18	1.2	7.3	90
2	Safdarjung Hospital & V.M.M.C. AurbindoMarg, New Delhi-29	1531	13.03.15	21	24	1.4	7.0	90
3	Hindu Rao Hospital, Delhi-110007	980	23.05.15	28	24	1.4	7.27	100
4	Indraprastha Medical Corporation Ltd. (Apollo Hospital Enterprises Ltd.), SaritaVihar, Mathura Road, New Delhi-76	615	19.04.15	22	39	1.5	7.30	100

5	St. Stephen's Hospital,	594	15.05.15	20	35	1.3	7.4	100

5.10 Common Regional Facility (CRF) for final disposal of infectious BMW

Total bio medical waste generated in the hospitals/nursing homes/clinics covered by the Common Bio Medical Waste Treatment Facilities for the year 2014 shown in an Annexure-V. CRF for final disposal of infectious BMW generated Hospitals, private/government practitioners, urgent situation care center though aware of the rules do not have the time or resources to arrange satisfactory disposal of BMW. Self contained onsite treatment methods may be desirable and feasible for large health care facility. It will not be economical for smaller nursing homes/institutes/clinics. An acceptable common scheme should be in situate which will provide free supply of colour coded bins, per day collection of infectious waste, & safe carrying of waste to offsite treatment facilities and final disposal with appropriate technology. Total waste treated by the CBWTF 14.49 tones in a day and out of this BMW waste, 5231.56 kg/day treat by Biotic Waste Solution Pvt. Limited. Information on CBWTFs given in the Annexure-V

The Systems approach adopted in this Study aims to identify organizational, technical and social factors involved in the BMW disposal system. The ultimate goal of this approach is to suggest methods of improvement keeping in mind the current environment in which the system works. There was wide variation in the amount of BMW generated per bed across various HCEs even within the same level of HCEs.

Therefore, the median values were taken to calculate BMW in each category of hospitals. The Users had no complaints as regards collection, segregation and transportation of BMW to kerb site was concerned. The results of our study are similar to that of studies conducted Safdarjung Hospital & Hindu Rao Hospital , outsourcing company recognized by Delhi Pollution Control Board, on a 500-1000 bedded hospital in Delhi. The Bio Medical Waste generated from HCEs include plastic waste also and these two common bio medical waste treatment facilities have the facility of shredding & autoclave for treatment of infected plastic so these are the accepted agency for plastic waste also in context in of HCEs Delhi. The wide variation in BMW

generated could be due to the confusion in colour coding as various categories have multiple options as per BMW Rules. The CPCB has attempted to address this problem by now giving new colour coding options which are mutually exclusive to various categories of BMW.

These common bio medical waste treatment facilities are having treatment equipments i.e. Autoclave, Shredder, Incinerator, etc. for the treatment and disposal of the BMW collected from the HCEs in Delhi. CBWTFs are also having Effluent Treatment Plant (ETP) for the treatment of the waste water generated from their services. Waste carrying vehicles shown in Fig 5.8

Figure 5.8 Partition in waste carrying vehicles

Overwhelming majority of hospitals have recommended for outsourcing as a viable method of disposal of BMW. A proportional Study of Economics involved in common BMW treatment facility (CBWTF) v/s individual system by a private vendor (handling BMW of one Command hospital and one less than 300 bedded service hospital) has concluded that cost of running CBWTF is approx. 52.12% lower than running one's own facility.15 Outsourcing is being successfully carried out in four of our service HCEs.

Therefore, in cities where a State PCB approved vendor is available for outsourcing final disposal of BMW, the service HCEs should enter into a rate contract based on the rate approved by the local civic body. The basis of calculation should not be authorized beds but the average bed occupancy over the last three years,2 as has been done by one of our service hospital.

Chapter-6

CONCLUSIONS

BMW management program cannot effectively be implement without the motivation, devotion, self inspiration, cooperation and contribution of all sections of staff of any HCE. Therefore, it becomes the responsibility to segregate and manage the waste in such a way, that it is no longer hazard for hospital staff, public and environment. Inappropriate management of BMW, the Ministry of Environment and Forests notified the "Bio-Medical Waste (Management & Handling) Rules, 1998." These rules are intended to protect the community, patient & health care staff. The most essential part of the waste management strategy is to develop a structure through training, education and determined motivation of the hospital staff. There is a urgent need of bio meical waste managment education as to the hazards connected with inappropriate waste disposal. The effective statement strategies are necessary keeping in view the less awareness level amongst different category of hospital staff in the health care establishments/institute regarding BMW management.

The total average waste generation in AIIMS hospital, waste from the all wards was 2450 kg/day and overall waste generated 1.04kg/bed/day, waste from the Safdarjung hospital was 1275 kg/day and waste generated 0.832 kg/bed/day, waste the various wards of Hindu Rao Hospital from was 410 kg/day (including general waste) and overall waste generated is 0.41kg/bed/day. In Apollo Hospital, 855 kg/day waste generated from various wards (including general and kitchen waste), per bed waste generated is 1.39 kg/day & waste from St. Stephan Hospital was 330 kg/day and overall waste generated .55 kg/bed/day.

The bio-medical waste is segregated at source of generation and placed into different color coded bins e.g. the biodegradable waste in black color bag, infectious in yellow bags and sharp in blue color bag. Analysis of results reveals that segregation minimizes considerable the Bio-Medical Waste Volumes. The following further conclusion are found on the basis of the findings of the study research.

1. All waste was collected twice in a day from each words and stored at waste storage site within the hospitals.
2. The rate of generation of autoclavable waste is more than the incinerable waste.

3. Labelling and bio-hazard symbol was not proper on the waste carrying trolleys and dustbins in many places of the hospital.
4. The effluent parameters such as pH value, suspended solids, BOD, oil & grease and Bio-Assay test are within the permissible limits as prescribe in Bio Medical Waste (Management and Handling) Rules 1998.
5. Study shows that segregation of BMW is not as per the Bio Medical Waste (Management & Handling) Rules, 1998
6. Some waste was not segregated as per the guidelines at the source of generation in many department of the hospitals.
7. In Delhi, hospitals or health care facilities produce around 14.94 Tons of Bio-Medical Waste daily.

Recommendations

- Review of the waste management policies should be done so that it focuses not only on the medical waste decreasing strategies but shall also hold strategies to encourage larger appointment and to change the projected behavior to a additional sustainable behavior.
- Should improve the waste management by:

    - Making proper arrangement to shut the medical waste bin when it is three forth full.
    - There should be collection of waste at least twice or thrice in a day.
    - The waste manager/nodal officer should discuss with the staffs and a accord should be completed on the location of waste bins.
    - The hospital staff should be highly positive to inform the medical waste management team/nodal officer whenever they have lay waste in wrong/different color bin.
    - There should be proper maintenance of bio medical waste record in each ward.
    - Should support the proper waste management practices especially for the house keeping staff/employees/student in the hospitals.
    - The hospital should have separate budget line for their, waste management program as this is very cost intensive.
    - The kitchen and canteen waste can be utilized for the production of manure

from vermin composting.

- It is recommended that the infectious waste should be segregated from the other waste carefully. Strategies should be planned not to put plastics in yellow bag. It is recommended to use non- chlorinated plastics products.
- There should be a provision of organization advanced training programs to the staff at various levels time to time prevent and minimize the waste production and treat the waste by safe and environmental friendly methods.

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Annexure -I

Table : Survey being conducted as part of a case study on Hospital Waste Management

Assessment of Biomedical Waste

Tick the appropriate answer:

Your position:

Doctor / Dentist Class IV employee Nurse Lab technician

Section 1: Knowledge of biomedical (BM) waste generation, hazards and legislation

1. Do you know about BM waste generation and legislation?

   Yes No Not sure

2. What agency(ies) regulate(s) wastes generated at health care facilities?

   State Private Do not know

3. Do you think it is important to know about BM waste generation, hazards and legislation?

   Yes No Somewhat

4. Biomedical Waste (Management & Handling) Rules were first proposed in:

   1997 1998 1999 2000

5. Amendments to the Biomedical Waste (Management & Handling) Rules were made in:

   2000 2001 2003 2004

6. Which statement describes one type of BM waste:

   Materials that may be poisonous, toxic, or flammable and do not pose disease-related risk.

   Waste that is saturated to the point of dripping with blood or body fluids contaminated with blood. Waste that does not pose a disease-related risk.

7. According to the Biomedical Waste (Management & Handling) Rules, waste should not be stored beyond:

   12 hours 48 hours 72 hours 96 hours

8. One gram of mercury (source from dental amalgam) is enough to contaminate the following surface area of a lake:

20 acres 30 acres 25 acres 15 acres

9. Who regulates the safe transport of medical waste?

Pollution Control Board of India.

Transport Corporation of India.

College Administration.

10. Do you need a separate permit to transport biomedical waste?

Yes No Cannot say

Section 2: Level of awareness on biomedical waste management practice

11. Do you know about colour-coding segregation of BM waste?

Yes No Not sure

12. Do you follow colour-coding for BM waste?

Yes No Sometimes

13. Is the waste disposal practice correct in your hospital?

Yes No Cannot comment

14. Objects that may be capable of causing punctures or cuts, that may have been exposed to blood or body fluids including scalpels, needles, glass ampoules, test tubes and slides, are considered biomedical waste.

How should these objects be disposed of?

Black bags Yellow bags Clear bags Sharps container

15. Documents with confidential patient information are to be disposed of into the paper recycling bins.

True False Do not know

16. The colour code for the BM waste to be autoclaved, disinfected is:

Red Black Yellow Blue/white

17. The approximate proportion of infectious waste among total waste generated from a health care facility is:

10-20% 30-40% 50-60% 80-90%

18. The colour code for disposal of normal waste from the college is:

Red Black Yellow Blue

19. All the following steps should be followed after an exposure with infected blood/body fluid and contaminated sharps EXCEPT:

Exposed parts to be washed with soap and water.

Pricked finger should be kept in antiseptic lotion.

Splashes to eyes should be irrigated with sterile irrigants.

Splashes to skin to be flushed with water.

20. All of the following statements about hazardous waste containers are true, except for:

Containers must be closed except when removing or adding waste.

Containers must be clean on the outside.

Contents must be compatible with the type of waste containers.

Any type of container, including food containers, can be used to contain hazardous waste

Section 3: Attitude/behavior assessment towards biomedical waste

21. Safe management of health care waste is not an issue at all.

Agree Disagree Cannot comment

22. Waste management is team work/no single class of people is responsible for safe management.

Agree Disagree Cannot comment

23. Safe management efforts by the hospital increase the financial burden on management.

Agree Disagree Cannot comment

24. Safe management of health care waste is an extra burden on work.

Agree Disagree Cannot comment

25. Do you think that the college should organize separate classes or a continuing dental education program to upgrade existing knowledge about biomedical waste management?
Yes No Cannot comment

26. Will you like to attend voluntarily programs that enhance and upgrade your knowledge about wastemanagement?

Yes No Cannot comment

27. Do you think that infectious waste should be sterilized from infections by autoclaving before shreddingand disposal?

Yes No Cannot comment

28. Do you think that an effluent treatment plant for disinfection of infected water should be set up in dental colleges?

Yes No Cannot comment

29. Do you think it is important to report to the Pollution Control Board of India about a particular institution if it is not complying with the guidelines for biomedical waste management? Yes No Cannot comment

30. Do you think that labelling the container before filling it with waste is of any clinical significance?

Yes No Cannot comment

Section 4: Level of knowledge among nurses, doctors, attendants, lab technicians on needle-stick injuries

31. Is needle-stick injury a concern?

Yes No Do not know

32. Do you re-cap the used needle?

Yes No Do not bother

33. Do you discard the used needle immediately?

Yes No Have not noticed

34. Are you aware of consequences of needle-stick injury?

Yes No Not concerned

35. Have you sustained a needle-stick injury during the last 12 months?

Yes No Do not remember

36. If yes, how many injuries?

37. How did the most recent incident happen?

Poor disposal of needle Individual carelessness/accident Cannot remember Other (specify)

38. To whom did you report the injury?

Line manager Occupational health

Infection control Nobody

Cannot remember Other (specify)

39. Did you fill in an incident report?

Yes No Cannot remember

40. Have you been fully inoculated against hepatitis B?

Yes No Not sure

Thank you for your valuable time and cooperation.

Annexure-II

Table: Waste generation in hospitals

S.No	Hospitals Name	Beds	Quantity of Incinerable (Kgs)/day	Quantity of Autoclavable (Kgs)/day	Quantity of Shredder (Kgs)/day	Total (Kgs)/day
1	All India Institute of Medical Sciences, Gautam Nagar, Ansari Nagar East, New Delhi	2345	825	1350	275	2450
2	Safdarjung Hospital & V.M.M.C. AurbindoMarg, New Delhi-29	1531	550	600	125	1275
3	Hindu Rao Hospital, Delhi-110007	980	400	425	30	855
4	Indraprastha Medical Corporation Ltd. (Apollo Hospital Enterprises Ltd.), SaritaVihar, Mathura Road, New Delhi-76	615	150	225	35	410
5	St. Stephen's Hospital, Tis Hazari, Delhi-54	594	75	175	80	330

Annexure -III

Table: Characterization of Plastic

Categories	**Product type**	**Weight (kg/day)**				
		A	S	H	I	St
Polyethylene	White or Colorless bottle	9.7	8.2	7.77	4.89	3.6
High Density polyethlene (H.D.P)	Chemical, Bottles, hard Plastic stuff etc.	56.1	42.3	39.84	24.71	18.285
Poly vinyl chloride (PVC)	Tubing, Ilexes and Plastic bags thin plastic claver	384.02	343.45	255.5	148.12	109.61
Low Density Polyethylene (L.D.P)	Jam, Small Juice container & caps	17.02	16.2	13.65	9.67	7.81
Polypropylene (P.P)	Thermo coal small coffee cups	67.8	53.63	44.1	26.4	19.536
Polystyrene	Thin plastic and packing bottoms	28.46	19.4	15.54	6.84	5.06

A-AIIM**S, S-**Safdarjung**, H-**Hindu Rao**, I-** Inderprastha& **St-**St Stephen

Annexure -IV

Table : Component of each beg and treatment technology used for each beg

Color Code	**Yellow Bag**	**Blue Bag**	**Black Bag**	**Blue Puncture Proof Container**
Treatment Option	Incineration	Autoclaving/ Shredding	Shredding Disposal	Autoclaving/ Shredding
Waste Constituents	Blood Soaked Cotton Plasters/ Cats Human And Animal tissues/ Organs/ Parts Discarded Medicines/ Cytotoxic Drugs Without Breaking Ampouces/ Vials/ Bottles	Tubing's/Catheters/ Sets/Urine Bags/Gloves/Blood Empty Bags/Syringes Separated From Barrel & Also Containers Without Needles Cut Into Pieces At Source of Generation, Put into 1%SodiumHypochloriteSolutionForAtLeast Half An Hour Transferred To Bag ForAutoclaving And Shredding	Paper, Card Board, Plastic Glass Bottles Metal Cans Kitchen Waste (Taken Away By Municipality For Disposal)	Broken Nozzles Of Syringes, Burnt Remains Of Hypodermic Needles, Scalpel Lancets/Blades All Soaked In 1%Hypochlorite Solution And Taken To Shredding Site Form Disfigurement And Final Disposal

Annexure -V

Table: Information on Common Bio-Medical Waste Treatment Facility (CBWTFs)

(For the Year 2014)

S.No	Name & Address of CBWTF	Name of Cities /areas covered by CBWTF	Total No. of HCFs being covered	Total No. of beds covered	Total Quantity of BMW collected, treated and disposed off (kg/day)	Cost of treatment of BMW charged by the CBWTF operator	Treatment equipment/facilities installed at CBWTF (*)		
							Equipment	Nos.	Total Installed Capacity in Kg/Day
1	Biotic Waste Solution Pvt. Ltd., 46, SSI Industrial Area, Delhi-33	Delhi	1,604	13,714	5231.56	As approved by DHS	Incinerator	2	250 Kg/Hr
							Autoclave	1	200Kg/batch
							Shredder	1	300 Kg/Hr
							ETP	1	100 KLD
2	Synergy Waste Management Pvt. Ltd., Near Composite Plant, OkhlaTank, SukhdevViha	Delhi	2,147	15,844	6203.98	As approved by DHS	Incinerator	1	300 Kg/Hr
							Autoclave	1	300 Kg/batch
							Shredder	1	500 Kg/hr.
							ETP		20 KLD

	r, Mathura Road, New Delhi-20								
3	SMS Water Grace Pvt. Ltd., Nilothi Sewage Treatment Plant Complex of DJB, Nilothi, Delhi-41	Delhi	1434	15,437	2719.20	92 / bed / month (As approved by DHS)	Incinerator	2	250 Kg/Hr
							Autoclave	1	300 Kg/batch
							Shredder	1	300 Kg/Hr
							ETP	1	100 KLD

Annexure -VI

Waste Water Parameters

Parameters	Permissible Limits
pH	5.5-9.0
Suspended Solids	600 mg/L
Oil & Grease	10 mg/L
BOD	350mg/L
Bio-assay Test	90% survival of fish after 96 hours in 100% effluent