Chapter – 2

IMPACT OF BIO-MEDICAL WASTE ON ENVIRONMENT
2.1 INTRODUCTION

The issue of biomedical waste management has assumed great significance particularly in view of the rapid upsurge of HIV and Hepatitis B infections. Safe handling of biomedical waste continues to be a matter of serious concern for health authorities in India and problem. Thousands of tonnes of biomedical waste originating from hospitals, nursing homes and clinics in the form of cotton swabs and bandages infected with blood, IV fluid bags, needles, catheters, human tissues, body parts etc, is dumped in open garbage bins on the roads in most parts of the country. This causes serious pollution of environment which poses threat to the health of human, ecology, ecosystem, biodiversity, health of animals, plants etc. Improper management and irresponsible handling of biomedical waste has created alarming threats to the environment by its hazardous effect upon it which directly results in perilous consequences leading to degradation and decay of environment. The nexus is clear and factual. From almost every facet of our environment, i.e., air, water, earth and the communities of people etc., such negative impact can be inferred.

The issue pertaining to biomedical waste cannot be summarily and merely taken lightly because, in our own context, the following factors in a compelling manner inform us that biomedical waste disposal is going to be the key and central concern in the overall ambit of environment protection¹.

i) Consistent dwindling of state’s budgetary allocation on ‘public health’.

ii) Every increasing and entrenching health care needs owing to umpteen and varied social and economic factors.

iii) Multiplying private investment in healthcare delivery resulting in enormous growth of healthcare centers purportedly catering to the healthcare needs of our population.

iv) Influence and impact of technological advances in the realm of medical sciences has unheard solutions in healthcare, innovative diagnostic procedures and

appropriately customized surgical interventions with avoidable degrees of life threatening consequences;

v) Slow and steady positive influence of IPR’s (Intellectual Property Right) on pharmaceutical scenario fuelling R & D (Research & Development) growth and expansion;

vi) Public consciousness and awareness effectively driving growth potential in the primitive, preventive and costive healthcare solutions etc.

The term ‘hazardous waste’ evokes images of inadequately stored; toxin-filled drums leaking into the earth, polluting the water supply, and endangering the lives and genetic constitution of thousands of people. There have been well-publicized instances of such harm. But the concept of ‘hazardous waste’ is much broader. Applying the precautionary principle includes a wide array of items that ‘might be’ hazardous, or are so only when the aggregate of human activity is considered. Thus, all medical waste is hazardous waste by definition. Even simple bandages fall within its scope, because some might carry infection which poses a threat to human health and the environment. The problem with the disposition of hazardous waste (includes Biomedical Waste) is not only observed in international level but also observed the same in the national level. This could be better understood by analyzing data of Biomedical Waste Management from different countries and also those data available from international institutions to combat the problem of Biomedical Waste Management. The factual situation of other countries would definitely give a clear view of management of biomedical wastes in the international scenario. For the purpose of the study International Organizations, Agencies, Associations and Institutions etc like World Health Organization, International Atomic Energy Agency, and International Solid Waste Association etc have been taken into consideration due to their enormous contribution in the management of biomedical waste world-wide.

Similarly, the management of biomedical wastes practices of US and UK and its best Practices, Technologies, Innovations, Handling etc have been highlighted in the present study so that comparative study would be easier and better understood. It would
also help to know the better technologies that would rather be useful to implement in developing country like India.

The different aspects of biomedical waste management including adverse effects to health and environment could also be studied from data of USA and U.K.

Therefore, medical waste is nothing less considered hazardous waste which is equally responsible for deterioration of environment. The term environment implies all the external factors-living and non-living, material – which surround man. In its modern concept, environment includes not only the water, air and soil that form our environment but also the social and economic conditions under which we live.

For descriptive purpose, environment has been divided into three components, all closely related:

i) Physical: water, air, soil, housing, wastes, radiation, etc.

ii) Biological: plant and animal life including, bacteria, viruses, insects, rodents and animals.

iii) Social: customs, culture, habits, income, occupation, religion etc.

Therefore the key to man’s health lies largely in his environment. In fact, much of man’s ill-health can be traced to adverse environmental factors such as water pollution, soil pollution, air pollution, poor housing conditions, and presence of animal reservoirs and insect vectors of diseases which pose a constant threat to man’s health. Often man is responsible for the pollution of his environment through urbanization, industrialization and other human activities. In 1972 the UN Conference on the Human Environment focused world-wide attention on the environmental hazards that threaten human beings. To facilitate work in this area, WHO has compiled a wide-ranging survey of environmental hazards with human health1.

The dictionary meaning of the word ‘Sanitation’ is “the science of safeguarding health” but one of the best definitions is that given by the National Sanitation Foundation of the USA, which is as follows:

“Sanitation is a way of life. It is the quality of living that is expressed in the clean home, the clean farm, the clean business, the clean neighborhood and the clean

community. Being a way of life it must come from within the people, it is nourished by knowledge and grows as an obligation and an ideal in human relations.”

The term ‘Environmental Sanitation’ has been defined by World Health Organization (WHO) as “the control of all those factors in man’s physical environment which exercise or may exercise a deleterious effect on his physical development, health and survival”. This has direct influence on bio-medical waste because it is one of the contributories to pollution of environment. It is also well known that bio-medical waste causes air, water, land and soil pollution etc. However, man’s mastery over his environment is not complete. As old problems are being solved, new problems are arising. Air pollution is of growing concern in many urban centers. Industrial growth has given rise to the problem of environmental pollution by industrial wastes. Bio-medical waste also causes radio-active pollution as well as industrial wastes are produced by incineration process. Therefore, the attainment of a healthy environment has become more and more complex. The purpose of environmental health is to create and maintain ecological conditions that will promote health and thus prevent disease. Then the question naturally arises are, what are the hazards to environment and humans due to hospital wastes? The hazards posed by biomedical waste are of two categories.

A) Environmental Hazards

If hospital waste is mixed with general municipal waste, the latter becomes infectious and difficult to treat. If dumped indiscriminately, it can contaminate the soil and even ground and surface water. Not only do infectious wastes pose a threat to the environment, but also the procedures used to treat the waste could contribute to environmental dangers. For example, in incinerator ash if dumped indiscriminately may lead to soil or ground water pollution as it may contain toxic metals. Incineration of hospital wastes which contain plastics leads to release of hydrocarbons, sulfur dioxides and other toxic gases (like dioxins and furans) that cause air pollution.
B) Human Hazards

It has been clearly stated that even small amounts of infectious waste when mixed with general waste makes the entire waste infectious and harmful for healthcare personnel who handle such wastes. Disposable items if they are reused without treatment can cause infections. Indiscriminate treatment and dumping of infectious wastes could also cause harm to humans (rag pickers) and animals, when they stray into such areas and rummage through them. Unscrupulous disposal of sharps without proper segregation and treatment can result in cuts and injuries of health care personnel handling them. Patient material such as blood, pus, urine, etc., on contact, could also lead to infections. Therefore improper management of biomedical wastes not only affects environment but also human health ultimately. In *M.C. Mehta V. State of Orissa*¹ it has been clearly highlighted that bio-medical wastes when caused environmental pollution and health hazard it has been strictly directed by High Court to combat the problem and also bring attention to stop such pollution from further continuation by passing the suitable Orders. In the instant case, the petitioner a practising advocate of the Supreme Court and General Secretary of the Indian Council for Enviro Legal Action, a registered voluntary organization, had filed the writ petition seeking for a *Writ of Mandamus* to protect the health of thousands of innocent people living in Cuttack and Adjacent areas who were suffering from pollution being caused by the Municipal Committee, Cuttack and the S.C.B. Medical College Hospital, Cuttack alleging violation of not only *Article 21 of the Constitution of India* but also, the *National Health Policy*, the *Environment Act* and the *Water Act*.

The facts leading to the case were that the petitioner came to visit the thousand year old silver city, Cuttack, hoping to have a look at the rich and cultural heritage of the city. He saw that there was a horrible pollution of water in the city. The petitioner visited Taladanda Canal which was excavated about 100 years back for the purposes of irrigation of a part of Mahanadi Delta of Cuttack District. This canal had become highly polluted. A large section of the population living in the basin along the coast of the canal was using

the water of the canal for bathing, drinking and other domestic purposes. Similarly, the unsanitary conditions of the storm water and waste from hospital were discharged into the River Kathajori was creating health problem in the city. There was need for constructing appropriate sewage system for the city and installing waste water treatment at the hospital. And these two important systems were neglected and therefore became reason for institution of this case. In the above circumstances, the Judgment of the Division Bench of the Orissa High Court\(^1\) is more commendable in combating pollution of the water by either municipal or hospital wastes.

2.1.1 Bio-Medical Waste: India

Introduction:

One of the crucial issues which have fascinated the minds of many Statesmen, Jurists, Judges, Lawyers, Environmentalists and Public in general is the issue relating to Management of Bio-Medical waste for ensuring proper environment and ecological balance. Today there is a greater concern for handling of hazardous waste including Bio-Medical waste (BMW) in the interest of health of the people as well as clean and pollution free environment. When one starts examining the problem relating to Bio-

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\(^1\) M.C. Mehta V. State of Orissa, AIR 1992 Ori 225(226, 231, 232) Division Bench of the Orissa High Court held, inter alia, as follows:

1. “As indicated above, the stand of the State and its functionaries and the Municipal Authorities is evasive and considering the counter affidavit filed by them it is found that while the Board has revealed the correct position, they have tried to suppress the truth. It is unfortunate; particularly when the reports of the Board referred to above discloses a hazardous state of affair. The health of large number of people is at stake, therefore, no amount of plea of helplessness or passing the buck to the other wings of the department will be of any assistance ……….”

2. “…………….. the authorities should wake up before the matter slips out of their hands. Their approach should not smack of mercenariness. We direct the State Government to immediately act on the reports relating to Pollution Load in Taladanda Canal and Water Pollution from Mass Bathing in Mahanadi during Karthik Purnima Annexed as Annexure 1/6 to 2/6 to the counter affidavit filed by the board. We also direct constitution of a committee consisting of the Executive Engineer, Public Health, Cuttack; the Chairman, Cuttack Municipal; the Collector, Cuttack; the Secretary to Government in the urban and Housing Department; the Secretary to Government in the Health Department; the Executive Officer Cuttack Department Authority the Superintendent, S.C.B. Medical College Hospital, Cuttack and such other functionaries and authorities as the State may feel necessary immediately to consider the reports and take necessary steps to prevent and control water pollution and to maintain wholesomeness of water which is applied for human consumption. Ways and means to prevent entry of sewage water and effluents to rivers Mahanadi and Kathajori and desirability of having Sewage Treatment Plant or Plants, the same is set up without further delay. The Storm Water Drain may be operated in such a manner as to prevent entry of sewage water through it to the rivers. The exercises indicated by us and such other decisions and exercises as may be necessary to prevent pollution of water may be taken within one year from today.”
Medical waste, invariably one is confronted with many questions like what is Bio-medical waste? How Bio-Medical waste can be properly regulated as well as managed? Then what is the impact of these wastes on human health as well as on environment and how law is regulating the issues relating to Bio-Medical waste?

2.1.1.1 Meaning of Bio-Medical Waste:

‘Bio-medical Waste’\(^1\) means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining there to or in the production or testing of biological, and including categories mentioned in Schedule I.

It is also noted that, all the waste generated in a health care setting, including the general waste as well as the biomedical waste is referred as ‘Hospital Waste’, ‘Health Care Waste’, ‘Clinical Waste’ and ‘Regulated Medical Waste’\(^2\) so on accordingly.

The Bio-medical Waste means any solid, fluid or liquid waste including the containers and any intermediate product, which is generated during the diagnosis, treatment or immunization of human beings or animals. In other words the rubbish containing human tissues, body excreta, unused drugs, swabs, disposable syringes and sticky bandages etc. constitute Biomedical Waste\(^3\).

Under *Basel Convention of 1989* bio-medical waste is also considered as one of the hazardous wastes. Under the scope of the Convention of 1989 *Article 1* states ‘hazardous waste’\(^4\) which includes wastes that belong to any category contained in where as Annex-I have the list of the categories of wastes to be controlled as:

Y1 referring to clinical wastes from medical care in hospitals, medical centers and clinics;

Y2 wastes from the production and preparation of pharmaceutical products;

Y3 wastes, pharmaceuticals, drugs and medicines and

Y4 wastes from the production, formulation and use of biocides and phytopharmaceuticals.

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\(^3\) JK-Practitioner, Vol.8 No.4, October-December 2001.

2.1.1.2 Classifications of Bio-Medical Waste:

The biomedical wastes are classified into different categories of wastes. These are divided into categories because some wastes are non-hazardous and others are hazardous in nature. It is also required to treat and dispose the similar wastes accordingly. The disposal would be easier when the wastes are segregated according to their classified categories. It has been mentioned under the Biomedical Waste Rules\(^1\) and also requires strict compliance of the same under the law. When the wastes are classified and segregated for treatment and disposal it would be necessary and helpful to place it in particular type of container for disposal\(^2\). About 75-90 percent of the bio medical waste is innocuous and as Harmless as any other municipal waste. The remaining 10-25 percent differs from other waste and can be injurious to human or animal health and harmful to the environment. If both these types are mixed together then the entire lot becomes harmful\(^3\). The waste generated by the hospitals are of two types namely; *general wastes* and *infectious wastes*. General wastes are also known as ‘communal waste’ or ‘general health care wastes’ or ‘non-risk waste’ or ‘non-hazardous waste’. These wastes include (solid wastes that are not infectious, chemical, or radioactive). General wastes includes domestic wastes, packing material, non-infectious breeding from animals, garbage from hospital kitchens and other wastes materials that are non-infectious or non-hazardous to the human health or environment. Similarly, *infectious waste* is the waste, which comes in the contact of blood and mucous membrane and is capable of transmitting viral, parasitic or bacterial diseases.

The wastes that are Hazardous in nature can be grouped as *Sharps wastes*\(^4\), *Culture and stocks of infectious agents and associated Biological*\(^5\),

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\(^4\) These include hypodermic needle, syringes, scalpels, blood specimen tubes, Pasteur pipettes and broken glass that have been exposed to infectious agents.

\(^5\) Specimen cultures from medical and pathological laboratories, cultures and stocks of infectious agents from research and industrial laboratories, wastes from the production of biological and discarded live and attenuated vaccines, culture dishes and devices used to transfer, inoculate, and mix cultures.
Infectious waste\(^1\), Bulk Human blood and blood products\(^2\), Pathological wastes\(^3\), Injurious wastes\(^4\), Isolation wastes\(^5\), Animal Wastes\(^6\), Cytotoxic wastes (Antineoplastic)\(^7\) (Antineoplastic)\(^7\) and Chemical Wastes\(^8\).

It is very necessary to note the different categories of wastes\(^9\) under Bio medical waste Rules 1998. Therefore, it is necessary to properly dispose and treat them as per the prescribed rules. The improper management of these wastes has become global problem affecting large scale environmental pollution.

There are many instances where carelessness and negligence on the part of the “Occupier”\(^10\) or “Operator of a bio-medical wastes facility”\(^11\) causing irreparable damage to human health and environment. It is true that Bio-medical waste is a hazardous pollutant and health peril to the human beings. This was first notified when used syringes, plastic vials, tubes and other such wastes found floating and drowned in several East coast beaches of U.S.A in 1980’s. Thereafter it was taken as a very serious matter and ended up with Medical Waste Tracking Act (MWTA) in 1988 and many restrictions

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1 It has potential to contain pathogens (bacteria, fungi, parasites and viruses) in concentration and quantity sufficient to cause diseases in susceptible individuals. A few of the diseases that may be transmitted by infectious wastes which are Tuberculosis, AIDS, Typhoid fever and Hepatitis A, B, and C.
2 Human blood, products of blood, serum, plasma, and other components which includes the soiled wastes.
3 Human tissues, organs, body parts and body fluids that are removed during surgery and postmortem procedures, with the exception of teeth, excreta and corpses and body parts intended for interment or cremation.
4 It includes sharps bio-medical waste (ampoules, Scalpsels, needles, hypodermic needles, knives, infusion sets, broken glass, nails etc) that can cause puncture, wounds or cuts. A few of the diseases that may be transmitted by injurious wastes are: AIDS, Septicemia, Hepatitis, Tetanus etc.
5 These are the wastes contaminated with blood, excretion, exudate, or secretion from sources isolated to protect other from highly communicable infectious diseases.
6 These include contaminated animal carcasses, body parts, fluids and bedding of animals that have been exposed to infectious agents during research (including research in Veterinary hospitals), production of biologicals, or testing of pharmaceuticals.
7 These are trace contaminated materials are hazardous pharmaceuticals used in chemotherapy, which are in addition to being toxic which are mutagenic and / or teratogenic when discarded or spilled. It also has potential to injure the cell. It includes the contamination materials from drug preparation and administration such as needles, syringes, gauzes, vials and packaging and expired drugs. A few of the diseases that may occur due to cytotoxic wastes are Anaemia, Cancer, Thrombocytopenia and Foetal abnormalities.
8 It includes radioactive materials, chemotherapy waste, heavy metals such as mercury, waste anesthetic gases and dyes and also shows ignitability, corrosivity, reactivity or the ability to produce toxic leachate in landfill. A few of the diseases that may occur due to chemical wastes are: Cancer, poisoning and skin diseases.
10 *Id* Rule 3(8) “Occupier”.
11 *Id* Rule 3(9) “Operator of a bio-medical waste facility”.

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were imposed to prohibit the dumping of Bio-Medical Waste in ocean under **United States Public vessel Medical Waste Anti Dumping Act of 1988.**

Similarly, Indian legislation such as Bio-Medical Waste Management of 1998 has also effective provisions for segregation, treatment, transportation and disposal of Bio-Medical Waste according to the mentioned classification/categories in the rules. But it is unfortunate that in spite of legal provisions bio-medical waste are not being properly disposed off by the hospitals and the medical practitioners; rather there is a large scale violations of the legal provisions.

**2.1.1.3 Sources of Bio-Medical Waste:**

The sources are nothing but the very generation of the waste and it is significant to identify the same for effective implementation of the laws. Bio-medical waste is generated mainly in human and animal hospitals\(^1\), nursing homes, clinics, dispensaries, blood banks\(^2\), animal houses\(^3\), and research institutions\(^4\) as well as in households\(^5\).

The above different sources of hazardous wastes are responsible for damaging the environment and ecology if they are not properly treated and disposed. These wastes so produced should be properly disposed of otherwise it would be contributing for pollution of the environment. It is not only dangerous but also a threat to human health and environment.

Unfortunately, household bio-medical wastes are not mentioned in the BMW Rules 1998. And today it is growing concern that more and more medical drugs, syringes,

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\(^1\) Hospitals (for human and animals) generates all types of wastes listed under the biomedical waste notification viz. Schedule I of Biomedical waste (management and Handling) Rules, 1998.

\(^2\) Blood Banks and clinical laboratories generate most of the categories of biomedical waste found in Bio-Medical Waste (Management and Handling) Rules 1998.

\(^3\) Animal houses, Laboratories of industries, and research institutions also generate Bio-Medical Waste in huge quantity. It mainly consists of animal tissues, organs, body parts, carcasses, body fluids, blood of experimental animals. Microbiological and biotechnological wastes are also generated in these institutions. Bio-Medical Waste generated by these institutions is also under the purview of Bio-Medical Waste (management & Handling) Rules of 1998.

\(^4\) Industrial, Educational Organizations and Research Centers.

\(^5\) Household: These generate a small amount of Bio-Medical Waste which is less than about 0.5% of the total waste generated. The types of Bio-Medical Waste generated in a household are as follows:


needles etc., are found in household wastes. And it also cannot be denied that every household waste in India would contain either of the above mentioned medical waste in general. Therefore, in India it is an urgent need to regulate household bio-medical waste.

It is also the same in case of Mortuary and beauty parlors etc though these generate bio-medical waste, yet they are not mentioned under the law and regulated. And these aspects have to be mentioned as a serious matter of concern and the law has to take note of the same and regulate accordingly.

2.1.1.4 Hazards of Bio-Medical Waste:

The waste thus produced during diagnosis, immunization, treatment, research etc should always be, disposed of in a given appropriate manner as given under the law\(^1\). It is very important to treat and dispose of the medical waste because the waste could be either infectious or non-infectious. Medical waste that which is infectious if mixed with non-infectious waste become totally infectious and naturally become hazardous in nature. These hazardous wastes create ecological imbalance, health hazards and pollution and could be detrimental to the environment. Therefore to know the hazards of bio-medical waste various observations have been notified under different context for the purpose of the study. In Dr. S.V. Joga Rao’s Book\(^2\) hazards of bio-medical waste has been categorized into two parts namely, Health Hazards and Environment Hazards.

Under health hazards the author has identified certain infections and risks that would cause detrimental to health due to improper management of bio-medical waste such as injuries from ‘sharps’ to all categories of hospital personnel and waste handlers, nosocomial (hospital acquired) infections due to poor infection control and poor waste management, risks of infections outside hospitals for waste handlers, scavengers and eventually, the general public, risks associated with hazardous chemicals, drugs when they are being handled and sold without being even washed and drugs disposed of being repacked and sold to unsuspecting buyers. The indiscriminate disposal of sharps within and outside institutions leads to occupational hazards among hospital employees, municipal workers and rag packers increases the incident of Hepatitis B, C and HIV

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among these groups who transmit these diseases to others in the community and also succumb to such fatal diseases. Therefore the problem with medical waste lies in the fact that it is not handled and treated according to its type, which leads to hazardous working conditions for these groups. Bio medical waste management is a special case wherein the hazards and risks exist not just for the generator and operators but also to general community.

Secondly, the environmental hazards is identified as toxic emissions like dioxins, furans gases and carbon, sulphur particles from defective and inefficient incineration, indiscriminate disposal of incineration ash residues, leachate from improper waste treatment residues, leading to contamination of ground water. The improper management of bio-medical waste causes serious environmental problems and hazard in terms of air, water and land pollution. The nature of pollutants could be classified into biological, chemical and radioactive.

Under the problem of health care wastes it has been studied that the hazards of bio-medical wastes is to its pinnacle in Indian context and identified sources have caused adverse health and environmental hazards in its mention. It has been pointed out the major sources of Bio-Medical wastes in health care facilities include wards, delivery rooms, operating theaters, emergency and outpatient services, laboratories, and pharmaceutical and chemical stores. Persons at risk of exposure include health care facility employees (doctors, nurses, and health care assistants, maintenance personal for waste handling, transportation, and laundry), patients and their visitors, and waste management facility employees and scavengers. Infectious wastes containing potentially harmful micro–organisms could infect hospital patients, health care employees, and patient’s visitors. Used needles, syringes, and other sharps present risks of injury and infection (for example, hepatitis B and C, and HIV) for health care employees. Chemical and pharmaceutical wastes may cause intoxication or injuries such as burns. Genotoxic

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1 Bio-Medical Waste Management.htm. last visited on (June 29, 2007).
4 Bekir Onursal, The problem of health care wastes, HEALTH CARE WASTE MANAGEMENT IN INDIA, lesson from experience, 1, October 2003, THE WORLD BANK.
wastes are hazardous and may have mutagenic\textsuperscript{1}, teratogenic\textsuperscript{2}, or carcinogenic properties. Radioactive sources may cause severe injuries to humans such as destruction of tissue.

Untreated liquid wastes from health care facilities pose risk of surface water contamination, and leachate from untreated or improperly treated HCWs (Health care Wastes) may contaminate ground water at disposal sites. Improper disposal of Bio-Medical wastes in open dumps increases the risk of injury from sharps and the spread of infectious diseases to waste handlers and scavengers, and uncontrolled burning of Bio-Medical wastes increases the risk of improper to hazardous emissions. In addition, poorly designed or operated Bio-Medical waste incinerators pose health and environmental risks to incinerator operators and nearby communities. Such incinerators may emit carcinogenic dioxins and furans\textsuperscript{3}, formed through incomplete combustion at low temperature of Bio-Medical wastes containing chlorine based components (such as polyvinyl chloride or sodium hypochlorite) and organic materials\textsuperscript{4}. Emissions of particulate matter containing heavy metals (for example, cadmium, lead and mercury) increase the risk of neurotoxic and carcinogenic effects. Acid gases (for example, hydrogen chloride and sulfur dioxide) can cause eye and respiratory irritation as well as well as environmental damage (acid rain) and material damage (corrosion of metals).

According Bio-Medical waste Management rules 1998 there are many prescribed norms and it must be strictly adhered. The only solution is proper Bio-Medical Waste management and awareness among every citizen of the India. It is not only regional issue but a global problem where every nation is combating with the same problem. According to a study conducted by W.H.O (World Health Organisation) in 1996, revealed that more than 50,000 people died, everyday from infections.

\textsuperscript{1} A mutagen is an agent that can induce or increase the frequency of a mutation in an organism.
\textsuperscript{2} A teratogen is an agent that causes malfunction of an embryo or a foetus.
\textsuperscript{3} Dioxins and furans are polychlorinated hydrocarbons.
\textsuperscript{4} Temperature between 200°C and 400°C are most conductive to forming dioxins and furans.
The general route of transmission of diseases by bio-medical waste could be listed as:

1) Ingestion, 2) Contamination of wounds, 3) Inhalation, 4) Absorption from cutaneous and mucous membranes, 5) Injury leading to a breach in continuity of skin surface followed by infection\(^1\).

These routes are the main culprit that allows the unknown diseases causing pathogens.

Hazards to the general public:

The general public’s health can also be adversely affected by bio-medical waste. Improper practices such as dumping of bio-medical waste in municipal dustbins, open spaces, water bodies etc., leads to the spread of diseases. Emissions from incinerators can cause cancer and respiratory diseases. Exposure to radioactive waste in the waste stream can also cause serious health hazards. An often ignored area is the increase of in home health care activities. An increase in the number of diabetics and terminally ill patients etc at home, all generate bio-medical waste which can cause health hazards. Public health is compromised due to lack of accountability in the handling of some hospital and veterinary wastes; specifically body fluid contaminated equipment and containers as well as microbiological materials. The most important to protect public health is a manifest system of cradle-to-grave accountability for an infectious portion of a hospital’s waste. The waste produced in the course of health-care activities carries a higher potential for infection and injury than any other type of waste. Inadequate and inappropriate handling of healthcare waste may have serious public health consequences and a significant impact on the environment (Pruss et al., 1999)\(^2\).

Occupational health hazards:

The health hazards due to improper waste management can not only affect the occupants in institutions, but also spread in the vicinity of the institutions. Occupational health concerns exist for janitorial and laundry workers, nurses, emergency medical

\(^1\) Sharma, Madhuri, HOSPITAL WASTE MANAGEMENT AND ITS MONITORING, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, 2002.

\(^2\) Surjit S. Katoch, Biomedical Waste Classification and Prevailing Management Strategies, PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SUSTAINABLE SOLID WASTE MANAGEMENT 169-175 (September 5 - 7 2007), Chennai, India.
personnel, and refuse works. Injuries from sharps and exposure to harmful chemical waste and radioactive waste also cause health hazards to employees in institutions generating bio-medical waste. The problem of occupational health hazards due to biomedical waste is not publicized as there is lack of information. Hence, the Bio-Medical Waste (Management and Handling) Rules, 2000 prescribed a form under schedule VI to report such incidences in order to develop a database that can solve the problem of occupational hazards to a large extent.

2.1.2 Bio-Medical Waste: World Health Organisation:

The World Health Organization (WHO) has greatly contributed towards safe management of wastes from health-care activities and WHO recommends safe, efficient, sustainable, and it is hoped affordable and culturally acceptable methods for the treatment and disposal of health-care waste, both within and outside health-care establishments. Particular attention is paid to basic processes and technologies, more sophisticated or advanced methods, many of which have been undergoing major developments. WHO aims not only to promote a sound managerial approach and the use of appropriate technologies, but also to inform countries about the health risks that result from inadequate management of health-care waste. The intended readership includes public health managers, hospital managers and other administrators of health-care establishments, policy-makers, regulators, waste managers, and environmental health professional. Health-care waste management, as well as posing technical problems, is strongly influenced by cultural, social, and economic circumstances. A well designed waste policy, a legislative framework, and plans for achieving local implementation are essential. Hospitals and other health-care establishments have a “duty of care” for the environment and for public health, and have particular responsibilities in relation to the waste they produce. The onus is on such establishments to ensure that there are no adverse health and environmental consequences of their waste handling, treatment, and disposal activities. By implementing a health-care waste management policy, including the components outlined here, medical and research facilities are moving towards the achievement of a healthy and safe environment for their employees and communities.

In pursuing their aims of reducing health problems and eliminating potential risks to people’s health, health-care services inevitably create waste that may itself be hazardous to health. The waste produced in the course of health-care activities carries a higher potential for infection and injury than any other type of waste. Wherever it is generated, safe and reliable methods for its handling are therefore essential. Inadequate and inappropriate handling of health-care waste may have serious public health consequences and a significant impact on the environment. Sound management of health-care waste is thus a crucial component of environmental health protection. In both the short term and the long term, the actions involved in implementing effective health-care waste management programmers require multisectoral cooperation and interaction at all levels. Policies should be generated and coordinated globally, and the management practices implemented locally. Establishment of a national policy and a legal framework, training of personnel, and raising public awareness are essential elements of successful health-care waste management. Improved public awareness of the problem is vital in encouraging community participation in generating and implementing policies and programmes. Management of health-care waste should thus be put into a systematic, multi-faceted framework, and should become an integral feature of health-care services.

World Health Organization, together with WHO’s European Centre for Environment and Health in Nancy, France, setup an international working group to produce a practical guide, addressing particularly the problems of Health Care Waste management in developing Countries and it is also user friendly. It provides guidelines for the responsible national and local administrators and is the first publication to offer globally relevant advice on the management of health-care waste. The guidelines complement and supplement those produced in different regions in the past. WHO strongly encourages the widespread implementation of these guidelines and is ready to assist users in adapting them to national settings. This study has been prepared as a practical response to the need for improved health-care waste management, especially in developing countries. Therefore in order to achieve the aim International Agency for Research on Cancer (IARC), the International Atomic Energy Agency(IAEA), the International Solid Waste Association(ISWA), the United States Environmental Protection Agency(USEPA), the Japanese Society for Research on Medical
Waste (JSRMW), and the Swiss Corporation for Appropriate Technology (SCAT) has contributed in the field of international medical waste management supporting World Health Organization.

2.1.2.1 Meaning of Bio-Medical Waste:

According to World Health Organization (WHO) definition ‘Health-Care Waste’\(^1\), includes all the waste generated by health-care establishments, research facilities, and laboratories. In addition, it includes the waste originating from “minor” or “scattered” sources such as that produced in the cases of health care undertaken in the home (dialysis, insulin injections, etc.).

According to Technical Guidelines on the Environmentally Sound Management of Biomedical and Health Care Wastes, “Health Care Waste”\(^2\) is also defined as ‘waste produced by medical activities such as diagnosis, monitoring, treatment, prevention of disease or alleviation of handicap in humans or animals, including related research, performed under the supervision of a medical practitioner or veterinary surgeon or another person authorized by virtue of his or her professional qualifications’.

2.1.2.2 Classification of Bio-Medical Waste:

The World Health Organization has categorized health care waste accordingly that includes several different waste streams, some of which require more stringent care and disposal. The attempt of recognizing the different categories of health care waste were also done previously by World Health Organization\(^3\) before a detailed document ‘Safe Management of Wastes from Health-Care Activities’\(^4\) came in to existence. This document can be said as corrective of the previous document as there were many grey areas like the classifications did not include cytotoxic drugs and liquid. At the same time ash generated in incinerator is also a waste need to be classified. These were filled up successfully by later. The most extensive collection and study of bio medical waste is

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\(^1\) Point No. 2.1.1 Definition “Health-care waste” at p.2, Safe Management of Wastes from Health-Care Activities, World Health Organization Geneva 1999.

\(^2\) Point No. 3.1 “General definition of biomedical and health care waste” at P.4, Technical Guidelines on the Environmentally Sound Management of Biomedical and Health Care Wastes (y1;y4) Basel Convention series/SBC No. 2003/3.

\(^3\) See WHO Publication 97; World Health Organization (1985).

very minutely observed and recorded and it also made elaborate study on ill-effect of such wastes on health and environment which is very relevant in the present context. Eventually, it is necessary to note that it applies to Indian legislation on bio medical waste management as India is also a signatory to World Health Organization.

World Health Organization (WHO) has given detail description under health care waste management and its hazardous effects under classifications and categories of health-care waste with examples.

The health care waste is divided as **Communal and Special waste** which could be still simplified as non-infectious and infectious waste.

**Communal waste** is all solid waste not including infectious, chemical, or radioactive waste. This waste stream can include items such as packaging materials and office supplies. Generally, this stream can be disposed of in a communal landfill or other such arrangement. Segregation of material greatly reduces the impact burden of this waste stream.

**Special waste** consists of several different categories:

**Infectious waste consists of** discarded materials from health care activities of transmitting infectious agents to humans. These include discarded materials or equipment from the diagnosis, treatment and prevention of disease, assessment of health status or identification purposes, that have been in contact with blood and its derivatives, tissues, tissue fluids or excreta, or wastes from infection isolation wards. Such wastes shall include, but are not limited to, cultures and items; tissues; drawings, swabs of other items soaked; diapers; blood bags etc. Waste from nursing homes, home treatment or from specialized health care establishment which do not treat infectious diseases (eg. Psychiatric clinics) is an exception to this definition and are not considered as infectious health care waste. Sharps, whether contaminated or not, should be considered as a subgroup of infectious health care waste and it includes; syringe needles, scalpels, infusion sets, knives, blades, broken glass.
The different classification and categories under special/infectious waste are mentioned below:

**Anatomical waste**: Anatomical waste consists of recognizable body parts. **Pathological waste**: Pathological waste consists of tissues, organs, body parts, human fetuses and animal carcasses, blood, and body fluids. Within this category, recognizable human or animal body parts are also called anatomical waste. This category should be considered as a subcategory of infectious waste, even though it may also include healthy body parts.

**Sharps**: Sharps are items that could cause cuts or puncture wounds, including needles, hypodermic needles, scalpel and other blades, knives, infusion sets, saws, broken glass, and nails. Whether or not they are infected, such items are usually considered as highly hazardous health-care waste. **Pharmaceutical waste**: Pharmaceutical waste includes expired, unused, spilt, and contaminated pharmaceutical products, drugs, vaccines, and sera that are no longer required and need to be disposed of appropriately. The category also includes discarded items used in the handling of pharmaceuticals, such as bottles or boxes with residues, gloves, masks, connecting tubing, and drug vials. **Genotoxic waste**: Genotoxic waste is highly hazardous and may have mutagenic, teratogenic, or carcinogenic properties. It raises serious safety problems, both inside hospitals and after disposal, and should be given special attention. Genotoxic waste may include certain cytostatic drugs, vomit, urine, or faeces from patients treated with cytostatic drugs, chemicals, and radioactive material. Cytotoxic (or antineoplastic) drugs, the principal substances in this category, have the ability to kill or stop the growth of certain living cells and are used in chemotherapy of cancer. They play an important role in the therapy of various neoplastic conditions but are also finding wider application as immunosuppressive agents in organ transplantation and in treating various diseases with an immunological basis. Cytotoxic drugs are most often used in specialized departments such as oncology and radiotherapy units, whose main role is cancer treatment; however, their use in other hospital departments is increasing and they may also be used outside the hospital setting. The most common genotoxic substances used in health care are listed below and Most common genotoxic products used in health care\(^1\) are classified as

\(^1\) Classified by working groups of the International Agency for Research on Cancer (IARC).
Carcinogenic such as Chemicals: benzene, Cytotoxic and other drugs, Azathioprine, chlorambucil, chloramphazine, ciclosporin, cyclophosphamide, melphalan, semustine, tamoxifen, thiopeta, treosulfan, Radioactive substances: (radioactive substances are treated as a separate category).

Some Harmful cytostatic drugs are also categorized as follows: Alkylating agents: cause alkylation of DNA nucleotides, which leads to cross-linking and miscoding of the genetic stock; Antimetabolites: inhibit the biosynthesis of nucleic acids in the cell; Mitotic inhibitors: prevent cell replication.

Cytotoxic wastes are generated from several sources such as Contaminated materials from drug preparation and administration, such as syringes, needles, gauges, vials, packaging, Outdated drugs, excess (leftover) solutions, drugs returned from the wards, Urine, faeces, and vomit from patients, which may contain potentially hazardous amounts of the administered cytostatic drugs or of their metabolites and which should be considered genotoxic for at least 48 hours and sometimes up to 1 week after drug administration. In specialized Oncological hospitals, genotoxic waste (containing cytostatic or radioactive substances) may constitute as much as 1% of the total health-care wastes.

Chemical waste: Chemical waste consists of discarded solid, liquid, and gaseous chemicals, for example from diagnostic and experimental work and from cleaning, housekeeping, and disinfecting procedures. Chemical waste from health care may be hazardous or nonhazardous; in the context of protecting health, it is considered to be hazardous if it has at least one of the following properties are found such as Toxic, Corrosive (e.g. acids of pH < 2 and bases of pH > 12), Flammable, Reactive (explosive, water-reactive, shock-sensitive), Genotoxic (e.g. cytostatic drugs).

Nonhazardous chemical waste consists of chemicals with none of the above properties, such as sugars, amino acids, and certain organic and inorganic salts. The types of hazardous chemicals used most commonly in maintenance of health-care centres and hospitals and the most likely to be found in waste are discussed in the following paragraphs.
**Formaldehyde:** Formaldehyde is a significant source of chemical waste in hospitals. It is used to clean and disinfect equipment (e.g. haemodialysis or surgical equipment), to preserve specimens, to disinfect liquid infectious waste, and in pathology, autopsy, dialysis, embalming, and nursing units. **Photographic chemicals:** Photographic fixing and developing solutions are used in X-ray departments. The fixer usually contains 5 to 10% hydroquinone, 1 to 5% potassium hydroxide, and less than 1% silver. The developer contains approximately 45% glutaraldehyde. Acetic acid is used in both stop baths and fixer solutions. **Solvents:** Wastes containing solvents are generated in various departments of a hospital, including pathology and histology laboratories and engineering departments. Solvents used in hospitals include halogenated compounds, such as methylene chloride, chloroform, trichloroethylene, and refrigerants, and non-halogenated compounds such as xylene, methanol, acetone, isopropanol, toluene, ethyl acetate, and acetonitrile. **Organic chemicals:** Waste organic chemicals generated in health-care facilities include: Disinfecting and cleaning solutions such as phenol-based chemicals used for scrubbing floors, perchlorethylene used in workshops and laundries; Oils such as vacuum-pump oils, used engine oil from vehicles (particularly if there is a vehicle service station on the hospital premises); Insecticides, rodenticides. **Inorganic chemicals:** Waste inorganic chemicals consist mainly of acids and alkalis (e.g. sulfuric, hydrochloric, nitric, and chromic acids, sodium hydroxide and ammonia solutions). They also include oxidants, such as potassium permanganate (KMnO4) and potassium dichromate (K2Cr2O7), and reducing agents, such as sodium bisulfate (NaHSO3) and sodium bisulfite (Na2SO3). **Wastes with high content of heavy metals:** Wastes with a high heavy-metal content represent a subcategory of hazardous chemical waste, and are usually highly toxic. Mercury wastes are typically generated by spillage from broken clinical equipment but their volume is decreasing with the substitution of solid-state electronic sensing instruments (thermometers, blood-pressure gauges, etc.). Whenever possible, spilled drops of mercury should be recovered. Residues from dentistry have high mercury content. Cadmium waste comes mainly from discarded batteries. Certain “reinforced wood panels” containing leads are still used in radiation of X-ray and diagnostic departments. A number of drugs contain arsenic, but these are treated here as pharmaceutical waste. **Pressurized containers:** Many types of gas are used in health care.
and are often stored in pressurized cylinders, cartridges, and aerosol cans. Many of these, once empty or of no further use (although they may still contain residues), are reusable, but certain types—notably aerosol cans—must be disposed of. Whether inert or potentially harmful, gases in pressurized containers should always be handled with care; containers may explode if incinerated or accidentally punctured.

**Most common gases used in health care:**

**Anesthetic gases:** Nitrous oxide, volatile halogenated hydrocarbons (such as halothane, isoflurane, and enflurane), which have largely replaced ether and chloroform. An application of the gas is done in hospital operating theatres, during childbirth in maternity hospitals, in ambulances, in general hospital wards during painful procedures, in dentistry, for sedation, etc. **Ethylene oxide:** Ethylene oxide is applied for sterilization of surgical equipment and medical devices, in central supply areas, and, at times, in operating rooms. **Oxygen:** Oxygen is stored in bulk tank or cylinders, in gaseous or liquid form, or supplied by central piping. It is applied through inhalation supply for patients.

**Compressed air:** Compressed air is applied in laboratory work, inhalation therapy equipment, maintenance equipment, and environmental control systems.

**Radioactive waste**

**Background on radioactivity:**

Ionizing radiations cannot be detected by any of the senses and other than burns, which may occur in exposed areas usually cause no immediate effects unless an individual receives a very high dose. The ionizing radiations of interest in medicine include the X-rays Alpha and Beta-particles, and Gama-rays emitted by radioactive substances. An important practical difference between these types of radiation is that X-rays from X-ray tubes are emitted only when generating equipment is switched on, whereas radiation from radionuclides can never be switched off and can be avoided only by shielding the material. Radionuclides continuously undergo spontaneous disintegration (known as “radioactive decay”) in which energy is liberated, generally resulting in the formation of new nuclides. The process is accompanied by the emission of one or more types of radiation, such as Alpha and Beta-particles, and Gama-rays. These cause ionization of intracellular material; radioactive substances are therefore
genotoxic. **Alpha-Particles** are heavy, positively charged, and include protons and neutrons. They have a low penetration power, and are hazardous to humans mostly when inhaled or ingested, **Beta -Particles** are negatively or positively charged electrons with significant ability to penetrate human skin; they affect health through ionization of intracellular proteins and proteinaceous components, **Gama-Rays** are electromagnetic radiations similar to X-rays but of shorter wavelength. Their penetrating power is high and therefore shielding is required to reduce their intensity.

*Radioactive substances used in health care and generation of waste are as follows:*

Radioactive waste includes solid, liquid, and gaseous materials contaminated with radionuclides. It is produced as a result of procedures such as *in-vitro* analysis of body tissue and fluid, *in-vivo* organ imaging and tumor localization, and various investigative and therapeutic practices.

**Principal Radionuclides used in health-care establishments**:1

- Radionuclide $^3$H emits $\beta$ (Beta) rays from acted as Unsealed having half –life of 12.3 years which is applied for *Research purpose.*
- Radionuclide $^{222}$Rd emits (Alpha) rays formatted as Sealed (seeds) having half –life of 3.8 days which is applied for *In-Vitro Diagnosis; therapy; Therapy purpose.*
- Radionuclide $^{133}$Xe emits $\beta$ (Beta) rays formatted as Unsealed having half –life of 5.3 days which is applied for *In-Vitro Diagnosis; therapy; Diagnostic imaging purpose.*
- Radionuclide $^{192}$Ir emits $\beta$ (Beta) rays formatted as Sealed (ribbons) having half –life of 74 days which is applied for *In-Vitro Diagnosis; therapy; Therapy purpose.*

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1 Adopted from WHO (1985).
2 $^3$H used for research purposes account for the largest amount of radioactive health-care waste.
3 Disintegration is measured in terms of the time required for the radioactivity to decrease by half the Half-life. Each radionuclide has a characteristic half-life, which is constant and by which it may be identified. Half-lives range from fractions of a second to millions of years.
Radionuclides used in health care are usually conditioned in unsealed (or “open”) sources or sealed sources. Unsealed sources are usually liquids that are applied directly and not encapsulated during use; sealed sources are radioactive substances contained in parts of equipment or apparatus or encapsulated in unbreakable or impervious objects such as “seeds” or needles. Radioactive health-care waste usually contains radionuclides with short half-lives, which lose their activity relatively quickly. Certain therapeutic procedures, however, require the use of radionuclides with longer half-lives; these are usually in the form of pins, needles, or “seeds” and may be reused on other patients after sterilization. The type and form of radioactive material used in health-care establishments usually results in low-level radioactive waste (<1MBq). Waste in the form of sealed sources may be of fairly high activity, but is only generated in low volumes from larger medical and research laboratories. Sealed sources are generally returned to the supplier and so do not enter the waste stream.

The waste produced by health-care and research activities involving radionuclides, and related activities such as equipment maintenance, storage, etc., can be classified as follows: Sealed sources; Spent radionuclide generators; Low-level solid waste, e.g. absorbent paper, swabs, glassware, syringes, vials; Residues from shipments of radioactive material and unwanted solutions of radionuclides intended for diagnostic or therapeutic use; Liquid immiscible with water, such as liquid scintillation-counting residues used in radioimmunoassay, and contaminated pump oil; Waste from spills and from decontamination of radioactive spills; Excreta from patients treated or tested with unsealed radio nuclides; Low-level liquid waste, e.g. from washing apparatus; and Gases and exhausts from stores and fume cupboards.

Therefore the clear mention of the classification and categories under World Health Organisation has been given very effectively so that the impact could be analysed and simultaneously segregation of the waste produced could properly carried and disposed of systematically according to the concentration of the waste.
2.1.2.3 Sources of Bio-Medical Waste:

Similarly, WHO Guidelines 1999 on Management of health-care waste has identified the different sources of health-care wastes. The Sources of health-care waste\(^1\) has been classified as major or minor according to the quantities produced.

Under **Major Sources** of health-care waste it is classified as

(i) *Hospitals* such as University hospital, General hospital and District hospital.

(ii) *Other health-care establishments* such as Emergency medical care services, Health-care centres and dispensaries, Obstetric and maternity clinics, Outpatient clinics, Dialysis centres, First-aid posts and sick bays, Long-term health-care establishments and hospices, Transfusion centres and Military medical services.

(iii) *Related laboratories and research Centres* such as Medical and biomedical laboratories, Biotechnology laboratories and institutions and Medical research centres.

(iv) Mortuary and Autopsy Centres,

(v) Animal research and testing,

(vi) Blood banks and blood collection services and

(vii) Nursing homes for the elderly.

Under **Minor Sources** of health-care waste again it is divided into

(i) Small health-care establishments, it has recognized Physicians’ offices, Dental clinics, Acupuncturists and Chiropractors.

(ii) Specialized health-care establishments and institutions with low waste Generation have noted Convalescent nursing homes, Psychiatric hospitals and Disabled persons’ institutions.

(iii) Non-health activities involving intravenous or subcutaneous interventions have noted Cosmetic ear-piercing and tattoo parlours and illicit drug users.

(v) Funeral services, Ambulance services and

(vi) Home treatment.

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2.1.2.4 Hazards of Bio-Medical Waste:

The WHO guidelines 1999 have equally contributed to identify hazards of Biomedical Waste as follow:

The WHO guidelines 1999 on management of health –care waste has noticed the severe impact of health-care waste on health under Health impacts of health-care waste¹ and also categorized under hazards of health care waste² as Types of hazards, Persons at risk, Hazards from infectious waste and sharps, Hazards from chemical and pharmaceutical waste, Hazards from genotoxic waste, Hazards from radioactive waste and Public sensitivity. Health-care waste includes a large component of general waste and a smaller proportion of hazardous waste. This part of the study addresses the potential hazards of exposure to hazardous (or risk) health-care waste.

Types of hazards:

Exposure to hazardous health-care waste can result in disease or injury. The hazardous nature of health-care waste may be due to one or more of the following characteristics: It contains infectious agents, it is genotoxic, it contains toxic or hazardous chemicals or pharmaceuticals, it is radioactive and it contains sharps.

1. Persons at risk:

All individuals exposed to hazardous health-care waste are potentially at risk, including those within health-care establishments that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management. The main groups at risk are the following:

- Medical doctors, nurses, health-care auxiliaries, and hospital maintenance personnel;
- Patients in health-care establishments or receiving home care;
- Visitors to health-care establishments;
- Workers in support services allied to health-care establishments, such as laundries, waste handling, and transportation;

² id  Page No.  20-24.
- Workers in waste disposal facilities (such as landfills or incinerators), including scavengers.

The hazards associated with scattered, small sources of health-care waste should not be overlooked; waste from these sources includes that generated by home-based health care, such as dialysis, and that generated by illicit drug use (usually intravenous).

2. Hazards from infectious waste and sharps:

Examples of infections that can be caused by exposure to health-care waste are listed below together with the body fluids that are the usual vehicles of transmission. There is particular concern about infection with human immunodeficiency virus (HIV) and hepatitis viruses B and C, for which there is strong evidence of transmission via health-care waste. These viruses are generally transmitted through injuries from syringe needles contaminated by human blood. The existence in health-care establishments of bacteria resistant to antibiotics and chemical disinfectants may also contribute to the hazards created by poorly managed health-care waste. It has been demonstrated, for example, that plasmids from laboratory stains contained in healthcare waste were transferred to indigenous bacteria via the waste disposal system. Moreover, antibiotic-resistant *Escherichia coli* have been shown to survive in an activated sludge plant, although there does not seem to be significant transfer of this organism under normal conditions of wastewater disposal and treatment. Concentrated cultures of pathogens and contaminated sharps (particularly hypodermic needles) are probably the waste items that represent the most acute potential hazards to health. Sharps may not only cause cuts and punctures but also infect these wounds if they are contaminated with pathogens. Because of this double risk of injury and disease transmission sharps are considered as a very hazardous waste class.
In order to understand clearly Examples of infections caused by exposure to health-care wastes, causative organisms, and transmission vehicles\(^1\) are given below.

**Table 2.1.2.4 Examples of infections caused by exposure to health-care wastes, causative organisms, and transmission vehicles**

<table>
<thead>
<tr>
<th>Type of infection vehicles</th>
<th>Examples of causative organisms</th>
<th>Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Gastroenteric infections</td>
<td>Enterobacteria, e.g. Salmonella, Shigella spp.</td>
<td>Faeces and/or vomit</td>
</tr>
<tr>
<td>2) Respiratory infections</td>
<td>Mycobacterium tuberculosis; measles virus; Streptococcus pneumonia.</td>
<td>Inhaled secretions; Saliva</td>
</tr>
<tr>
<td>3) Ocular infection</td>
<td>Herpesvirus</td>
<td>Eye secretions</td>
</tr>
<tr>
<td>4) Genital infections</td>
<td>Neisseria gonorrhoeae Herpesvirus.</td>
<td>Genital secretions</td>
</tr>
<tr>
<td>5) Skin infections</td>
<td>Streptococcus spp.</td>
<td>Pus</td>
</tr>
<tr>
<td>6) Anthrax</td>
<td>Bacillus anthracis</td>
<td>Skin secretions</td>
</tr>
<tr>
<td>7) Meningitis</td>
<td>Neisseria meningitidis</td>
<td>Cerebrospinal fluid</td>
</tr>
<tr>
<td>8) Acquired Immune deficiency syndrome (AIDS)</td>
<td>Human immunodeficiency virus (HIV)</td>
<td>Blood, sexual secretions</td>
</tr>
<tr>
<td>9) Haemorrhagic fevers</td>
<td>Junin, Lassa, Ebola, and Marburg viruses</td>
<td>All bloody products and secretions</td>
</tr>
<tr>
<td>10) Septicaemia</td>
<td>Staphylococcus spp.</td>
<td>Blood</td>
</tr>
<tr>
<td>11) Viral hepatitis A</td>
<td>Hepatitis A virus</td>
<td>Faeces</td>
</tr>
<tr>
<td>12) Viral hepatitis B and C</td>
<td>Hepatitis B and C viruses</td>
<td>Blood and body fluids</td>
</tr>
</tbody>
</table>

The principal concerns are infections that may be transmitted by subcutaneous introduction of the causative agent, e.g. viral blood infections. Hypodermic needles constitute an important part of the sharps waste category and are particularly hazardous because they are often contaminated with patients’ blood.

3. **Hazards from chemical and pharmaceutical waste**

Many of the chemicals and pharmaceuticals used in health-care establishments are hazardous (e.g. toxic, genotoxic, corrosive, flammable, reactive, explosive, shock-sensitive). These substances are commonly present in small quantities in health-care waste; larger quantities may be found when unwanted or outdated chemicals and pharmaceuticals are disposed of. They may cause intoxication, either by acute or by chronic exposure, and injuries, including burns. Intoxication can result from absorption of a chemical or pharmaceutical through the skin or the mucous membranes, or from inhalation or ingestion. Injuries to the skin, the eyes, or the mucous membranes of the airways can be caused by contact with flammable, corrosive, or reactive chemicals (e.g. formaldehyde and other volatile substances). The most common injuries are burns. Disinfectants are particularly important members of this group they are used in large quantities and are often corrosive. It should also be noted that reactive chemicals may form highly toxic secondary compounds.

Chemical residues discharged into the sewerage system may have adverse effects on the operation of biological sewage treatment plants or toxic effects on the natural ecosystems of receiving waters. Similar problems may be caused by pharmaceutical residues, which may include antibiotics and other drugs, heavy metals such as mercury, phenols, and derivatives, and disinfectants and antiseptics.

4. **Hazards from genotoxic waste**: 

The severity of the hazards for health-care workers responsible for the handling or disposal of genotoxic waste is governed by a combination of the substance toxicity itself and the extent and duration of exposure. Exposure to genotoxic substances in health care may also occur during the preparation of or treatment with particular drugs or chemicals. The main pathways of exposure are inhalation of dust or aerosols, absorption through the skin, ingestion of food accidentally contaminated with cytotoxic drugs, chemicals, or
waste, and ingestion as a result of bad practice, such as mouth pipetting. Exposure may also occur through contact with the bodily fluids and secretions of patients undergoing chemotherapy. The cytotoxicity of many antineoplastic drugs is cell-cycle-specific, targeted on specific intracellular processes such as DNA synthesis and mitosis. Other antineoplastics, such as alkylating agents, are not phase-specific, but cytotoxic at any point in the cell cycle. Experimental studies have shown that many antineoplastic drugs are carcinogenic and mutagenic; secondary neoplasia (occurring after the original cancer has been eradicated) is known to be associated with some forms of chemotherapy.

Many cytotoxic drugs are extremely irritant and have harmful local effects after direct contact with skin or eyes. They may also cause dizziness, nausea, headache, or dermatitis. Additional information on health hazards from cytotoxic drugs may be obtained on request from the International Agency for Research on Cancer (IARC). Special care in handling genotoxic waste is absolutely essential; any discharge of such waste into the environment could have disastrous ecological consequences.

5. Hazards from radioactive waste:

The type of disease caused by radioactive waste is determined by the type and extent of exposure. It can range from headache, dizziness, and vomiting to much more serious problems. Because radioactive waste, like certain pharmaceutical waste, is genotoxic, it may also affect genetic material. Handling of highly active sources, e.g. certain sealed sources from diagnostic instruments, may cause much more severe injuries (such as destruction of tissue, necessitating amputation of body parts) and should therefore be undertaken with the utmost care. The hazards of low-activity waste may arise from contamination of external surfaces of containers or improper mode or duration of waste storage. Health-care workers or waste-handling or cleaning personnel exposed to this radioactivity are at risk.

6. Public sensitivity:

Quite apart from fear of health hazards, the general public is very sensitive about the visual impact of anatomical waste, which is recognizable human body parts, including

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1 International Agency for Research on Cancer, Unit of Gene-Environment Interactions, 150Cours Albert-Tgamas, 69372 Lyon Cedex 08, France.
fetuses. In no circumstances is it acceptable to dispose of anatomical waste inappropriately, such as on a landfill. In some cultures, especially in Asia, religious beliefs require that human body parts be returned to a patient’s family, in tiny “coffins”, to be buried in cemeteries. The Muslim culture, too, generally requires that body parts are buried in cemeteries.

Public health impact of health-care waste

After analyzing the hazards of biomedical waste on health and environment it has been also identified that the health impact of such health care waste on public health through various infections, chemicals etc could cause detrimental to public at large.

1. Impacts of infectious waste and sharps:

For serious virus infections such as HIV/AIDS and hepatitis B and C, health-care workers particularly nurses are at greatest risk of infection through injuries from contaminated sharps (largely hypodermic needles). Other hospital workers and waste-management operators outside health-care establishments are also at significant risk, as are individuals who scavenge on waste disposal sites (although these risks are not well documented). The risk of this type of infection among patients and the public is much lower. Certain infections, however, spread through other media or caused by more resilient agents, may pose a significant risk to the general public and to hospital patients. For instance, uncontrolled discharges of sewage from field hospitals treating cholera patients have been strongly implicated in cholera epidemics in some Latin American countries. Individual cases of accidents and subsequent infections caused by healthcare waste are well documented below. The overall situation, however, remains difficult to assess, especially in developing countries. It is suspected that many cases of infection with a wide variety of pathogens have resulted from exposure to improperly managed healthcare wastes in developing countries.

A Reported case of infection caused by contact with health-care waste² has been stated as a hospital housekeeper in the USA developed staphylococcal bacteraemia and endocarditis after a needle injury. The annual rates of injuries from sharps in medical

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² id, Page No. 24
waste from health-care and sanitary service personnel, within and outside hospitals, were estimated by the US Agency for Toxic Substances and Diseases Register (ATSDR) in their report to Congress on medical waste. Many injuries are caused by recapping of hypodermic needles before disposal into containers, by unnecessary opening of these containers, and by the use of materials that are not puncture-proof for construction of containers.

2. **Impacts of chemical and pharmaceutical waste:**

While there is no scientifically documented incidence of widespread illnesses among the general public due to chemical or pharmaceutical waste from hospitals, many examples may be found of extensive intoxication caused by industrial chemical waste. Moreover, many cases of injury or intoxication result from the improper handling of chemicals or pharmaceuticals in health-care establishments. Pharmacists, anesthetists, and nursing, auxiliary, and maintenance personnel may be at risk of respiratory or dermal diseases caused by exposure to such substances as vapours, aerosols, and liquids. To minimize this type of occupational risk, less hazardous chemicals should be substituted whenever possible and protective equipment should be provided to all personnel likely to be exposed. Premises where hazardous chemicals are used should be properly ventilated, and personnel at risk should be trained in preventive measures and in emergency care in case of accident.

3. **Impacts of genotoxic waste:**

To date there are few data on the long-term health impacts of genotoxic health-care waste. This is partly because of the difficulty of assessing human exposure to this type of compound. A study undertaken in Finland, for example, found a significant correlation between fetal loss and occupational exposure to antineoplastic drugs during the Rest three months of pregnancy, but similar studies in France and the USA failed to this result.

Numerous published studies have investigated the potential health hazard associated with the handling of antineoplastic drugs, manifested by increased urinary levels of mutagenic compounds in exposed workers and an increased risk of abortion. A recent study has demonstrated that exposure of personnel cleaning hospital urinals
exceeded that of nurses and pharmacists; these individuals were less aware of the danger and took fewer precautions. The concentration of cytotoxic drugs in the air inside hospitals has been examined in a number of studies designed to evaluate health risks linked to such exposure. No scientific publication has yet reported adverse effects on health resulting from mismanagement of genotoxic waste.

4. Impacts of radioactive waste:

Several accidents resulting from improper disposal of nuclear therapeutic materials have been reported, with a large number of persons suffering from the results of exposure. In Brazil, one case of carcinogenic impact on the general population linked to exposure to radioactive hospital waste has been analyzed and fully documented. While moving, a radiotherapy institute left a sealed radiotherapy source in its old premises. An individual who gained access to these premises removed the source and took it home. As a consequence, 249 people were exposed, of whom several either died or suffered severe health problems (IAEA, 1988). Apart from the Brazil incident, no reliable scientific data were available on the impact of radioactive hospital waste. It may be that many cases of exposure to radioactive health-care waste, and associated health problems, go unreported. The only recorded accidents involving exposure to ionizing radiations in health-care settings have resulted from unsafe operation of X-ray apparatus, improper handling of radiotherapy solutions, or inadequate control of radiotherapy.

Survival of pathogenic microorganisms in the environment could cause health hazards as pathogenic microorganisms have limited ability to survive in the environment. This ability is septic to each microorganism and is a function of its resistance to environmental conditions such as temperature, humidity, ultraviolet irradiation, availability of organic substrate material, presence of predators, etc. The hepatitis B virus is very persistent in dry air and can survive for several weeks on a surface; it is also resistant to brief exposure to boiling water. It can survive exposure to some antiseptics and to 70% ethanol and remains viable for up to 10 hours at a temperature of 60°C. The Japanese Association for Research on Medical Waste found that an infective dose of hepatitis B or C virus can survive for up to a week in a blood droplet trapped inside a hypodermic needle. By contrast, HIV is much less resistant. It survives for no more than
15 minutes when exposed to 70% ethanol and only 3-7 days at ambient temperature. It is inactivated at 56 °C. Bacteria are less resistant than viruses, but much less is known about the survival of agents of degenerative neurological diseases (Creutzfeldt-Jakob disease, kuru, etc.), which seem to be very resistant. With the exception of waste containing pathogenic cultures or excreta of infected patients, the microbial load of health-care waste is generally not very high. Furthermore, health-care wastes do not seem to provide favorable media for the survival of pathogens, perhaps because they frequently contain antiseptics. Results of a number of studies have shown that the concentration of indicator microorganisms in health-care waste is generally no higher than in domestic waste, and that survival rates are low. In evaluating the survival or spread of pathogenic microorganisms in the environment, the role of vectors such as rodents and insects should be considered. This applies to management of health-care waste both within and outside health-care establishments. Vectors such as rats, and cockroaches, which feed or breed on organic waste, are well known passive carriers of microbial pathogens; their populations may increase dramatically where there is mismanagement of waste.

5. Needs for further research and epidemiological surveys:

Very few data are available on the health impacts of exposure to healthcare waste, particularly in the case of developing countries. Better assessment of both risks and effects of exposure would permit improvements in the management of health-care waste management and in the planning of adequate protective measures. Unfortunately, the classical application of epidemiology to the problem is difficult because of methodological complications and uncertainties regarding evaluation of both exposure and health outcome. The great diversity of hazardous wastes that can be involved and of circumstances of exposures is a particularly problematic feature of all such evaluations. It prevents not only the development of a unified analytical approach to the assessment of exposure and health outcome but also the generalization of any statistical inferences drawn about a septic waste-exposed population. Never the Health impacts of health-care waste less, suspected cases of adverse health effects of health-care waste should be adequately documented, with precise descriptions of exposure, exposed individuals or populations, and outcome. Within health-care establishments, the surveillance of infection and record-keeping are important tools that can provide indications of
inadequate hygiene practices or of contamination of the immediate environment (including that caused by health-care waste). Surveillance allows an outbreak of infection to be recognized and investigated and provides a basis for introducing control measures, for assessing the efficacy of those measures and of the routine preventive measures taken by the establishment, and for reducing the level of avoidable infection. It will also ensure that the control measures have maximum effect and are as cost-effective as possible.

2.1.3 Bio-Medical Waste: USA

Introduction:

Regulated medical waste (RMW), also known as ‘bio hazardous’ waste or ‘infectious medical’ waste, is the portion of the waste stream that may be contaminated by blood, body fluids or other potentially infectious materials, thus posing a significant risk of transmitting infection. There are several key categories of waste that are typically classified as ‘regulated’. Each category typically has special handling requirements that may be state-specific in USA.

Most State laws of USA require Regulated medical waste to be rendered non-infectious before it can be disposed of as solid waste.

Regulated medical waste is unique to the healthcare sector and presents a number of compliance challenges. Unlike many regulations that apply to healthcare, most regulations governing medical waste are defined at a state, rather than a federal level. Adding yet a further level of complexity, authority for medical waste rules often comes from multiple agencies at the state level in USA.

Federal law does not provide an explicit definition of medical waste. Typically, State Departments of Health issue the regulations that determine which wastes are considered ‘regulated’ or require special handling.

During the 1980’s, the public became aware that used syringes and similar wastes had been found washing up on several East Coast beaches. In response, Congress
enacted the Medical Waste Tracking Act (MWTA)\(^1\), which required Environment Protection Agency (EPA) to create a two-year medical waste demonstration program. The Medical Waste Tracking Act (MWTA):

- Established a cradle-to-grave tracking system.
- Required management standards for segregation, packaging, labeling, and storage of the waste.
- Established record-keeping requirements.
- Defined penalties that could be imposed for mismanagement.

These standards for tracking and management of medical waste were in effect in four States (New York, New Jersey, Connecticut, Rhode Island), and in Puerto Rico, from June 1989 to June 1991. During this time, Environment Protection Agency (EPA) also gathered information and performed several studies related to medical waste management. The regulations promulgated under the Medical Waste Tracking Act (MWTA) expired on June 21, 1999. From the information gathered during this period, Environment Protection Agency (EPA) concluded that the disease-causing potential of medical waste is greatest at the point of generation.

After the Medical Waste Tracking Act 1988, the council of State Governments entered into a grant agreement with the U.S. Environmental Protection Agency’s Office of Solid Waste (EPAOSW) in 1990-91 to develop guidelines for use by States and other entities that generate and/or manage medical waste.

The purpose of such guidelines was necessary as the Medical Waste Tracking (MWT) Act 1988 was not applicable to all the States of America and it was only enacted as demonstration programme for few years and it expired on June 21, 1999. It was applicable only for four States as already mentioned above.

\(^1\) Medical Waste Tracking Act of 1988, An Act enacted to amend the Solid Waste Disposal Act to require the Administrator of the Environmental Protection Agency to promulgate regulations on the management of infections waste, H.R. 3515, 100\(^{th}\) Congress of the USA, 25-01-1988.
2.1.3.1 Meaning of Bio-Medical Waste:

The Medical Waste Tracking Act (MWTA) of 1988 has defined ‘Regulated Medical Waste’\(^1\) as:

“Medical waste means any solid waste which is generated in the diagnosis, treatment (e.g. provision of medical services), or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biological”.

The U.S. Department of Transportation (DOT) considers Regulated Medical Waste (RMW) as a hazardous material during transport. The Department of Transportation (DOT) defines ‘Regulated Medical Waste’\(^2\) as “a waste or reusable material known or suspected to condition an infectious substance in (World Health Organization) Risk Group 2 or 3, and generated in-

- The diagnosis, treatment or immunization of human beings or animals;
- Research on the diagnosis, treatment or immunization of human beings or animals; or
- The production or testing of biological products”\(^3\).

Whereas ‘Regulated Medical Waste’ is defined under MEDCOM Regulation\(^4\) as waste that is potentially capable of causing disease in man and may pose a risk to both individuals and community health if not handled or treated properly.

There is an exemption to the definition of regulated medical waste accordingly several wastes are not to be regulated as medical waste. This ruling is in effect because some wastes are already managed under other regulations; in other cases, for example, household waste, regulation is simply impractical. The following wastes are not to be regulated as medical waste\(^5\) and such Hazardous waste are identified or listed in the Act\(^6\) as Household wastes, Ash from incineration of regulated medical waste, Residues from treatment and disposal of medical waste and human remains intended for interment or cremation.

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1. (40 CER 259.1) of MWTA 1988
2. Regulated Medical Waste (RMW) (per 49 CFR 173.134)
4. MEDCOM Regulation40-35
2.1.3.2 Classifications of Bio-Medical Waste:

In USA the classification of medical waste has been given importance so that handling of the waste would be easier. The Medical Waste Tracking Act 1988\(^1\), Environment Protection Agency (EPA), Medical Regulations of United States and Model Guidelines State Medical Waste Management\(^2\) has identified the different categories of waste for the proper management of the waste accordingly.

The different classifications are as follows:

1. **Cultures and stocks** of infectious agents and associated biological, including cultures from medical and pathological laboratories, cultures and stocks of infectious agents from research and industrial laboratories, wastes from the production of biological, discarded live and attenuated vaccines, and culture dishes and devices used to transfer, inoculate, and mix cultures are all considered as medical wastes.

2. **Pathological wastes** origin includes tissues, organs and body parts removed during surgery or autopsy.

3. **Human blood and blood products**: (i) liquid wastes from human blood; (ii) products of blood; (iii) items saturated and or dripping with human blood or; (iv) items that were saturated and or dripping with human blood that are known mixed with dried human blood; including serum, plasma, and other blood components, and their containers, which were used or intended for use in either patient care, testing and laboratory analysis or the development of pharmaceuticals. Intravenous bags are also included in this category.

4. **Sharps**: that have been used in animal or human care or treatment or in medical research, or industrial laboratories, including hypodermic needles, syringes (with or without) the attached needle, Pasteur pipettes, blades, blood vials, needles, Pasteur pipettes tubing, and culture dishes (regarded of presence of infectious agents). Also included are the other types of broken or unbroken glassware that are in contact with infectious agents, such as used slides and cover slips.

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1 Section 11002 of MWTA 1988.

5. **Animal waste:** contaminated animal carcasses, body parts and bedding of animals that were known to have been exposed to infectious agents during research, production of biological, or testing of pharmaceuticals.

6. **Laboratory wastes** from medical, pathological, pharmaceutical, or other research, commercial, or industrial laboratories that were in contact with infectious agents, including slides and cover slips, disposable gloves, laboratory coats, and aprons.

6. **Discarded medical equipment** and parts that were in contact with infectious agents.

7. **Isolation waste:** biological waste and discarded materials contaminated with blood, excretion, exudates or secretions from humans who are isolated to protect others from certain highly communicable diseases; or insulation animals known to be infected with highly communicable diseases.

8. **Unused Sharps:** unused, discarded sharps, hypodermic needles, suture needles, syringes and scalpels blades.

9. **Cytotoxic Waste:** which in addition to being toxic are mutagenic and or teratogenic when discarded or spilled,

10. **Radio-active waste.**

    The other wastes are wastes from surgery or autopsy that were in contact with infectious agents, including soiled dressings, sponges, drapes,avage tubes, drainage sets, under pads, and surgical gloves and Dialysis wastes that were in contact with the blood of patients undergoing hem dialysis, including contaminated disposable equipment and supplies such as tubing, filters, disposable sheets, towels, gloves, aprons, and laboratory coats and so on.

    Therefore, such other waste material that results from the administration of medical care to a patient by a health care provider and is found by the Administrator to pose a threat to human health or the environment is all considered as medical waste.

**2.1.3.3 Sources of Bio-Medical Waste:**

Although hospitals have been the primary target of medical waste regulations, they are not the only generators of medical wastes but small practices and non-facility sources such as illicit drug users have also been responsible for beach wash-ups mismanagement of medical wastes.
These incidents have incited stricter state and federal oversight of medical waste management. Medical facilities are the most easily identifiable sources for regulation, but not necessarily the worst offenders. Tighter control of medical facilities has seemed to alleviate some of the public concern over medical waste issues, but there are many other types of generators who need to improve their management methods. The sources are identified by not only the *Medical Waste Tracking Act 1988 (MWTA)* but also Under Model Guidelines.

There are many sources of medical waste with a wide variation in the amount of waste produced by each type of generator. The range of potential generators includes:

1. **Hospitals**: Hospitals are recognized as General medical and surgical, psychiatric, tuberculosis, other specialty (obstetrics and gynecology, eye/ear/nose/throat, rehabilitation) health care centers, **Intermediate care facilities**: Intermediate care facilities include Nursing homes, in-patient care facilities for the developmentally disabled, **Clinics**: Chronic dialysis, free clinics, community, employee, surgical, urgent care, abortion, drug rehabilitation and health maintenance organizations are all mentioned under clinics, **Physician offices**: General and family practice, internal medicine, pediatrics, obstetrics and gynecology, ophthalmology, orthopedic, surgery, dermatology, psychiatry, otorhinolaryngology, urological surgery, cardiovascular disease and neurology includes under Physician offices, 2. **Laboratories**: Medical research, industrial, commercial diagnostic, biologics manufacturing, medicinal chemicals and botanical products, pharmaceutical preparations are considered as laboratory establishments, 3. **Animal Care**: Shelters, fur farms, breeders and experimentation units all come under animal care, 4. **Emergency medical services**: Ambulance services is one of the best know emergency medical service, 5. **Hospices Household/Home Health Care**: Health care providers and self care are noted as Hospices Household/Home Health Care, 6. **Health Units In**: Industry, Schools, fire and rescue services are advised to have health units, 7. **Medical and nursing schools**, 8. **Illicit drug users**, 9. **Dental offices**, x. **Funeral homes**, xi. **Veterinarians**, xii. **Agricultural**, xiii. **Blood Banks** are all recognized as the prominent sources of medical waste in US.
The U.S. Environment Protection Agency (EPA) reports that the vast majority of regulated medical waste (about 77 percent) is generated by hospitals. However, hospitals comprise less than 2 percent of the total number of generators.1

Thus, the U.S. Law has taken care to mention every possible generator to seriously identify and keep control on medical waste so produced.

2.1.3.4 Hazards of Bio-Medical Waste:

Medical waste could therefore be considered more of an occupational concern than an environmental concern affecting the general public: the risk to the general public of disease caused by exposure to medical waste is likely to be much lower than the risk for the occupationally exposed individual.

The Medical Waste Regulations Act, along with Environment Protection Agency’s associated program, served to focus attention on the medical waste issue. It also provided a model that was subsequently used by some states and by other federal agencies in developing their own medical waste programs.

The State Medical Waste Regulations of nearly all 50 States have enacted medical waste regulations to some extent.

Some state medical waste rules are fashioned after the Medical Waste Tracking Act, while others have little or no resemblance to this historical law.

The Occupational Safety & Health Administration Regulations (OSHA), whether it is the U.S. Department of Labor Occupational Safety & Health Administration or an OSHA State Program (24 States operate their own program), regulates several aspects of medical waste, including management of sharps, requirements for containers that hold or store medical waste, labeling of medical waste bags/containers, and employee training. These standards are designed to protect healthcare workers from the risk of exposure to blood borne pathogens. However, they also help to systematically manage wastes, which benefit the public and environment.

The US Environment Protection Agency Regulations. Although Environment Protection Agency no longer plays a central role with medical waste management,

Environment Protection Agency has active regulations governing emissions from Hospital/Medical/Infectious Waste Incinerators as well as requirements under the *Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)* for certain medical waste treatment technologies which use chemicals for treating the waste.

The Department of Transportation Regulations has mentioned regulated medical waste as a hazardous material. The Department of Transportation rules mostly apply to transporters rather than healthcare facilities; although, knowledge of these rules is important because of the liability associated with shipping waste off-site.

Similarly, the potential for infection resulting from contact with non-sharp medical waste is virtually non-existent. For example, for infection to occur from contact a viable human pathogen; an individual must come in direct contact with the medical waste; an injury must occur following this contact, thereby creating a portal of entry, or a portal of exit); a sufficient number of a viable infectious agent must enter a susceptible host via this portal of entry; then the agent causes infection that may or may not result in clinical disease\(^1\). Obviously, there are many effective means of interrupting this chain of transmission, and these include confining medical waste to bags or boxes or both and employing Universal Precautions\(^2\).

Based on the principles of disease transmission, it is extremely unlikely that infectious agents from medical waste will be introduced into a host by the respiratory tract, urinary tract, gastrointestinal tract, or mucous membranes of the mouth, eyes, or nose and therefore the standard health measures and proper personal hygiene practices are to be adhered (e.g., no ingestion, no injection).

The only medical waste that has been associated with infectious disease transmission is contaminated sharps. This is not surprising, given the intrinsic capability of sharps to disrupt the skin’s integrity and introduce infectious agents into the wound\(^3\).

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Public Health Implications of Waste:

Medical waste poses virtually no infectious hazard to the public. Wash-ups of floatable medical and other waste on the beaches of New Jersey and the New York area during the summers of 1987 and 1988 brought with them intensified public concern for public health and safety. Because of the public’s concern with AIDS, medical waste on beaches brought a perceived threat to health and safety.\(^1\)\(^2\)

Although the issue of medical waste on beaches is a serious aesthetic and economic problem requiring immediate attention, the public’s health risks are virtually non-existent. For example, the theoretical estimate that the events necessary for infection will occur in sequence and a person will develop HIV infection from a needle on the beach is one in 15 billion to one in 390 trillion.\(^3\) Equally important, there is far less medical waste on beaches than the media led the public to believe.\(^4\) The amount of medical waste, in the form of plastic syringes, collected on the beaches of the 23 Coastal States constituted less than 0.1% of the total debris found.\(^5\) In another study, New York and New Jersey were found to have more medical waste reported on their beaches (1% to 10% of the total debris) than the national average. Even though there is agreement among public health experts that the actual risks or ‘hazards’ posed by medical waste at the beaches or in landfills are exceedingly low, the present climate in our society is that complete safety (i.e. zero risk) is a feasible goal regardless of cost. In such a climate, legislators or public health officials may respond with extreme measures. Because increased costs for the affected services are not obviously linked to the actions or laws, the system becomes titiled to overreaction.\(^6\)

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Renn and Covello\(^1\) hypothesized that the public perceived the risk of medical waste as a serious threat because the potential outcome is death (e.g., from AIDS), and the pathway to infection is intuitively plausible. They also point out that several factors amplify the public’s risk perception or ‘outrage’ to include: dreaded consequence (e.g., AIDS); lack of personal control; familiarity with risk the perception of equitable sharing of the benefits and risks (i.e., people living near a waste-disposal site rarely appreciate the benefit because they assume a larger burden of the costs); and the potential for blame (i.e., the possibility of assigning blame to a person, institution, or industry for creating a risk situation). Efforts to explain a ‘hazard’ are unlikely to succeed so long as the ‘outrage’ is high. Risk perception researchers believe that to lessen public concern about exceedingly low ‘hazards,’ experts and public health officials must diminish the ‘outrage’\(^2\).

Ironically, the combined forces of public opinion and federal legislation of medical waste would do little to correct the problem of beach wash-ups or the broader issue of environmental degradation. The real source of the problem is not correctable by tracking medical waste, by broadening the definition of medical waste, nor by regulating medical waste from hospitals and clinics. The source of the wash-ups is much more difficult to regulate: wealth patterns (i.e., prevailing winds) and currents; mechanical failures in sewage systems of coastal cities; and a failure to deal adequately with garbage disposal in general and medical waste from non-hospital healthcare sites and the general public in particular\(^3\).

Public Health and Occupational Risks:

There is no evidence that a member of the public or a waste industry worker has ever acquired infection from medical waste. The only medical waste that has been associated with infectious disease transmission is contaminated sharps\(^4\). All reports of

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transmission of infectious agents by contaminated sharps described, occurrences in the healthcare setting during patient care, laboratory procedures, or sharp disposal, and are not associated with environmental injuries that occurred after extramural disposal\textsuperscript{1}. There is no epidemiological evidence that hospital waste disposal practices have caused disease in the community\textsuperscript{2}. Further, occupational exposure of waste industry workers to medical and municipal waste has been found to lead to an increased risk of acquiring blood borne infections\textsuperscript{3}. For example, Cimino\textsuperscript{4} reported on the disease and injury data over a two-year period (1968-1969) for the 14,000 persons employed by the New York Department of Sanitation. He found a higher overall injury rate than other industrial occupations, but no case of hepatitis developed in the group suffering needle punctures.

Similarly, there are no demonstrated non-infectious health risks associated with waste treatment technologies that are currently employed; however, public health concerns regarding treatment technologies require further investigation and subsequent development of scientifically based standards. The health risks associated with the incineration of medical waste continue to be debated because of the paucity of data. The pollutants of primary concern from both hospital and municipal waste incinerators include dioxins and Furans (some of which are suspected carcinogens), acid gases (e.g., hydrogen chloride), metals (e.g. lead, mercury, cadmium), and particulate emissions (which may absorb heavy metals and organics and serve as irritants). Some of these substances (e.g. heavy metals, dioxins, and furans) also can be a constituent of incinerator ash\textsuperscript{5}. Preliminary studies using the \textit{Ames Salmonella typhimurium} assay indicate that


\textsuperscript{2} Burdick A. Hype tide. THE NEW REPUBLIC, June 12, 1989;15-18.


stack fly ash and particulate emissions from medical waste incinerators are less mutagenic than emission estimates published for wood stoves, automobile gas engines, and residential furnaces\(^1\). However, the public health concerns of chemicals in the emissions or ash require further investigation that should lead to the development of scientifically based standards.

Currently, statewide moratoriums or stringent rules (particularly air emission) and permit requirements make it virtually impossible for hospitals to install incinerators and difficult for hospitals to use installed incinerators. Health facilities in New York are preparing for strict new incineration standards that took effect from January 1, 1992, and may close about 75% (220/300) of the health facility incinerators. New Jersey’s incineration standards have forced most health facilities to close their incinerators or pay fines of $5,000 per month\(^2\). This results in increased disposal costs for the shipment of regulated medical waste, sometimes long distances to regional incinerators.

Documented health risks from steam sterilization do not exist. Potentially, workers could be exposed to aerosolized organic solvents or other hazardous chemicals if these materials were autoclaved and the workers were exposed to the vented steam. This potential emission problem can be prevented by not autoclaving hazardous chemicals\(^3\).

The health risk associated with new alternative technologies (e.g., microwave, gamma radiation, infrared) requires further examination. When an alternative waste treatment technology is considered, any new (e.g., gamma radiation exposure) or additional employee exposures that could result from the new methods should be identified and evaluated\(^4\).

*Infection Risks Associated with Recycling Hospital Waste*

There are no infectious risks associated with recycling hospital waste. Effective management of hospital waste incorporates a waste reduction and recycling component


where ever appropriate. Presently, recycling efforts by hospitals have generally focused on no patient contact sources of waste such as glass, scrap metal, aluminum cans, cardboard, and packaging material\(^1\). Although there are no infection risks posed by recycling these components of the hospital waste stream, reports of hospitals being unable to market certain items for recycling (e.g. glass intravenous bottles) because they are perceived to be ‘infectious/medical waste’ have occurred. This highlights the need for better understanding of the actual public health risks posed by the medical waste stream. From an infectious disease perspective, only a few items (e.g. sharps, plastic associated with microbiological cultures) generated in the healthcare setting are not likely candidates for recycling\(^2\).

Public Education:

An increase in medical waste from residential sources is attributable to a number of changes in and outside of the health care delivery system. The *Agency for Toxic Substances and Disease Registry (ATSDR)* reported that the number of injuries refuse workers sustain from sharps in residential solid waste is increasing. This trend appears to coincide with the increasing trend to in-home health care\(^3\).

There are several trends that have increased the amount of medical waste emanating from unregulated sources:

1. Hospital patients are released on an out-patient basis sooner and more frequently and they are often prescribed with medical supplies for self-care at home.
2. The use of disposable items has increased the volume of medical waste entering the solid waste stream from private homes. The American Diabetic Association estimates that diabetic patients generated one billion used syringes in 1987, assuming that the syringes were not reused\(^4\).

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3. Many one-time use items are available over the counter for small live stock operations and other business or non-profit entities that do not come within the jurisdiction of regulated generators of medical waste.

4. An increase in the users of illicit intravenous drugs is another source of unregulated medical waste. The National Institute on Drug Abuse estimates that there are between 1.1 million and 1.3 million illicit IV drug users nationwide.

Education of the public, especially small generators such as home health care users of medical products, could greatly expedite the management of medical waste.

The hasty promulgation of unscientific regulations for transport and disposal of medical waste should be replaced with the development of uniform regulations based on scientific data for proper decontamination and disposal of the very small amount of medical waste that may pose an infectious hazard. Additionally, an intensive public education program regarding the actual risks posed by medical waste and methods for their proper management may reduce the public’s outrage. This approach may prevent the wasteful expenditure of approach healthcare resources and would safeguard the environment and the public’s health.

Based on the scientific literature reviewed it could be concluded that in the following way:

- The vast majority of waste on beaches is general debris (>99%), not medical waste, and the risk of acquiring infection from medical waste on a beach is virtually nonexistent.
- There is no scientific evidence that medical waste has ever been the source of infection for any person outside the healthcare setting, and there is no evidence that a waste industry worker has ever contracted an infection from medical waste.
- Medical waste may be safely land filled, provided procedures to prevent worker contact with these wastes during disposal are employed. Bulk blood and body fluids may be safely discarded by pouring them into a sanitary sewer system.

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1 U.S. Department of Health and Social Services, 1990, p. 3.22.
Based on epidemiological and microbiological data, only two types of medical waste would require special handling and treatment: sharps and microbiological waste.

An Implementation of the MWTA for all USA hospitals would result in an extraordinary increase in medical waste disposal costs with no environmental or public health benefit.

**Educational efforts should:**
1. Provide the public with an understanding of the medical waste management process and the fact the proper and safe management is possible.
2. Inform medical waste generators of safe and proper methods of disposal.
3. Inform persons who use syringes or similar items in the home (e.g. diabetics, etc) as to ways in which they can reduce or eliminate hazards that may occur through improper disposal of these items.
4. Distribute pamphlets and administer on-site training programs designed to assist waste handlers in identifying potentially infectious waste as a limited subset of the composite medical waste stream.
5. Make employees within health care facilities aware of the potential hazards that existed within them. They also need to know that just because something is thrown away, it does not suddenly disappear. Waste material can pose threats to both workers and the general public.

Fueling the fears of the public about medical waste are such concerns as the hypothetical risk of medical waste for transmitting the Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and other agents associated with blood borne diseases. The public also is concerned about the emissions from incinerators that burn medical waste and whether these emissions may contain microorganisms or toxic substances.

Thus, a lack of understanding of the modes of transmission of agents associated with blood borne disease, the fear of a fatal disease such as the Acquired Immunodeficiency Syndrome (AIDS), and a distrust of healthcare facilities accentuated by intense and often misleading media coverage has led to intense public pressure on federal, state, and local politicians to regulate medical waste.
The purpose of this information is to summarize the available scientific data with respect to the public health and environmental hazards associated with disposal of medical waste and to present conclusions as to its public health importance.

2.1.4 Bio-Medical Waste: UK

The safe management of bio-medical waste is the most concentrated area of U.K. waste management system. Therefore, the safe disposal and subsequent destruction of clinical waste is a key step in the reduction of illness or injury caused when came in contact with this potentially hazardous material, and in the prevention of environmental contamination. The transmission of blood borne virus infection is a major risk; respiratory, enteric and soft tissue infections are also recorded frequently. Other risks include physical injury and adverse local or systemic effects through contact with potentially hazardous pharmaceuticals.

In U.K. the safe disposal of clinical waste has received much attention over many years. Emphasis is placed on the correct segregation and disposal of waste from clinical areas, and on technical developments in the destruction of waste. With the implementation (in 2005) of the Hazardous Waste Regulations 2004, there existed a wide array of legislation, Codes of Practice, and licensing for both waste producers and those providing merchant clinical waste disposal services. It also covered all issues of waste transport, storage and disposal, including aspects of site hygiene and security. Additional obligations are imposed on UK hospitals by Health and Safety legislation.

Failure in proper containment of clinical waste in hospital breaches several Codes of Practice and operational ‘good practice’ guidelines are in operative. Environmental law requires clear and robust procedures to ensure correct containment of clinical waste.

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2 J.I. Blenkharn , Standards of clinical waste management in UK hospitals, 18 South Road, Ealing, London W5 4RY, UK Received 18 April 2005; accepted 5 August 2005 Available online 6 December 2005.
and effective segregation from other waste streams\(^1\). Health and Safety legislation has also been used for successful prosecution of National Health Service Trusts in breach of the same, this Act\(^2\) places on employers “\textit{a duty …. to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not exposed to risks to their health of safety}”. Trusts must exercise an appropriate \textit{Duty of Care} that wastes is properly managed to ensure the safety of its employee and of others. Prosecution has followed storage of clinical waste in hospital areas accessible to the public. This naturally procures more attention towards safety of health and environment in U.K. regarding management of clinical waste and of course they are taking all the reasonable care for which the administration, legislation and public is very much supportive.

\subsection{2.1.4.1 Meaning of Bio-Medical Waste:}

In the health care sector traditionally waste is known as ‘\textit{clinical waste}’ on the basis of infection risk is infectious waste according to UK Regulations.

\textbf{Clinical Waste:}

\textit{Gay Hawkins (2006)} has, like many other writers on waste, written that its simplest definition is discarded, expelled of excess matter. She writes that:

\textit{….waste is at the heart of many moral economies that it’s hard to find a sense in which it isn’t bad. To be unproductive or to excessively expend is a sign of poor discipline and irresponsible conduct. Minimizing waste in the interest of efficiency is regarded as evidence of effective economy: industrial, moral, and psychic\(^3\).}

In U.K. the meaning of biomedical waste is stated to be \textit{clinical waste} and it is defined as under:

The definition of “\textit{clinical waste}” has historically been used to describe as waste produced from healthcare and similar activities that pose a risk of infection and hence may prove hazardous. Clinical waste must be segregated from other wastes and treated /

\(^2\) Section 3, Subsection 1 of the Health and Safety at Work Act, 1974.  

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disposed of appropriately in suitably licensed facilities on the basis of the hazard that it poses.

The **Controlled Waste Regulations 1992** (issued under the Environmental Protection Act, and in Northern Ireland by the *Waste and Contaminated Land (Northern Ireland) Order*) has defined ‘clinical waste’ as:

(a) “. . . any waste which consists wholly or partly of human or animal tissue, blood or other bodily fluids, excretions, drugs or other pharmaceutical products, swabs or dressings, syringes, needles or other sharp instruments, being waste which unless rendered safe may prove hazardous to any person coming into contact with it; and.

(b) any other waste arising from medical, nursing, dental, veterinary, pharmaceutical or similar practice, investigation, treatment, care, teaching or research, or the collection of blood for transfusion, being waste which may cause infection to any person coming into contact with it.”

**Non-clinical waste definition (Offensive / hygiene waste)**

This is a new term to describe waste which is both non-infectious and non-hazardous (and therefore does not require specialist treatment or disposal) but which may cause offence to those coming into contact with it. The category includes waste previously described as human hygiene waste and ‘sanpro’ waste. For Examples offensive/hygiene waste includes incontinence and other waste produced from human hygiene, Sanitary waste, Nappies etc.

In UK, Clinical Waste is broadly classified as **“Infectious”** and **“Medical Waste”** in order to concentrate on Proper Handling and disposal of such wastes.

**Infectious Waste:**

Infectious waste is defined as waste that poses a known or potential risk of infection. Even minor infections are included in the definition of infectious waste. Any implanted medical device that has been in contact with infectious bodily fluids should also be classified and treated as infected waste. All health care waste – whether produced in a hospital or a community setting – is assumed to be infectious waste until it’s
assessed. This assessment is based on an item and patient-specific clinical assessment, which is undertaken by the health care practitioner. Any failure to segregate infectious waste from non-infectious waste would mean the entire waste stream has to be classified as infectious waste, and consigned for appropriate treatment and recovery, or disposal.

Medical waste:

Medical waste includes expired, unused, spilt and contaminated pharmaceutical products, drugs, vaccines, and sera that need to be disposed of appropriately. It also includes discarded items contaminated from use in the handling of pharmaceuticals, such as bottles or boxes with residues, masks, connecting tubing, syringe bodies and drug vials. Only cytotoxic and cytostatic medicines are classified as hazardous waste and must be segregated from other medicines. Failure to segregate cytotoxic medicines will mean the entire medical waste stream must be disposed at a waste incinerator. Other non-cytotoxic medicines may have harmful properties (for example, controlled drugs) and should be referred to the appropriately authorized personnel for disposal and destruction.

2.1.4.2 Classification of Bio-Medical Waste:

In U.K., Waste regulation requires the classification of health care waste, produced as a consequence of health care activities in hospitals and community settings, on the basis of its hazardous characteristics point production. There are two types of health care waste – hazardous and non-hazardous.

As a result of recent regulatory changes including the Landfill Regulations, the Hazardous Waste Regulations and the List of Wastes Regulations, all health care waste must now be classified using European Waste Catalogue (EWC) codes. Under the Special Waste Regulations, the ‘hazardous waste’ is defined as ‘special waste’ which is applied in Scotland instead of other waste regulations.

The EWC is produced by the European Commission in accordance with the European Waste Framework Directive\(^1\) to provide common terminology for describing

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\(^1\) European Waste Framework Directive (75/442/EEC).
waste throughout Europe. The EWC list is reviewed periodically and incorporates the European Hazardous Waste List pursuant to the Hazardous Waste Directive.\textsuperscript{1}

The European Hazardous Waste Directive (EHWD), and the Hazardous Waste Regulations 2005 (HWR) which has implement and this European Directive in the UK from July 2005\textsuperscript{2}, have much to commend them. They seek to identify wastes hazardous to health or to the environment, and to ensure that care is taken in their disposal. The EWC is pivotal to this legislation, enabling classification of wastes based upon composition and hazard. Non-hazardous wastes escape stringent control in disposal that had previously been applied, permitting correspondingly lower disposal costs.

European Waste Catalogue (EWC) provides UK guidance on the interpretation and risk-based identification of infectious waste. Failure to segregate infectious waste from noninfectious waste will mean that the entire waste stream (that is, where it includes any quantity of infectious waste) will need to be classified as infectious waste and consigned for appropriate treatment and recovery or disposal.

*Infected/used medical devices:*

Where implanted medical devices have been in contact with infectious bodily fluids and have been assessed to be infectious, they should be classified and treated as infectious waste.

If the device contains hazardous substances or components including nickel cadmium and mercury-containing batteries, the description of the waste on the consignment note must fully describe the waste and all its hazards.

*Categorization of different categories of clinical wastes are classified under European Waste Catalogue (2002) such as:*

1. Wastes from human and animal health care and/or related research (except kitchen and restaurant wastes not arising from immediate health care).

2. Wastes from natal care, diagnosis, treatment or prevention of disease in humans.

\textsuperscript{1} Hazardous Waste Directive.1 91/689/EEC.
\textsuperscript{2} J.I. Blenkharn, Lowering standards of clinical waste management: do the hazardous waste regulations conflict with the CDC’s universal/standard precautions? 18 South Road, London W5 4RY, UK Received July 19, 2005; accepted 29 September 2005 Available online February 07, 2006.

4. Body parts and organs including blood bags and blood preserves.

5. Wastes whose collection and disposal is subject to special requirements in order to prevent infection.

6. Wastes whose collection and disposal is not subject to special requirements in order to prevent infection (e.g. dressings, plaster casts, linen, disposable clothing, nappies).

7. Chemicals consisting of or containing dangerous substances.

8. Cytotoxic and cytostatic medicines.


Other wastes which are non-hazardous are considered as Municipal waste household waste and other similar commercial, industrial and institutional waste (including separately collected fractions).

The waste which is hazardous in nature is to be classified absolutely depending on their composition and the concentration of ‘dangerous substances’ within them. The hazard potential is determined by reference to published threshold limits or, for infection hazards, on risk assessment.

The Hazardous Waste Regulations\(^1\) define infectious as Infectious Substances containing viable microorganisms or their toxins which are known or reliably believed to cause disease in man or other living organisms.

Waste regulation requires the classification of waste on the basis of hazardous characteristics and point of production. The table below shows examples of the types of waste produced by the healthcare sector that are classified as hazardous and nonhazardous under UK Regulations. It is also stated that Medicinal waste /Clinical waste should be segregated from other types of waste and be treated/disposed of

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\(^1\) The 14 hazard groups identified in the Hazardous Waste Regulations 2005 as:
- H1 Explosive
- H2 Oxidising
- H3A Highly Flammable
- H3B Flammable
- H4 Irritant
- H5 Harmful
- H6 Toxic
- H7 Carcinogenic
- H8 Corrosive
- H9 Infectious
- H10 Toxic for reproduction
- H11 Mutagenic
- H12 Substances that release toxic gases
- H13 Substances capable of yielding substances listed above
- H14 Ecotoxic
appropriately in suitably permitted, licensed or exempt facilities on the basis of the hazard it poses.

Examples of waste produced in the healthcare sector\(^1\) are as follows:

<table>
<thead>
<tr>
<th>Hazardous waste</th>
<th>Non-hazardous waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious waste</td>
<td>Domestic waste (black-bag or municipal waste)</td>
</tr>
<tr>
<td>Fluorescent tubes</td>
<td>Food waste</td>
</tr>
<tr>
<td>Laboratory chemicals</td>
<td>Offensive/hygiene waste</td>
</tr>
<tr>
<td>Cleaning chemicals</td>
<td>Packaging wastes</td>
</tr>
<tr>
<td>Photo chemicals</td>
<td>Recyclates (paper, glass, aluminium etc)</td>
</tr>
<tr>
<td>Oils</td>
<td>Furniture</td>
</tr>
<tr>
<td>Batteries</td>
<td>Construction and demolition waste</td>
</tr>
</tbody>
</table>

2.1.4.3 Sources of Bio-Medical Waste:

In U.K, clinical wastes are considered as dangerous wastes. It has been also stated that clinical wastes are dangerous but if handled properly and disposed of carefully the risk of infection or injury can be minimized\(^2\).

However, despite stringent U.K and EC legislation and detailed guidelines for the safe disposal of clinical wastes\(^3\), serious errors in waste disposal continue to occur. Under-reporting is undoubtedly common and meaningful statistics are difficult to derive but most incidents could be related to the inappropriate actions of health care staff and sub-standard handling of bulk wastes within hospitals.

In U.K. there exist many different sources of clinical wastes which are summarized as follows:

Hospitals and associated clinics, Health centers, General Practitioner surgeries, Needle exchange schemes/drug treatment centers, Public health laboratories, Blood transfusion centres, School and company health clinics, Ambulance services, Community

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1 Note: Adapted from ‘Welsh Health Estates’ ‘Healthcare waste strategy for Wales’ guidance document.
health care services, first aid centres, Dental surgeries/hygienists, Dental laboratories, Police services, Trauma services (accidents, street violence etc.), Veterinary hospitals/ surgeries, Veterinary laboratories/ pet shops, medical research institutions, Physiotherapists, chiropodists, Tattooists, cosmetic piercers, Acupuncturists, osteopaths and other alternative practitioners, Funeral parlors/undertakers/embalmers, Residential homes, Domestic premises from domiciallary dialysis etc., Domestic premises Pharmacists, and armed forces establishments.

Waste streams in hospitals are also identified in order to monitor proper management of clinical waste in U.K. and segregated accordingly. Clinical wastes, sharps, Linen, Foul or infected linen, Laboratory waste-diagnostic laboratories, research laboratories, experimental animals (bedding/carcasses etc.), Domestic refuse, Documents, Pharmaceutical wastes, Cytotoxic wastes, Chemicals, including oil, Radioactive wastes, Residues from gas scavenging systems, Food, Deceased persons/post-mortem waste, Almoner/Social services (belongings from deceased persons), Glass, Sanitary wastes, Sewage, Waste water, including cooling water from air conditioner systems.

The management of clinical waste is given more importance in U.K system of waste management. In spite of such crucial step, it has been stated that most wastes will be contaminated with potentially pathogenic micro-organisms; numbers of organisms are generally small and in any volume of waste. At its site of arising, only a minor fraction of the total may actually be contaminated. Later, cross- contamination will occur and most items will become contaminated rendering the entire load potentially harmful. Bacterial multiplication may occur in the days after initial disposal as the moisture content is generally high and stored wastes are rarely refrigerated. Nonetheless, most authorities agree that clinical wastes generally contain fewer bacteria than household refuse\(^1\) although the number of potential human pathogens is considerably greater and these may present an increased risk of infection compared with domestic refuse. Dialysis wastes have long been considered to pose an additional threat to health, this view prejudicially based upon much publicized outbreaks of hepatitis B infection the late 1960s and early

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1970s. Only one study has addressed this issue directly, identifying serological markers of hepatitis B virus in >2% of blood-drenched items recovered from clinical waste. Current methods for disposal and containment of wastes, together with effective terminal destruction, should minimize any hazard and no additional risk should be attributed to clinical wastes containing such virus agents provided these are adequately contained and disposed of carefully\(^1\).

2.1.4.4 Hazards of Clinical Waste:

The generation of waste and the collection, processing, transport and disposal of waste is known as the process of ‘waste management’ which is important for both the health of the public and aesthetic and environmental reasons. Waste is anything discarded by an individual, household or organization. As a result, waste is a complex mixture of different substances, only some of which are intrinsically hazardous to health. The potential health effects of both waste itself and the consequences of managing it have been the subject of a vast body of research.

Hepatitis B virus, Hepatitis C virus and HIV are the principal infection risks for those handling clinical wastes. The risk of transmission of blood borne viruses is well documented. Although sharps users are at greatest risk of sharps injury, porters and other ancillary workers involved in the early stages of the disposal chain feature as the next most frequent group reporting needle stick injuries\(^2\). Under-reporting is widely assumed, and this may be particularly true among waste industry personnel where occupational health services are unlikely to be co-ordinated and accurate statistical data is impossible to obtain.

Conflict between the Hazardous Waste Regulations 2005 (HWR) and UK Health and Safety legislation is of particular concern. Health and Safety legislation has been


used to bring successful prosecution of National Health Service (NHS) trusts\(^1\). This Act places on employers ‘a duty to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected are not thereby exposed to risks to their health or safety’. The UK Health and Safety Executive Public Register of Convictions\(^2\), records several cases involving failure in the safe and proper management of clinical wastes by National Health Service trusts. Prosecution has followed storage of clinical wastes in areas of hospitals accessible to the public, and also prosecuted in one case by adverse reportage in a national daily newspaper. And no mitigation was entertained based on the infectious nature of the waste, or lack of it. Thus, under Health and Safety legislation, clinical wastes are deemed to be a potential hazard to health, and producers must exercise an appropriate duty of care to ensure that wastes are properly managed in such a way as to ensure the safety of its employees and others.

It is questionable if this duty of care will be satisfactorily discharged if some wastes are managed to a lesser standard based upon arbitrary and ill-defined European Waste Catalogue (EWC) categorization that may be fundamentally flawed through our inability to apply meaningful and precise definitions of infection risk. The infection risk, although possibly small, cannot be neglected, and relevant Health and Safety legislation may apply; additional civil liability may greatly magnify the costs. Clarity is provided by the Centers for Disease Control (CDC)’s Universal/Standard Precautions. These are at the heart of the protection of patients and healthcare workers from infection with blood borne viruses and other pathogens, can apply equally to those involved in the subsequent disposal of clinical wastes, and support the classification of all clinical wastes as hazardous in the context of the European Waste Catalogue (EWC).

The prevention of infection among healthcare staff and others, particularly infection caused by blood borne virus agents including hepatitis B, hepatitis C and HIV, has received considerable attention in recent years, and directly influence the approach to waste management in hospitals. Linked with overall standards of hospital hygiene, this is an issue of considerable public and professional concern. It is particularly important, in order to protect against infection, that blood and tissue wastes and other more general

\(^1\) In breach of Section 3, sub-section 1, of the Health and Safety at Work Act 1974 etc.
components of clinical wastes, such as used swabs and dressings, should be considered, without exception, as potentially hazardous to health and that these are managed accordingly, although with the recent (July 2005) implementation of the Health Waste Regulations HWR, this is not necessarily so. Some have recommended, on ecological and financial criteria, exclusion of items that may carry only a negligible risk of infection and may be categorized separately.

Prompt terminal destruction of clinical wastes is essential whether undertaken on-site, at a district or regional facility, or by removal to a merchant disposal facility. Landfill disposal still occurs although is largely replaced by high temperature incineration. The latter process, if properly conducted in a modern installation conforming to current emission standards, assures total destruction of wastes with minimal pollution risk. Although much attention is directed toward concentrations of oxides of nitrogen (NO$_x$) and sulphur (SO$_x$), hydrogen chloride, particulates, dioxins and furans in the gaseous emissions from clinical waste incinerators, and the difficulties associated with solid residues of incineration, few studies have addressed the microbiological safety of incinerator operation. Barbeito and Gremillion found incinerator temperatures of 370$^\circ$ necessary to kill Bacillus globigii spores. Subsequently, Barbeito and Shapiro$^2$ examined a small scale gas- or oil-fried pathological incinerator using simulated loads seeded with Bacillus subtilis var. niger spores.

Although still under development, microwave treatment is particularly attractive as the units are mobile, can handle wastes even when these contain significant amounts of metal, are generally non-polluting and have low capital and running costs. The process is unproved at present and suffers greatly, yet unjustly, from the adverse publicity surrounding the use of microwaves in both domestic and commercial kitchens. However, many studies point to the rapid lethality of 2450 MHz microwave energy for a range of bacteria including Escherichia coli, Pseudomonas aeruginosa, Salmonella typhimurium, Serratia marcescens, Staphylococcus aureus, Azotobacter spp., Bdellovibrio spp.,


Enterococcus faecalis and Streptococcus pyogenes\textsuperscript{1}, as well as the spore-forming species Bacillus subtilis var. niger, Bacillus cereus and bacillus stearothermophilus, yeast-like fungi including Saccharomyces cerevisiae\textsuperscript{2} and virus (\textit{E. coli} bacteriophage)\textsuperscript{3}. Cell death is consequent upon direct thermal effects on vegetative cells and spores even when microwave exposure is performed in the dry state. Re-growth of some surviving bacteria might be anticipated in the warm moist residues of the microwave treatment process. However, contamination with environmental saprophytes is more likely and the bioburden of treatment wastes is likely to be markedly different, qualitatively and quantitatively, from that of feedstocks.

Therefore, UK Legislations have taken prominent steps regarding clinical wastes from the point of generation to final disposal. It can also be analyzed that, in order to attain the containment of proper management, it is necessary to identify sources and classifications, hazards of clinical wastes and impact of clinical wastes on health and environment and all these have been critically examined and noted in the various regulations of UK Waste Management for effective implementation of the same.

2.2 CAUSES OF POLLUTION THROUGH BIO-MEDICAL WASTE

If Bio Medical Waste is not properly collected, stored, transported and disposed of in an appropriate manner, it leads to serious impact on environment in general, causing of air, water and land pollution in particular. The natural pollutants of it can be categorized as 1) Biological 2) Chemical and 3) Radioactive. It is true that Pollution cannot be completely eliminated but can be reduced to a greater sustainable limit or extent\textsuperscript{4}. Whereas there are several contributors to biomedical wastes but not all of them contribute detrimentally to the same extent like prisons / institutions for disabled persons, Psychiatry clinics, mortuaries / autopsy rooms, Beauty Parlors and Office etc. It could

also be noticed that medical waste generation according to sources in United States were worked out by Environmental Protection Agency and mentioned different sources like hospitals, nursing homes, physician offices, clinics, laboratories, dentists office, veterinarians, funeral homes and blood banks.

Observation on total quantity medical waste generated in some industrialized countries showed that University Hospitals generated maximum medical waste in United States (5.24 kg / per/ day ) while minimum of (3.3 kg / per/ day) waste in United Kingdom. General hospitals generated maximum (4.5 kg /per/ day) in United States and minimum (2.5 kg/bed/day) in France\(^1\). Accordingly, *Rule 3(8)* defines ‘Occupier’ and in this definition of Biomedical Waste (Management and Handing) Rules 1998 it has been clearly stated the sources and generation of biomedical waste in our Legislation and it has also been explained in *Rule 4* ‘Duty of Occupier’ of the same Rules 1998 about the care to be taken by the Occupier one who generates the biomedical wastes. Namely, *Rule 3 (8)* ‘Occupier’ is defined as one who “in relation to any institution generating bio-medical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institutions, animal house, pathological laboratory, blood bank by whatever name called, means a person who has control over that institution and / or its premises;

Secondly, *Rule 4* ‘Duty of Occupier’ states that it shall be the duty of every occupier of an institution generating biomedical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institutions, and animals house, pathological laboratory, blood bank by whatever name called to take all steps to ensure that such waste is handled without any adverse effect to human health and the environment.

After analyzing these two definitions it could be clearly understood that the Rules 1998 of Biomedical waste has recognized hospital, nursing home, clinic dispensary, veterinary institutions, animals house, pathological laboratory, blood bank, as principal source of generation of bio-medical waste in India.

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\(^1\) WHO / Europe Publication ERS 97 (Management of Waste from Hospitals).
Pollution due to biomedical waste:

Pollution due to biomedical waste is likely to spread disease dangerous to life and making atmosphere noxious to health. In early April, 2010 a machine from Delhi University containing cobalt-60, a radioactive metal used for radiotherapy in hospitals, ended up in a scrap yard in the city. The death from radiation poisoning of a scrap yard worker in Delhi has highlighted the lack of enforcement of waste disposal laws in India. The International Atomic Energy Agency said it was the worst radiation incident worldwide in four years. India being used as a dumping ground for hazardous waste, from foreign countries. Twenty containers with goods were detained by the officials of Special Intelligence and Investigation Branch attached to the Customs Department here recently. Packs of broken toys, used diapers, empty perfume bottles, used battery cells, thermocol, used aluminum foil packing materials and colored surgical gloves were found in the containers. It could also lead to contamination and spreading of communicable diseases.

The following pollutants of Biomedical Wastes lead to total environmental pollution affecting health and ecology\(^1\) which has been stated below.

Air Pollution

There are two types of air pollution caused by Bio-Medical Waste namely; *Indoor Air Pollution and Outdoor Air Pollution*. Whereas Indoor Air Pollution is caused due to poor ventilation and chemicals in the buildings of health center or hospital. Pathogens\(^2\) present in the waste would enter and remain in the air in Hospital for a long period in the form of spores or as pathogens itself and it contributes to acute respiratory infections in young children, chronic, long disease and cancer in adults and adverse pregnancy outcomes (such as still births) for women exposed during pregnancy and also can cause sick building syndrome to persons working / living in the building. Whereas Outdoor Air Pollution caused by pathogens, when waste without pretreatment is being transported outside the health care establishment, or if it is dumped openly, pathogens are released into the atmosphere and could find their way to drinking water, food articles, soil etc and


\(^2\) “Pathogens”. Micro organism capable of producing disease.
or remain in the air for a very long duration and cause infections in animals and human beings. Proper waste management practices can reduce this pollution to a large extent. Whereas Chemical pollutants that cause outdoor air pollution have two major sources namely **Open Burning and Incineration**.

Open burning of Bio-Medical Waste is the most harmful practice as plastics and other hazardous material in the waste would generate harmful gases such as oxides of Carbon, Sulphur and Nitrogen and also dioxins and furans which causes respiratory problems and cancer respectively. Therefore open burning should be strictly prohibited and safe techniques must be used to destroy the Bio-Medical Waste as per the prescribed norms whereas incineration must also take place at prescribed temperature as given under the Rules of 1998 otherwise, it would largely contribute to air pollution. There is another form of air pollution known as **Radioactive emissions** which affects all living organisms as a small dose of radioactive material may prove fatal and even can cause diseases like cancer and leukemia and also induces gene mutations which leads to abnormalities. Research and radio-immunoassay activities may generate small quantities of radioactive gas likewise the clinical application of 85 Ks and 133 Xe is the main source of gaseous radioactive waste material requiring appropriate disposal as per the prescribed norms. In order to reduce air pollution, monitoring of Air Pollution is very essential. The best way to monitor is by using indicators of air pollution which are mainly Sulphur dioxide, smoke and suspended particles. Sulphur dioxide is a major contaminant and its concentration is estimated in all air pollution surveys similarly, in case of Smoke or soiling Index a known volume of air is filtered through a white fitter paper under specified conditions and the stain is measured by photoelectric meter and in case of Grit and Dust, Measurement Deposit gauzes collect grit, dust and other solids to find out the pollution in the air. There are certain technical factors and index such as Coefficient of Haze – A factor used in assessing the amount of smoke or other aerosol in air and Air Pollution Index – It is an arbitrary index which takes into account one or more pollutants as a measure of the severity of pollution. In this way pollutant of air pollution can be identified and monitored. If it is not controlled it would affect health, social and

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1 Park, k; Park’s TEXT BOOK OF PREVENTIVE AND SOCIAL MEDICINE, (16th edn, Banasidas Bhanot Publishers, Jabalpur, Indian, 2000).
economic well-being. In case of Health aspects the health effects of air pollution are both immediate and delayed. The immediate effects are borne by the respiratory system, the resulting state is acute bronchitis. The delayed effects are chronic bronchitis, bronchial asthma, emphysema and respiratory allergies whereas in Social and Economic Aspects it causes destruction of plant and animal life, corrosion of metals, damage to buildings, costs of cleaning and maintenance and repairs and aesthetic nuisance. Air pollution also reduces visibility in towns. It can soil and damage clothings.

Plastic Biomedical Waste:

The use of plastics in medical equipment is now growing at the rate of more than 6% per annum. Their application and usage in medical devices are contributing significantly to the quality and effectiveness of health care system. These devices range from caterers to vascular grafts, from semi-occlusive dressing to mammary implants and from transversal drugs delivery system to medical patches. Most widely used plastic in health care setting are syringes, blood bags, surgical gloves, catheters, etc., that is why, plastics constitute a major portion of biomedical waste. Plastics used in health care setting are poly vinyl chloride (PVC), acryl nitrate butadiene styrene copolymers (ABS), ethylene vinyl acetate copolymers; methyl meth acrylate butadiene styrene copolymers, polyamide, polyethylene, polycarbonate, polyethyleneterephthalate (PET), polypropylene, and polyurethane. Plastic are petroleum products and have got place in hospitals because of its transparency, low cost, high resale value, and low infection rate with single use.

Unfortunately, there have been reports in newspapers on the alleged collection and resale of plastic disposable items of hospitals in a very high preparation. The reuse of medical equipment also has the possibility of spurious fluids. PVC contains additives like lead, cadmium and phthalate (Di-2ethylhexyl). All these substances can leach into the solution present in the container, which can cause toxicity for prolong use. If PVC burns it may lead to formation of dioxins and furans that are known carcinogenic and can cause various health effects like disturbance in liver enzymes, depression of immune system and allergies, fetotoxicity, abortions, and malignancies in experimental animals (Eriksson

1. Ibid
The plastic is non-degradable product and remains in the environment for the long period. The best solution for the PVC and other plastics is to reduce its use.

Water Pollution:

Water is also polluted due untreated bio-medical waste into water bodies. Pure uncontaminated water does not occur in nature. It contains impurities of various kinds – natural and man-made. The natural impurities are not essentially dangerous. These comprise dissolved gases (eg; Nitrogen, Hydrogen sulphide etc. which may be picked up during rainfall) and dissolved minerals (Eg. Salts of calcium, magnesium, sodium etc.) Which are natural constituents of water following its contact with soil; and suspended impurities (Eg. Clay, Silt, sand and mud) and microscopic organisms and these impurities are derived from the atmosphere, catchment area and the soil. Another serious aspect of water pollution is that caused by human activity under the name of urbanization and industrialization. The sources of pollutants resulting from these are:

1) Sewage  2) Industrial and trade wastes
3) Biomedical wastes  4) Agricultural pollutants 5) Physical pollutants.

Biomedical waste generated by Health care establishment would cause water pollution when Bio-Medical Wastes are thrown into water without pretreatment. These wastes with highly active pathogens are responsible for contaminating the ground water or surface water. Harmful chemicals present in biomedical waste such as heavy metals can also cause water pollution. Poor land filling technology may cause water pollution in the form of leachates. Excess nutrient leachates such as nitrates and phosphates from landfills can cause phenomenon called eutrophication (where surface of the water body develops algal blooms). There are instances where dioxins have been reported from leachates near incinerator plants as they easily enter the water body from the air\(^2\). The standards for effluents released from organizations should be maintained and should be monitored by appropriate agencies. Proper waste management practices will reduce the

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\(^1\) J. Kishore, and G.K. Ingle, BIOMEDICAL WASTE MANAGEMENT IN INDIA, (1\(^{st}\) edn., 2004), P-60, Century Publications, New Delhi.

\(^2\) http://www.distromed.com/introduction.htm (June 24, 2011).
water pollution considerably. Incinerators should be installed by health care establishments away from water bodies and care should be taken to construct proper liners in landfills to restrict leachate from entering water bodies.

As like biological and chemical pollutants of Bio-Medical Waste, radioactive pollutants thereby also cause water pollution. Many shipments of radioactive material are in liquid form. The residues of these shipments constitute the main liquid radioactive waste requiring proper handling and disposal. Radioactive waste in liquid form can come from chemical or biological research, from body organ imaging, from decontamination of radioactive spills, from patients’ urine and from scintillation liquids used in radio immunoassay. This liquid waste produces the largest volume of liquid radioactive waste and very low-level liquid radioactive waste is usually handled by direct dispersal in the sewer system. Higher-level radioactive waste, such as that generated in radio iodine therapy, can be stored pending decay, followed by appropriate radiation monitoring and subsequent dispersal in the sewer system. Under routine circumstances, urine and faeces can be handled as non-radioactive waste in the hospitals so long as the patient’s room is routinely monitored for radioactive contamination. In case of contaminated liquid scintillation phosphorous, the toxicity of the chemical matrix is probably more hazardous than its radioactivity. Therefore handling and monitoring of radioactive effluents is of more importance in the present scenario.

Bio-medical waste can cause water pollution. If the waste is dumped in low-lying areas or in the lakes and water bodies, can cause severe water pollution. Any liquid waste when it spills and gets entry in water, naturally bacterial flora will get favorable media and grows like mushrooms. Therefore, in that case it can cause water pollution and affects the whole of population. In case of heavy metals which are present in Bio-medical waste could cause water pollution and poor land filling technology may cause leachates. Water pollution can alter parameters such as pH, BOD, DO, COD etc., and there are instances where dioxins are reported from water bodies near incinerator plants, dioxin enter water body from the air and cause water pollution.

1 Park, k; Park’s, TEXT BOOK OF PREVENTIVE AND SOCIAL MEDICINE, ( edn., Banasidas Bhanot Publishers, Jabalpur, Indian, 2000).
Land Pollution:

Land pollution\(^1\) may be explained as de-spoliation of the landscape human being survives on. Land pollution can be defined as "any physical or chemical alteration to land which cause its use to change and render it incapable of beneficial treatment without treatment\(^2\)." Alternatively, it may be defined as "misuse of land, disuse of land, and chemical contamination of land\(^3\)." Land pollution is majorly caused due to dumping and improper disposal of industrial and domestic waste along with bio-medical waste. Out of all this dumping of industrial waste and municipal solid wastes not only seriously affects the productivity of the land but also affects the purity of the ground water by letting toxic substances leach and seep into the soil, and further are the major sources of land pollution. Municipal solid waste is another major reason for pollution. It consists of both commercial and domestic wastes including dried sludge and sewage. It also includes refuse which mainly contains garbage including food wastes, rubbish like papers, glasses, metallic cans, plastics etc. It also includes hazardous substances like aerosol cans, batteries, electronic gadgets, bleaches, chemicals and solvents, empty containers, light bulbs, tube lights, medicines, paints, oil, pesticides etc. The waste management in India is extremely deficient. Municipal solid waste and even bio medical waste is thrown on the streets, water bodies and drains. Radioactive material from atmospheric fall out in nuclear explosions, radioactive materials emitted by nuclear explosions and radioactive waste from laboratories, industries and power plants and the excreta of human beings, animals, birds along with faulty sanitation, accumulation of waste water all causes land pollution.

Therefore, bio-medical waste is one of the significant component that causes pollution of all kind and it is very necessary to control at the point of generation by using proper technologies along with strict implementation of laws and practical training to the concerned authorities, operators, generators, handlers including general public.

\(^1\) http://articles.manupatra.com last visited on (Feb 3, 2008)
\(^2\) Shanthakumar .S INTRODUCTION TO ENVIRONMENTAL LAW, p 207 (2nd edn., 2009).
\(^3\) Id.
2.3 IMPACT / EFFECT OF BIO-MEDICAL WASTE ON ENVIRONMENT.

Introduction:

*Hospital wastes*’ (liquid or solid waste) refers to all waste, biological or non biological, that is waste and not intended for further use (USEPA, 1989B) and these include: pathological, infectious, hazardous chemicals, radioactive wastes, stock cultures, blood and blood products, animal carcasses, pharmaceutical wastes, pressurized containers, batteries, plastics, low level radioactive wastes, disposable needles, syringes, scalpels and other sharp items. These are in addition to food service, cleaning and miscellaneous wastes. Other types of waste include toxic chemicals, cytotoxic drugs, flammable and radioactive wastes that can often be considered infectious.

There are many pathogens that are found in hospital wastes, the most predominant (80-90%) is the genus *Bacillus* with *Staphylococci* and *Streptococci* varying between 5 and 10%, whereas the most common pathogens is *Staphylococcus aureus* (from 2-10 colonies per gram of waste). *Esherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans* are also common along with varying numbers of other common nosocomial pathogens such as *Klebsiella*, *Proteus* and *Enterobacter species*. The survival rate of the viruses has revealed that most materials that are present in hospital wastes are able to carry viruses keeping them alive for several days (5-8 days). However the virus tends to decrease rapidly as time passes for example the Hepatitis B virus has been detected but its potential to provoke infection has not been established (*Giroletti and Lodola* 1993).\(^1\)

*Giroletti and Lodola* (1993) who reported the *Bacillus* was the predominant genus found in hospital wastes. These organisms are saprophytes and represent a large number of different species. They are found in soil, water, dust and air. Bio- Medical Waste is considered to be a special waste and certainly required it to be treated with proper care from its generation to disposal. In many previous instances it has been studied that the sources of bio-medical waste or the classification or the different hazards has given clear adverse effects of bio-medical waste. But still all over the country, unsegregated and

untreated biomedical waste is being indiscriminately discarded / disposed of into municipal bins, dump sites, on roadsides, open, etc which is being incompletely and improperly burnt. All this is leading to rapid proliferation and spreading of infections, dangerous and fatal communicable diseases like hepatitis, AIDS and several types of cancers. This has also increased the risk in terms of environmental hazards by pollution. The consequences are threatening ecological imbalance of nature as pollution has raised to its highest extent by polluting air, water, land, underground, animals, birds, plants, aquatics, human health and total ecosystem.

Therefore, it is the right time to analyze the problem and act necessarily according to the legal implications to solve the problem of pollution from bio-medical waste. Medical waste often presents the greatest risk of any waste of its category. This is a result of the possibility of pathogens in the waste. There are direct and indirect effects of medical waste. Medical waste has direct effect\(^1\) because of its shows in many case that it is not properly disposed of. Large amount of this waste have dangerous pathogens in the waste at the time of disposal which causes infections to individuals. These pathogens can then breed in the waste and possibly infect animals including ground water and food sources. Another factor is the large quantities of grave pathogens present in hospitals and other health care facilities. When otherwise sanitary waste comes in contact with pathogens already in the environment, it may become a breeding ground for those pathogens. In case of indirect effect\(^2\) medical waste, especially biological waste can become the breeding ground for pathogens that weren’t present at the time the waste was discarded. Though these wastes may be human tissues or blood, since they are no longer in the body, the body’s immune functions are not present to keep pathogen’s populations in check. This can result in population explosions of pathogens that live on a human tissue and blood. These populations may develop to sufficient quantities or mutate into forms that our immune systems cannot suppress. These populations could infect other animals that forage in waste, or they may contaminate the environment, including water and food sources.


\(^2\) Ibid Page No.3.
2.3.1 Impact / effect of bio-medical waste on Air:

The immediate environment of man comprises of air, which depends all forms of life. Apart from supplying the life-giving oxygen, air and atmospheric conditions serve several functions. The human body is cooled by the air contact; the special senses of hearing and smell function through air transmitted stimuli, disease agents may be conveyed by air. Pollution of air by dust, smoke, toxic gases and chemical vapors has resulted in sickness and death. Human beings need a continuous supply of air to exist\footnote{Park, k; Park’s, TEXT BOOK OF PREVENTIVE AND SOCIAL MEDICINE, 504 (16th edn., Banasidas Bhanot Publishers, Jabalpur, Indian, 2000).}

Air pollution signifies the presence in the ambient (surrounding) atmosphere of substances (e.g., gases, mixtures of gases and particulated matter) generated by the activities of man in concentrations that interfere with human health, safety or comfort, or injurious to animals and other environmental media resulting in chemicals entering the food chain or being present in drinking water and thereby constituting additional source of human exposure. The direct effect of air pollutants on plants, animals and soil can influence the structure and function of ecosystems, including self regulation ability, thereby affecting the quality of life. Today, air pollution has become more subtle and recognizes no geographical or political boundaries. Air pollution is one of the present day health problems throughout the world\footnote{WHO (1987) Air Quality Guidelines for Europe, WHO Regional publication, European Series No.23, Copenhagen.}. When sources of air pollution are studied it could be noted that the sources are Automobiles, Industries, Domestic sources, bio-medical wastes and Miscellaneous. They emit hydrocarbons, carbon monoxide, lead, nitrogen oxides and particulate matter, sulphur dioxide, nitrogen oxides and fly ash, wind borne dust, fungi, molds, bacteria etc all these contribute to air pollution.

There are other air pollutants that are also considered as hazardous such as fluorine compounds, organic compounds, radio-active compounds, mercury, benzene, fluorides, chloride, and lead etc. When the medical wastes are incinerated they produce certain hazardous emissions like, Lead and if lead is exposed, neurological effects of lead occur at lower threshold in children than in adults, cadmium is also emitted through waste incineration causing health hazard etc. One of the contributions of bio-medical
waste in the hospitals is indoor air pollution which has been discussed earlier of its effects. Indoor pollution is caused by solvents, adhesives containing benzene, toluene etc. that are used in health care establishments for various purposes.

Dioxins are environmental pollutants. They have the dubious distinction of belonging to the ‘dirty dozen’ - a group of dangerous chemicals known as persistent organic pollutants. Dioxins are of concern because of their highly toxic potential. Experiments have shown that they affect a number of organs and systems. Once dioxins have entered the body, they endure a long time because of their chemical stability and their ability to be absorbed by fat tissue, where they are then stored in the body. Their half-life in the body is estimated to be seven to eleven years. In the environment, dioxins tend to accumulate in the food chain. The higher in the animal food chain one goes, the higher the concentration of dioxins. The chemical name for dioxin is: 2,3,7,8-tetrachlorodibenzo(para)dioxin (TCDD). The name ‘dioxins’ is often used for the family of structurally and chemically related polychlorinated dibenzo para dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Certain dioxin-like polychlorinated biphenyls (PCBs) with similar toxic properties are also included under the term ‘dioxins’. Some 419 types of dioxin-related compounds have been identified but only about 30 of these are considered to have significant toxicity, with TCDD being the most toxic.

In terms of dioxin release into the environment, uncontrolled waste incinerators (solid waste and hospital waste) are often the worst culprits, due to incomplete burning. Technology is available that allows for controlled waste incineration with low emissions. Dioxins are found throughout the world in the environment. The highest levels of these compounds are found in some soils, sediments and food, especially dairy products, meat, fish and shellfish. Very low levels are found in plants, water and air. In July 2007, the European Commission issued a health warning to its Member States after high levels of dioxins were detected in a food additive - guar gum - used as thickener in small quantities in meat, dairy, dessert or delicatessen products. The source was traced to guar gum from India that was contaminated with pentachlorophenol (PCP), a pesticide no longer in use. PCP contains dioxins as contamination.
A few cases of intentional human poisoning have also been reported. The most notable incident is the 2004 case of Viktor Yushchenko, President of the Ukraine, whose face was disfigured by chlorine. Due to the omnipresence of dioxins, all people have background exposure and a certain level of dioxins in the body, leading to the so-called body burden. The developing fetus is most sensitive to dioxin exposure. The newborn, with rapidly developing organ systems, may also be more vulnerable to certain effects. Some individuals or groups of individuals may be exposed to higher levels of dioxins because of their diets (e.g., high consumers of fish in certain parts of the world) or their occupations (e.g., workers in the pulp and paper industry, in incineration plants and at hazardous waste sites, to name just a few).

*Prevention and control of dioxin exposure:*

Proper incineration of contaminated material is the best available method of preventing and controlling exposure to dioxins. The incineration process requires high temperatures, over 850°C. For the destruction of large amounts of contaminated material, even higher temperatures - 1000°C or more - are required. Prevention or reduction of human exposure is best done via source-directed measures, i.e. strict control of industrial processes to reduce formation of dioxins as much as possible.

*WHO activities related to dioxins:*

Reducing dioxin exposure is an important public health goal for disease reduction, also with respect to sustainable development. In order to give guidance on acceptable levels of exposure, WHO has held a series of expert meetings to determine a tolerable intake of dioxins to which a human can be exposed throughout life without harm. WHO, in collaboration with the Food and Agriculture Organization (FAO), through the joint FAO/WHO Codex Alimentations Commission, has established a ‘*Code of Practice for the Prevention and Reduction of Dioxin and Dioxin-like PCB Contamination in Foods and Feed*’. This document gives guidance to national and regional authorities on preventive measures. The establishment of Codex guideline levels for dioxins in foods is under consideration.

Since 1987, WHO has conducted periodic studies on levels of dioxins in human milk, mainly in European countries. These studies provide an assessment of human
exposure to dioxins from all sources. WHO is being working with the United Nations Environmental Programme (UNEP) on the implementation of the ‘Stockholm Convention’, an international agreement to reduce emissions of certain persistent organic pollutants (POPs), including dioxins. Incineration destroys harmful microorganisms and toxic substances often contained in biomedical waste. It is also the method for destroying recognizable human anatomical remains, reports environmental Health and Safety at the University of California. The disadvantage of this method is that it releases persistent pollutants to the air, including dioxin and toxic material such as mercury, reports the center for Environmental Studies at Virginia Commonwealth University. Medical waste incinerators are a major contributor of dioxin pollution to the environment.

The effect of air pollution by bio-medical waste incineration could be witnessed in one of the incidents where the putrid smell emanating from the biomedical waste piled up at the refusal collection point near Nehru Hospital had become a bane for PGI\(^1\) employees using the adjacent area for parking their vehicles. According to sources, not all the bags of waste collected from the hospital were being lifted as the hospital’s incinerator had developed a snag and was operating partially. During a visit to the scene, it was found hundreds of bags full of biomedical waste were lying inside the collection centre from where they were supposed to be taken to the incinerator set up at a distance in a desolate area causing intolerable stench in that area.

It was also noted that the ash generated by the incinerator contained mercury, arsenic, lead and cadmium all heavy metals harmful to the human body. Therefore the ash should be disposed of in an Engineered Land fill and should be chemically treated to prevent seepage of metal into the Earth causing Land and ground water pollution\(^2\).

### 2.3.2 Impact / effect of bio-medical waste on Water:

Pollution of water\(^3\) is a broad subject dealing with different types of pollutants entering the hydrological cycle. Surface flowing river water, underground water and vast sea water are included in a broad subject of water pollution. Out of them, pollution of drinking water is most important; as such pollution is directly connected with human

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health. Water being indispensible part of human body, the daily intake of water is of utmost important for all physiological activities. If such daily used drinking water is polluted, the health of human beings will be badly affected.

**Effects of Water Pollution:**

Water pollution has number of effects. The effects could be classified as *Effects on ecosystem, Effects on animal health* and *Effects on human health.*

**Effects on Ecosystem:**

The inorganic nutrient input, with the inflow of waste water, decomposition of organic wastes, waste treatment plant nutrients such as nitrates and phosphates takes place. This promotes the growth of oxygen consuming algae (algal bloom), especially the blue-green algae. The bio-medical waste, as discussed earlier forms leachates and helps to form algae blooms causing major effect on ecosystem. The growth of oxygen consuming algae, which deoxygenates water killing fish and other animals, is referred to as *eutrophication,* secondly, addition of mercury like components from bio-medical wastes to oxygen not sufficient to support life effects ecosystem badly, thirdly, addition of non-degradable broad-spectrum pesticides and germicides etc. used in Health care centers, which cause mass destruction of aquatic life results in degradation of ecosystem, fourthly, addition of various pathogens in water by bio-medical waste (blood, body fluids, anatomical waste, laboratory waste etc) destroys life by reducing oxygen and catching fire, destroying ecosystem.

**Effects on Animal Health:**

Effects on Animal Health could be from the chemical, biological and radioactive etc bio-medical waste present at large scale contribute death of aquatic and terrestrial animals, reduced reproduction rate, increased incidence of diseases, imbalances created in secondary food chains, Accumulation of bio accumulative and non-biodegradable pollutants (dioxins) in animal bodies, some organic chlorine pesticides (like DDT, BHC, Endrin) are known for bio accumulative and bio- magnifiable characters ultimately results in adverse effect on animal health.
**Effects on Human Health:**

Human Health effected by bio-medical waste with its factors consequentially such as increased incidence of tumors, ulcers due to nitrate pollution, increased incidence of skin disorders due to contact with pollutants, increased incidence of constipation, diarrhea and infections to intestine, dangerous effects on growing fetus in pregnant women, concentration of pollutants due to bio accumulative pesticides. Through secondary and tertiary food chain in case of non-vegetarians, Still births, abortions and birth of deformed children, 'Blue baby' disease caused by methane globinemia - which results in asphyxia (reduced O2 supply), reduced activity of immune system, loss of memory power and reduced mental sharpness, water borne diseases like jaundice, hepatitis, gastroenteritis will be more prevalent due to water pollution caused by bio-medical waste, reduced bone development and muscular development, Reduced male fertility and shifts in physiological cycles of human body.

According to Environmental Health and Safety at University of California, chlorine, quaternary ammonium and phenolic compounds can treat liquid or semi-liquid biomedical waste. However, this method brings environmental disadvantages when used in excess to treat bio-contaminated waste water. Quaternary ammonium compounds, or quats are hazardous to wildlife, especially fish and other aquatic creatures. Water pollution is a large set of adverse effects upon water bodies (lakes, rivers, oceans, groundwater) caused by human activities. Industrial waste water discharges a variety of pollutants like heavy metals, organic toxins, oils, nutrients, and solids. These discharges adversely effects plants, aquatic plants and animals, water bodies in toto.

**Effects on the Environment** can be viewed as The ‘EPA Fact Flash’ (The U.S Environmental Protection Agency) has stated that many substances in hazardous waste (which includes bio-medical waste) are not only mobile, but also persistent in waste may also climb up the food chain, affecting plants, animals and fish at the site of disposal or contaminated soil and then affecting other organisms that consume these food sources.

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1 Science daily (Sep 8th, 2009).
2.3.3 Impact / effect of bio medical waste on land:

There is enormous number of effects of land pollution. Land pollution has its own effects but more importantly it leads to other kinds of pollution such as water, air etc and hence needs to be regulated. It leads to a zillion diseases along with diseases transmitted by rodents and vector insects. Much of the pollution generated on land, however, is intentionally discharged or eventually flows into river systems leading to water pollution. Approximately eighty percent of the pollution that enters the marine environment also originates from land-based sources. Urban expansion of coastal areas has increased the amount of land-based pollution entering oceans and seas worldwide. Land-based pollution negatively affects water bodies and aquatic species in several ways and also leads to eutrophication. "Eutrophication is a condition in an aquatic ecosystem where high nutrient concentrations stimulate blooms of algae which disturb the functioning of marine ecosystems, by the creation of dead zones--areas of water that are too low in dissolved oxygen to sustain life."

Thus, pollution caused to land is unavoidable but it can be reduced to a great extent through proper treatment. Open dumping of biomedical waste is the greatest cause for land pollution. One of the methods used to treat Bio-Medical Waste is land filling but, it is also harmful to a limited extent. Soil pollution from biomedical waste is caused due to infectious waste, discarded medicines, chemicals used in treatment and ash and other waste like heavy metals etc generated during treatment processes. Heavy metals such as cadmium, lead, mercury, which are present in the medical waste, get absorbed by plants and can then enter the food chains. Large amount of trace nutrient elements and other elements including heavy metals in soil are harmful to crops, animals and human beings. Nitrates and phosphates present in leachates, from landfills, are also pollutants. Leachate containing concentrated heavy metals and or microbes, which are released from landfills, can lead to ground water and surface water pollution. Radioactive wastes generated from health care establishments can cause soil pollution. Cadavers, protective clothing, absorbent paper generated in the nuclear medicine imaging laboratory will also cause soil

1 Lakshman Guruswamy, 'INTERNATIONAL ENVIRONMENTAL LAW IN A NUTSHELL' 227, (1997)
2 Id.
3 Laura M. Schaefer, 'DEVELOPMENTS IN LAND-BASED POLLUTION IN 2004', 2004 Colo. J. Int'l Env'tl. L. & Pol'y 183
pollution. Therefore, reducing the waste and proper treatment before disposal on land are the only way to control the land pollution.1

There are many instances where the management of biomedical waste is neglected and as a result of it, environment and health has been greatly affected. The high fungi count of the hospital wastes dumpsites soil might be due to the fact that hospital waste is very rich in organic material, as reported by Jager and Ruden (1989). They also reported that fungi being heterotrophic organisms depends on the presence of organic material. Micrococcus leteus, Stapylococcus epidermidis, No. Sicca, M. roseus, B. Subtilis and B. Licheniformis that were isolated from the dumpsite soil were reported to be harmless but occasionally act as opportunistic pathogens from hospital wastes. The Trichothecium roseum that was isolated from the adjacent soil was a non pathogenic fungus which grows on wood, paper, fruits and vegetable as reported by Cattivelli (1990). Microsporum canis dermatitis in domestic animals (cat and dogs) which could transmit to humans as reported2. The high pH value of the dumpsite soil may be as a result of the ash been generated from open burning of the waste. These ashes could find their way to water bodies and soil resulting in water and land pollution as reported by Giroletti, and Lodola, (1993). Thus, study revealed that the unsecured hospital waste dumpsites might have adverse effects on its immediate environment as a result of the different disease causing pathogens are present in the waste.3

In a bizarre incident about Six Kerala State Lorries were seized in a Kutta Village, Kodagu District, in Karnataka State. A case was also registered against them under Sections 2694 and 2705 respectively under Indian Penal Code 1860. These Lorries carried some unwanted things and dumped near the village and returned back. It was regular act but nobody paid attention to it, as it was considered to be one of the common view of heaps of wastes in that village. Later, stray dogs and rag pickers started to scatter the waste and created obnoxious atmosphere. It had hazardous effect when children who played around such scatters fell ill due to infections and then it was recognized as

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1. Ibid.
4. Section 269 of IPC – 1860 – Negligent act likely to spread infection of disease dangerous to life.
5. Section 270 of IPC 1860 – Malignant act likely to spread infection of disease dangerous to life.
dumping of Bio-medical waste which was the root cause of such illness. And it was also revealed from the lorry drivers that they also carried similar wastes and dumped in Gundlupet, Chamarajanagar District, in the State of Karnataka\(^1\). This could be the best example of land pollution by bio-medical waste and also the study insists to strictly regulate the law to avoid such incidences in future.

### 2.3.4 Impact On Ecosystem, Underground Water, Bio Diversity (Animals And Plants):

The solid waste could be accumulated predominantly by hospital waste, household waste, animal by products, biodegradable waste, chemical waste etc. In a series of new studies, scientists have uncovered evidence suggesting that the soil in which solid waste is buried have hazardous impact on ground water because of deep fractures underground help contaminated water flow downward and reach water supplies too quickly for it to be purified. In such cases, underground water supplies can become contaminated\(^2\).

When waste without pretreatment transported outside the institution and it is dumped openly, pathogen can enter the atmosphere; the pathogens can find their way to drinking water, foodstuff, soil etc and or remain in the surrounding air and causes diseases in animals and human beings. Proper waste management practices can reduce this pollution to a large extent.

All biomedical wastes are finally disposed on land which is meant for. Even liquid effluent after treatment is spread on land hence pollution caused to land is inevitable. However, it can be minimized to large extent through proper treatment. Soil pollution from bio-medical waste is caused by infectious waste, discarded medicines, chemicals that are used in treatment such as cadmium, lead, mercury etc. These chemicals present in the waste will get absorbed by plants and therefore excessive amount of trace nutrient elements and other elements including heavy metals in soil are harmful to crops. These chemicals when exposed to animals and human beings, create serious health disasters. Emissions from incinerators and open burning are harmful gases

\(^1\) “Dumping of Bio –Medical Waste” STAR OF MYSORE, Page 1, Monday (December 18, 2006).
\(^2\) Science daily (Jan 4, 2001) Columbus, olio.
which cause cancer and respiratory diseases in animals and birds. Therefore, it can be analyzed that bio-medical waste can cause health hazard to animals and birds. Plastic waste can choke animals which scavenge on openly dumped waste. Injuries from sharps are common features affecting animals. Harmful chemicals such as dioxin and furans in the air and heavy metals in the soil can affect the reproductive health of animals and birds. It was also revealed in one of the studies that health of endangered species was affected due to open dumping of biomedical waste.

2.3.5 Impact / effect of bio-medical waste on Human Health:

Recently environment has captured worldwide attention. Unfortunately, quite some time medical community remained silent. Nevertheless, environment becomes a major concern to most non-medical professionals and general community, and forced the health care personnel to adopt the safety rules and guidelines. Many of the dangers or hazards associated with biomedical wastes are hidden. But it is necessary to unveil the hazards and reveal the consequences or effects of bio-medical waste on human health so that some kind of care or attention is paid towards the proper management of Bio-Medical Waste. The following are few commonly known effects:

1. Psychological Stress: Human organs can’t be disposed of as such due to aesthetic and religious reasons. It is observed that open disposal of human organs in general waste may create stress in the individual and community. Therefore human organs must be carried away and incinerated, II. Infections and Diseases: Improper disposal of human tissue or organs may become the ground for growth of infected organisms and may become the source of infection when a healthy person comes in contact with such tissue or organ. Biological agents, in particular microorganisms, may enter the human body in several routes-through the lung-inhalation, through the mouth-ingestion, by contact with the apparently unbroken skin and with mucus membranes by injection with hollow-bore needles and other sharps, through the conjunctivae, through the genitourinary track, and from animals (including arthropod bites and scratches).

Another important aspect of disease transmission is the agent load, i.e., enough of the infectious agent must be transmitted to the person who is exposed so that his immune

system cannot effectively protect him or her from the disease. The hazard classification would help the biomedical waste management to adapt different bio-safety or containment levels. HIV can be transmitted through being stuck by a needle or blood transfusion that contains the blood of an HIV-infected person\(^1\). However, the chance of contracting AIDS from a single needle stick, even if the needle does contain HIV-infected blood, has been estimated by the Centers for Disease Control to be only approximately 0.3%. The chances of getting infection to blood from an infected person are between 6% and 30%. The chances of not contracting the disease due to exposure are better if he or she receives prompt medical attention.

It is already established that infected needle puncture is associated with higher risk of transmission of infection particularly hepatitis B and C. Attending of patients without universal precaution could be dangerous to the healthcare workers. Clinical laboratory technicians and nurses are the most vulnerable group and have 3-5 times higher risk of hepatitis B than the general population. Similarly, waste handlers are also at the higher risk due to needle pricks and exposure to infected material. In another study, dealing with a health care setting, the Federal Centers for Disease Control has estimated that 12,000 health care workers whose jobs entailed exposure to blood became infected with hepatitis B each year, that 500-600 of them would be hospitalized as a result of that infection, and that 700-1,200 of those infected become carriers. Of the health care workers infected with hepatitis, about 250 would be expected die of hepatitis, cirrhosis of the liver or liver cancer. The hepatitis B virus (or “HIBV”) is more infectious as compared to HIV. Further, HIV normally does not survive for very long outside a living organism. Therefore, the chance of contracting AIDS from contact with medical waste in health care institutions is considered to be remote (\(ATRDR\ 1990\), \(III\).

**Tuberculosis:** Transmission of *mycobacterium tuberculosis* from a cadaver to an embalmer has been identified. *Mycobacterium tuberculosis* is also transmitted from medical waste to the waste workers where it was processed i.e., shredded, blown, compacted and finally deactivated. However, it has also been identified that equipment failure, insufficient employee and training failure to use respiratory protective equipment

\(^1\) See Smt. Vijaya V/s The Chairman and Managing Director, Singereni Collieries Company Ltd., AIR 2001 AP 502.
could be the contributing factors in transmission of the diseases, **IV. Respiratory Diseases:** Acute respiratory infections, *pneumonia, measles* are spread through moist droplets of an infected person while sneezes or coughs out into the air and another person breathe in. Vomits and droplets of infected patient may contaminate surface or article, if touched or inhaled in the form of dust by a healthy person it could cause the disease undoubtedly. Improper disposal of infected sputum may contaminate the dust that may be inhaled by a healthy person during sweeping or cleaning of the room. Organism start pathogenesis once reached to the respiratory tree, **V. Gastroenteritis:** Some infections such as *Cholera, Shigellosis, Salmonellosis, Bateraemia,* and *helminthes* are transmitted through feco-oral route when water gets contaminated with waste, **VI. Fungal infections:** *Athletes Foot* (tinea) is another common infectious disease that can be caught from walking or standing barefoot on the floors of public bathing areas where people infected with tinea have also been standing, **VII. Zoonoses:** Similarly animal waste can also transmit infections. Many diseases can be transmitted from slurry of animals, for example *anthrax, brucellosis, foot & mouth disease, leptospirosis, rabies, salmonella, E coli, Q-fever, Yersinia, giardiasis, streptococcus infections,* etc, **VIII. Injuries:** Injury causes damage to the surface or lining of body tissues. Injuries involving infectious materials, and is not always attributable to human error, occurs in the best-regulated health care institutions. Injuries are commonly caused by sharps, mainly due to needlesticks coming out of containers and piercing the skin. Not only can sharps puncture the skin, they can also allow disease-causing microorganisms to get into the blood and body. Reasons for needle prick are- recapping needle, handling needle during procedure, during waste disposal and reasons for cuts in health care institutions are procedures such as breaking the ampoules and vial, handling objects and broken glasses. Injuries are also associated with aspiration through pipettes, bite or scratch animal or acto-parasites in laboratories or waste management site spillages, and splashes. Physical injury may also occur if any chemical irritant is splashed or spilt onto the skin or eyes or breathed into the airways. Injuries, such as, burns is also common to health care workers.

Immediate first aid attention is needed to stop further damage to the eye, lung, or skin. It has been suggested that, workers should learn about ergonomic principles which if applied may improve their skills to handle sharps. Through proper handling incidence
of sharp injuries may reduce, IX. Dermatitis, conjunctivitis, Bronchitis: Cytotoxic drugs are used to treat cancer patients and can cause immediate harm when they come into contact with body. The cytotoxic substance can virtually ‘burn’ the area if comes into contact with, causing swelling, redness, pain or irritation and possibly ulceration. An allergic reaction such as asthma, rashes or itchy and watering eyes may also occur. Cytotoxic chemicals besides affecting local part may also cause systemic damage and can cause sterility and birth defects. Chemicals that which splashed on the worker would contaminated his/her skin or clothing he/she touches or eats. The lack of awareness and not using personal protective equipment further increase the risk of infection.

Bronchitis is the inflammation and irritation of the airways leading into the spasm or narrowing of bronchi. Breathing in certain chemicals may cause coughing and / or choking. Conjunctivitis is the inflammation and irritation of the membrane lining of the eye and eye-lids which might cause due to splashing of chemicals into the eyes or rubbing the eyes with hands that have been contaminated with cytotoxic chemicals in laboratories. In such cases immediate first aid attention is needed to stop further eye damage, IX. Genetic Mutations: Genetic mutations similar to cancer and happen when the characteristics of a cell are changed without the cell being killed. Low-level radioactive waste had not been linked directly to causing genetic mutations, but high-level radiation has (eg. Chernobyl, Hiroshima). Importantly any radioactive substance has the potential to damage the chemical makeup of the cells. This increases the risk of mutation and birth defects. Pregnant women dealing with cytotoxic, chemical or radioactive clinical and related wastes not only endanger their own cells but those of the developing baby in her womb. The fetus is at considerable risk because its cells are in developing stage and any small change in cell chemistry can have disastrous results. The effects can be severe deformations caused by Teratogens (some cytotoxic and other hazardous chemicals). There is also the possibility that the sex cells of the person (sperm in men and eggs in women) may be damaged to the point where they are unable to have children (Sterility), X. Cancer: Growth of abnormal cells that grow into masses called tumors. Some of these tumors continuously grow and can kill surrounding tissue or spread to other parts of the body. These tumors could be benign or malignant (cancer). Tobacco smoking, burning of Poly Vinyl Chloride (PVC), asbestos and high levels of
radiation all definitely cause cancer. There are certain conditions that speed up the
development of cancer. Any biomedical waste that causes cell damage can trigger the
development of cancer. Cytotoxic chemicals, radioactive wastes several other chemicals
have the potential to kill body cells and cause cancer growth. These sorts of waste are
called carcinogens and XI. Poisoning: Mercury is a toxic substance, which is discharged
into wastewater stream by dentists can cause poisoning on human exposure. Similarly,
many chemicals such as gluteraldehyde, formaldehyde, benzene, pharmaceutical drugs,
can cause poisoning1.

Health Hazards among Landfill Workers:

Medical waste poses great risk hepatitis B and HIV infection to the landfill
workers and rag pickers. This risk is mainly from needle-sticks or from infected blood or
blood-containing fluids being splashed or rubbed into open wounds, non-intact skin, or
mucous membranes. However, landfill workers are much lower at risks of getting
infected than health care workers do. The ATSDR study estimated that 200,000 refuse
workers nationwide in USA, medical waste injuries from discarded sharps can be
expected to cause only between 1 and 15 cases of hepatitis B and less than 1 case of HIV
infection per year.

Some of the other disease that could be transmitted through both biomedical
waste and ordinary household waste during land-filling include the acute respiratory
infection, bacterial conjunctivitis, chicken pox, and flu—all of which can be transmitted by
mucous membrane exposure, inhalation of airborne particles from soiled articles, or
inadvertent swallowing of particles after handling soiled articles. Bacterial infections are
less common communicable diseases that can potentially be transmitted through cuts or
abraded skin, following handling of contaminated articles.

With regard to impact of biomedical waste few reports\textsuperscript{1} are highlighted. There is strong epidemiological evidence from Canada, Japan and United States that the main concern of infectious medical waste is the transmission of HIV/AIDS virus and, more often, of hepatitis B or C virus through injuries caused by syringe needles contaminated by human blood. The group most at risk is medical care workers, especially nurses, followed by other hospital workers and by waste management operators outside the hospital. It is considered exceptional that victims include patients or the general public. One case has been reported in the United State of a hospital house keeper who developed \textit{Staphylococcal bacteraemia and endocarditis} after a needle injury. Unfortunately data from developing countries are scarce if non-existent.

Radioactive hospital wastes caused a notorious accident in a Brazilian city in 1989. There were fatal and other serious cases of irradiation by radioactive hospital waste in abandoned equipment that was scavenged from a dump. Recycling and reuse of medical waste such as disposable syringes, intravenous tubes and catheters, surgical gloves, blood and urine bags, soiled cotton and used bandages is rampant in our country, which not only threatens the spread of serious infections such as AIDS, tuberculosis, hepatitis and bacterial diseases but also undermines the drive to make treatment of patients safer through disposable products.

A research commissioned by the health department found the bio-medical waste management in Kashmir as primitive and highly hazardous for public health and environment. Dr Hassan Mir, Dr Syed Rumaiya Sajjad\textsuperscript{2} has addressed adverse effect of bio-medical waste on human health and environment.

It has been stated that the purpose of health care is to improve the health status of the population through identification of local health problems, factors pertaining to such problems, gap between need and provision, and attitudes as well as available resources to ensure better health condition for all. The Government of India, through the five year plans has expanded infrastructure and health services through Primary Health Centres and Sub-centres. However, the efficacy is still a question because of


\textsuperscript{2} State of health Volume 02, Issue 43 Tuesday, January 11, 2011 12:36.
understaffing, poor supply of medicines and equipment, and basic awareness about the concept of healthcare at all levels especially about the management of bio-medical waste. The bio-medical waste (potentially hazardous wastes from hospitals and clinics which have a pathogenic, chemical, explosive, or radioactive nature) management has been identified as one of the critical factors for determining the overall status of healthcare. Therefore, this study shows the symmetrical outline of threat of bio-medical waste throughout India on health and environment.

2.4 IMPACT OF BIO-MEDICAL WASTE AND ITS CONSEQUENCES WITH CASE LAWS

Since the beginning of this study chapter it has been elaborately discussed the various sources, classification, hazards and impact of bio-medical waste on environment. It is true that the facts and figures have no resultant force if the intervention of judiciary is in absentia. How far the country is working to fight or combat this problem could be analyzed only through the consequences with case laws that have really built confidence in the eyes of the public that our environment is safe and have hope in the judicial system that would take care of the State against environmental pollution and provide the pollution free environment for the present and future generation.

1. DR. B.L. WADEHRA V. UNION OF INDIA

The decision in the historic case law that has given the first ever directions in concern to hospital waste management and also has given strong foundation to build the regulation in the form of “Rules” to combat the hazardous effect of bio-medical waste on health and environment is Dr. B.L. Wadehra V. Union of India1 by Hon’ble Kuldip Singh and S.Sagir Ahmad JJ.

This case is also known as ‘Delhi garbage case’ as there was garbage dumps in the city of Delhi which was unattended by municipal authorities. Kuldip Singh, J has stated in the Order that “the historic city of Delhi the Capital of India is one of the most polluted cities in the world”. This has been quoted because of pollution that caused by

1 Dr. B.L. Wadehra v. Union of India (Delhi Garbage Case) AIR 1996 SC 2969, Per Hon’ble Kuldip Singh and S.Sagir Ahmad JJ.
untreated sewage and industrial waste throughout Delhi and it had resulted in obnoxious smell and unpleasant sight with open dumps all over the city. One of the main issues in this case was management and handling of Bio-Medical Waste in Delhi and this was very serious issue and the Court gave simultaneous direction to New Delhi Municipal Corporation to install incinerators for disposal of waste which were produced by the hospitals and to abide all the directions given regarding disposal of Bio-Medical Waste or else it would amount to penal provisions of law and also stated non-availability of funds, inadequacy or inefficiency of the staff, cannot be pleaded as ground for ‘non-performance of their statutory obligations’.

One of the major pollutions which were noticed relating to hospital wastes in which Hon’ble Kuldip Singh and S. Saghir Ahmad J J, have passed historical Orders. The Court had directed for the construction and installation of incinerators in all the hospitals / nursing homes, with 50 beds and above, under their administrative control. And also to install effective alternative disposal methods which ever was suitable. Similarly every private hospitals nursing homes were issued notices to make their own arrangements for the disposal of their garbage and hospital wastes and install incinerators. The Court also Ordered for the payment of suitable charges for the service rendered by municipalities in respect of collections, transportation and disposal of garbage and also observed that violation of any provision of law should be tried by Municipal Magistrates1.

This historic judgment of Supreme Court has been considered as first and foremost case law development in case of bio-medical waste management throughout India. This case is considered very important in the management of Bio-Medical Waste because it was decided by the Supreme Court before Bio-Medical Waste Rules 1998 came into existence. It later gave full support to formulate Rules on Bio-Medical Waste management.

And therefore, in 1998 under The Environment (Protection) Act, 1986, Rules were framed for Bio-medical waste management as the Bio-medical waste(Management and Handling) Rules, 1998 which have been passed by the Ministry of Environment and

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1 (Metropolitan Magistrates) under section 469 of the Delhi Act and Section 375 of the New Delhi Act for the trial of offence under these Acts).
Forest through a Gazette Notification, in exercise of the powers conferred by *Sections 6, 8 and 25 of the Environment (Protection) Act, 1986.*

In the above case, the judgement is much satisfactory because it led away long further to improve the quality of life and created awareness regarding importance of the health and environment by keeping the area clean and tidy. And it was also responsible for the bringing up of the new rule on the bio-medical waste management after the present case was decided. Thus, Bio-Medical Waste (Management and Handling) Rules 1998 was emerged and still playing a classic role even today.

2. **ALMITRA H. PATEL v. UNION OF INDIA**

The case which has suggested the importance of the management of waste that really makes the land mark decision by Hon’ble B.N. Kripal, M.B. Shah and D.P. MohapatraJJ. is most appreciable and evergreen judgment found in *Almitra h. Patel v. Union of India*.

Where in this case *Almitra Patel* of Bangalore filed a Writ Petition under Article 32 of the Constitution before the Supreme Court, seeking writs against the States and Principal Municipalities to implement ‘Cradle to grave’ MSW (Municipal Solid Waste) Management. As it was detected that garbage disposal was neglected area of urban development, the city was completely in the garbage as sewage was spewing and affected many due to obnoxious smell and stagnant water around causing health problems. The urban poor beard the immediate impact of the resulting unhygienic conditions, but few city dwellers escaped the periodic outbreaks of diseases that spread in unhealthy urban environments.

It was held that bio-medical waste and industrial wastes should not be mixed with municipal wastes and thus abide the MSW Rules of 2000. Accordingly, there must be separate procedures to be followed to collect, transport, dispose, recycle and reuse of municipal solid waste, bio-medical waste and industrial waste. Where as it has been scheduled under collection of (Municipal Solid Waste Management Rules 2000) wastes

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and compliance Criteria (iv) mentioning bio-medical waste and industrial wastes to be separately collected under specified rules for the purpose.

Thus, there were serious and effective directions given by the Supreme Court in this regard which are as follows:

- The Court on July 28, 1997 asked Municipal authorities to frame time bound schemes for the disposal of MSW in a scientific and hygienic manner seeking expert’s advice and to immediately take steps to use insecticides like DDT and BHC on garbage heaps and dump sites.

- In January 1998, the Supreme Court constituted an expert committee to examine all aspects of MSW management in class I cities (having a population over one lakh) and also to review municipal laws, formulate standards and regulations and suggesting suitable practices and provide technologies for the sorting, collection, transport, disposal, recycling and reuse of MSW in an eco-friendly manner.

- The Court on July 20, 1998, the Supreme Court considered the interim report of the committee and approved its proposal to conduct regional workshops to sensitize and to inform municipal officials about good MSW disposal practices.

- The Court on April 12, 1999, the court appreciated the work by the committee and directed the states to respond to the recommendations made in the final report.

- The Court on August 13, 1999, the Supreme Court noted that the Central Pollution Control Board had formulated draft MSW (Management and Handling) Rules, which were notified in the following month and invited suggestions and objections.

- The Court on February 15, 2000 the court issued directions and specified to Delhi Municipal authorities and Ordered to identify landfills and composting sites and also to recover fines for littering and lastly, to appoint magistrates to try offences in relation to littering, public nuisance and public health.

Accordingly, this is one of the most appreciated case laws which also showed that judiciary does play a major part to control and abate pollution. Such precedents should not be eventually ignored but rather be applied in every situation where there are instances of improper Bio-Medical Waste management.
3. MEDWIN HOSPITAL V. STATE OF A.P

In Medwin Hospital v. State of A.P\[1\] Hon’ble B. Sundershan Reddy J. has given the implementable Orders and has set a new confidence in the judiciary through this case law regarding bio-medical waste management and equally has recognized the power of administrative bodies regarding action taken for violating of provisions of law in case of pollution of water through disposal of hospital waste.

In the above case the alleged hospital was operating with 350 bed strength and carried its business in the field of Cardiology, Blood Bank, Dialysis, Gynecology, Radiology etc.

The authorities in order to maintain such a huge hospital drew water from Municipal Water Sources / Bore well in a large quantity and generated lots of waste water. The waste water without pre-treatment was discharged into sewer line of Municipal drainage system and it was alleged to cause contamination of the river Musi.

In addition to the waste water the hospital was alleged for generating large quantity of solid waste. The solid waste so produced were not managed properly and disposed of. The solid waste, especially infectious solid waste, the Amputed limbs, other operated materials and other infectious solid wastes generated from the Hospital were disposed on an open yard Autonagar, near Vanasthalipuram, Hyderabad which is located within the basin area of river Musi.

The above matter was noticed by the A.P. Pollution Control Board and filed complaint under Section 49\[2\] of Water Act, for prosecution under 43\[3\] and 44\[4\] for violation of Section 24\[1\], 25\[2\] and 26\[3\] of the said Act.

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1 Medwin Hospital v. State of A.P. CRL. P.No. 475 of 1998, per Hon’ble B. Sundershan Reddy J.
2 COGNIZANCE OF OFFENCES-Section 49, where it states that no court shall take cognizance of any offence under this Act except on a complaint made by –(a) a Board or any officer authorized in this behalf by it, The Water (Prevention and Control of Pollution) Act, 1974.
3 PENALTY FOR CONTRAVENTION OF PROVISIONS OF SECTION 24- Section 43, where it states that whoever contravenes the provision of section 24 shall be punishable with imprisonment for a term which shall not be less than one year and six months but which may extend to six years and with fine, The Water (Prevention and Control of Pollution) Act, 1974.
4 PENALTY FOR CONTRAVENTION OF SECTION 25 OR SECTIONS 26-Section 44 - where it states that whoever contravenes the provisions of section 25 or of section 26 shall be punishable with imprisonment for a term which shall not be ten than one year and six months but which may extend to six years and with fines, The Water (Prevention and Control of Pollution) Act, 1974.
The A.P. Pollution Control Board also stated that the Government of Andhra Pradesh prescribed standards for safe disposal of wastes generated by the hospital/health care establishments under the rules framed in A.P. Water Rules, 1976. It also further mentioned that:

1. Sub-clause (j) of Rule 2 of the said Rules defined ‘Health care establishments’ which means and include all the Hospitals, Nursing Homes, Diagnostic centers and Laboratories irrespective of size / capacity bed /strengths.

2. Rule 36 of the said Rules state that the all Health Care establishments are required to follow the regulatory and promotional guidelines as mentioned in Schedule V of the said Rules.

3. Rule 37 mandates that all Health Care establishments having bed strength of 25 or more shall have to take consent for establishment of the bio-medical waste disposal system and operation (handling) of the same and then discharge the waste into the sewer, stream or well or on land under Section 25 of the Act.

The Board urged that inspite of having the above mentioned guidelines and statutory framework, the hospital was allegedly discharged bio-medical waste indiscriminately into the municipal sewer without pretreatment and was allegedly responsible for the contamination of river Musi.

Therefore, the complaint by the Board stating the feature to comply with the statutory requirement and feature to obtain valid consent and commission by act of discharging, polluting, noxious, poisonous matter into the water and lastly, the omission to have valid consent are all punishable under the law.

The Court took cognizance of the facts and held that hospital was liable under the Act.

1. PROHIBITION ON USE OF STREAM OR WELL FOR DISPOSAL OF POLLUTING MATTER, ETC-Section 24, The Water (Prevention and Control of Pollution) Act, 1974.
3. PREVENTION REGARDING EXISTING DISCHARGE OF SEWAGE OR TRADE EFFLUENT-Section 26, The Water (Prevention and Control of Pollution) Act, 1974.)
After analyzing the case law it could be stated that, now bio-medical waste rules 1998 has taken all the responsibility regarding bio-medical waste management in all health care establishments and it has strong provisions of law that indicates care from the generation of waste to final disposal. The rules also had laid down the standards for treatment and disposal of bio-medical wastes (Schedule V Rule 5 and Schedule I). The Pollution Control Board has taken all the reasonable care to implement the laws very seriously and if there are any kinds of non-adherence to the provisions of Bio-Medical Waste Rules then, the Pollution Control Board can take any action directly under Bio-Medical Waste Rules regarding violation of any Rule under the same.

4. C.S. PRAKASH V. THE HUDA

This is also one of the land mark judgment given by the Hon’ble Chief Justice Sri. S. B. Sinha and V.V.S RAO J. in C.S. Prakash v. The Huda1 regarding the question relating to hospital establishments, proper waste disposal facilities and impact on health and environment.

The brief facts of the case

According to the facts of the case the petitioners are the residents of Durgabai Deshmukh colony, which is a residential area, situated beside Osmania University Campus. The respondents have made constructions on the residential plot for the purpose of running a corporate hospital. The petitioners contended that the big corporate hospital should not be given permission to be constructed and operated in the middle of residential locality and it’s not legal. The grievance of the petitioners is that the construction of hospital was creating nuisance in the locality in as much the roads in the colony are not wide enough to bear the traffic load and proper disposal of bio-medical waste was to be taken care of.

In this case the judgment was clearly and elaborately stated that the question of hospital establishments was permissible in residential areas because it cannot be outside the municipal areas as the hospitals should be helpful to the patients at the nearest and it could be constructed in a residential area in terms of Regulations 6.1.2 of the 1981 Zoning Regulations and Appendix-C made in terms of the provisions of 1955 Act. But

1 C.S. Prakash v. The HUDA Writ Petition No. 5319 OF 2001, per Hon’ble S.B. Sinha CJ & V.V.S Rao J.
after the establishment of the hospitals the Court stated that, the competent authority should take care of the proper disposal of bio-medical wastages without committing inconvenience to the people in and around because protection of ecology and health of the populace would come under the purview of Article 21 of the Constitution of India. And the Court stated that the A.P. Pollution Control Board must, therefore, strictly apply the laws governing the field, including the rules, regulations, and norms issued by it as by the Central Pollution Control Board in this behalf and also stated that the health care establishments must comply with the provisions of Bio-Medical Waste (Management and Handling) Rules, 1998 for proper disposal of the medical wastes.

In the above case the Court has given a sensible judgment regarding the health care establishment that it should be allowed to operate within the social vicinity. It is a very appropriate consideration of the Court as emergency could occur unexpectedly following attention of intensive care and at that time nearby hospital shall be “boon” than rather nuisance. The Court has rightly observed that clean and hygienic environment in an around health care establishment is a predominant feature of hospital management and added special reference to bio-medical waste management Rules for proper disposal of the bio-medical wastes. And finally the Court required the waste rules to be completely followed by all the health care establishments in this regard.

5. JYOTISH MEMORIAL HOSPITAL v. STATE OF ASSAM

The hospital management and its working was identified as irregular and illegal in Jyotish Memorial Hospital. v. State of Assam and this case was decided by Amitava Roy, J.

In this case, the petitioner being a company established under Companies Act 1956 had Managing Director with the objectives being to establish, acquire, maintain, and run and to carry on profession and business of health care, diagnostic centre, hospitals etc. The petitioners accordingly constructed hospital / nursing home at Seujpur and applied for its registration under the Assam Health Establishment Act 1993 and also applied for a ‘No Objection Certificate’ from the Pollution Control Board, Assam. In the

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meantime there was interference of the rowdy elements into the hospital and FIR was lodged by the petitioner hospital and as a result of it the Deputy Commissioner held the enquiry and inspection through the Magistrate and an Order was issued to close down the hospital.

_The observation and the conclusions at the close of the enquiry as contained in the report were extracted herein-below._

There was no hospital in the name and style of Jyotish Memorial Hospital, Seujpur, Dibrugarh. They have changed the name as ‘Upasana Hospital’ and running the nursing home without any license.

1. The nursing home had not appointed any Doctor as per the Rules. No formal appointment letter had been issued to any of the staff as well.

2. It was observed that there was no Radiologist in the nursing home.

3. The nursing home authority had not appointed any full time doctor.

4. The X-Ray machine was found out of order.

And from all these observations from the content of the report the Court upheld the decision of the District Magistrate, Dibrugarh, and directed the closure of the petitioner hospital.

This case law indicates that the judiciary is playing an important role in protecting health and environment. The court has given sustainable decision by directing the closure of the hospital, as the hospital showed incomplete establishment in every sense and such working of health care establishments are always considered to be dangerous to the society.

6. **THE CHEERANS MAYURA INDUSTRIES V. KERALA STATE OF POLLUTION CONTROL BOARD**

_The Cheerans Mayura Industries v. Kerala State of Pollution Control Board_¹ is one of the illustrative case law decided by Antony Dominic, J. of High Court of Kerala at

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¹ The Cheerans Mayura Industries v. Kerala State Of Pollution Control Board, Per Antony Dominic, J WP (C). No. 16336 of 2010.
Ernakulam. This case exclusively deals with the comparison of Bio-medical waste Rules 1998 regarding standard of emission that has notified under the law pertaining to incinerators.

In the present case, the petitioner *M/s. Cheerans Mayura Industries* was engaged in the manufacture, and installation of incinerators operated using coconut shell as its fuel. And therefore the petitioner applied for issuance of approval certificate from the Kerala State Pollution Control Board. The Board after a long procedure issued the same. After the certification, the company installed incinerators at various places. And meanwhile the Board issued an order of cancellation of the certificate of approval of consultant on the condition that the incinerators did not confirm to the standards and guidelines prescribed by the Ministry of Environment and Forest and the Central Pollution Control Board and also stated that the show cause notice was issued in that regard it was not complied by the petitioners.

The petitioner appealed the Appellate Authority stating that the certificate was issued for the period of 3 years from 07-02-2004 to 06-02-2007 and in between suddenly issued Order of cancellation on 06-03-2006 without any notice issued. Whereas the Court held that the issue in question was the use of coconut shall as a fuel and whether it could be permissible? Secondly, whether it met the standards of the Central Pollution Control Board? These questions had much significance while deciding this case because it has the direct implication ‘on polluting air by incinerators used for the disposal of bio-medical wastes using coconut shell as the fuel’.

*The Bio-medical wastes Rules 1998 Schedule 5 has stated the emission limits and has pointed out 5 notes that are mandatory for the installation of incinerators which are as follows:*

1. Incinerators should have suitably designed pollution control devices installed / retrofitted.
2. Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants.
3. Chlorinated plastics shall not be incinerated.
4. Toxic metals in incineration ash shall be limited within the regulatory quantities as defined under the Hazardous Waste (Management and Handling) Rules, 1989

5. Only low sulphur fuel like L.D.O. / L.S.H.S / Diesel shall be used as fuel in the incinerator.

In the present case, the coconut shell was considered as an organic material and a low sulphur solid fuel by the court. It also observed that, coconut shell as a fuel shell come within the purview of bio-medical waste rules 1998 (Schedule 5). Therefore, the court allowed the petitioner to use coconut shell as solid fuel to the incinerator.

This case can be taken as good precedent with regard to bio-medical waste management as the court has taken all the necessary care while giving impressive decision by taking the existing rule into consideration in order to protect the health and environment.

7. **M. C. MEHTA v. STATE OF ORISSA**

In *M. C. Mehta v. State Of Orissa* case Pasayat, J. has given memorable judgment which highlights the essential factor that is very important in order to protect the health and environment from pollution caused by the Municipal and Biomedical waste.

The facts leading to the case were that the petitioner came to visit the thousand year old Silver City, Cuttack and he saw that there was a horrible pollution of water in the city. The petitioner a practicing advocate of the Supreme Court and General Secretary of the Indian Council for Enviro Legal Action, a registered voluntary organization, filed the writ petition seeking for a Writ of Mandamus to protect the health of thousands of innocent people living in Cuttack and adjacent areas who were suffering from pollution being caused by the Municipal Committee, Cuttack and the S.C.B. Medical College Hospital, Cuttack, alleging violation of not only Article 21 of the Constitution of India but also, the National Health Policy, the Environment Act and the Water Act.

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1 AIR 1992 Ori 225, 226, 231, 232
This case has direct influence on control of pollution and action taken by the judiciary to protect health and environment. This case illustrates the ill-effects of water pollution by hospital wastes in Cuttack.

The Court took the cognizance of the issue seriously and held that the hospital authorities should install waste water treatment facility so that no polluted water would cause hazardous health and environmental pollution.

The court has given healthy directions regarding installation of waste water treatment plant in the present case. It is also significant to note that, court has recognized the importance of historic places and the cleanliness in such place was expected to be maintained in a special manner. This was taken seriously because visitors from different parts of the world would visit and unpleasant, obnoxious smell scatters etc. all would cause inconvenience to the visitors. This particular case law is quite necessary to note in the instant study because the present research study is conducted in Mysore, State of Karnataka and which is one of the world famous historical places. This city has to be taken much care and implement such orders to similar situation if arise.

8. SMT. M.VIJAYA v. THE CHAIRMAN AND MANAGING DIRECTOR, SINGARENI COLLIERIES COMPANY LTD.

Smt.M.Vijaya v. The Chairman and Managing Director, Singareni Collieries Company Ltd\(^1\) case has tremendous impact on the society because it has clearly stated that any mere negligence in concerned to health care aspects including bio medical waste management has adverse effect on the social, economical, psychological, mental and cultural behavior of human status and this case was decided by the Judges: S.B.Sinha,C.J, B.Subhashan Reddy, Dr.Motilal B.Naik, Bilal Nazki and V.V.S.Rao very effectively.

Smt. M. Vijaya is the petitioner with three children and her husband was working as Pump Operator in the Respondent Company (SCCL) since seventeen years. The petitioner underwent a family planning operation in Singareni Maternity Hospital where after she started suffering from abdominal pain. After investigation and scanning, it was diagnosed as *Chronic Cervicitis* and she was advised to undergo an operation for removal

\(^{1}\) Smt.M.Vijaya v. The Chairman And Managing Director, Singareni Collieries Company Ltd, AIR 2001 Andra Pradesh 502.
of her uterus. She was again admitted to the same Hospital and for the Hysterectomy
operation where a unit of blood was immediately required which was donated by her
brother Pettam Lakshmirajam. After fifteen days thereafter she started suffering from
fever and approached to the hospital, but fever had not receded. Again she got herself
admitted to other Private hospital wherefrom she was discharged after treatment. She
again visited another private hospital with the same complaint where after conducting
certain test she was declared to be HIV-positive patient. The test in her husband was
resulted in HIV-negative. She again went to Singareni Area Hospital and doctor
confirmed the disease. She being vexed with conduct of the medical staff and officers
SCCL hospital, came to the Nizams Institute of Medical Sciences (NIMS), Hyderabad
where after conducting certain tests she was informed to be a HIV-positive patient. She
got to Madras General Hospital wherein again the disease was confirmed. The
petitioner went to Fair Pharmacy Hospital in Ernakulum, Kerala State Ayurvedic
treatment. They conducted HIV test on both to her and husband and also to her brother,
the donor of the blood. Then it was revealed that her brother was a HIV-positive patient.
It was alleged that before transfusion of the blood from her brother, no care was taken to
conduct the relevant and necessary blood tests and because of the negligence on the part
of the hospital authorities, she was infected with the disease. The real cause of the
spreading of infection and its effects were finally detected and realized that disposable
needles / syringes were not used and medical wastes were not properly management
according to law. In this case the most difficult situation which went unsolved and
probably cannot be solved was the mental status of the petitioner who came to know the
infection spread within her for no fault of hers and physical sufferance, reaction of
husband, children, family members and friends.

In the instant case many issues emerged as it was not only looked as a case law
but also as an example to the society that any negligence of handling bio medical waste
and the negligence of medical and paramedical staff causes hazardous effect on the
health and environment. Besides, it would also violate right to life and also issue relating
to degrading one’s dignity and reputation in the society.

In this case the court suggested the remedy to the victim and clearly specified
reasonable amount of compensation of Rs.1 Lakh to be given to the petitioner due to the
negligence on the part of the medical and paramedical staff of the hospital of the company in conducting tests on the victim at the appropriate stages\(^1\). The Court has given certain directions to the government\(^2\) and it has been stated that all the government hospitals should use only disposable needles while administering injections and registered medical practitioners should be compelled to use only disposable syringes\(^3\). Similarly, it has been clearly stated that bio-medical waste collected from hospitals and nursing homes should be properly destroyed or disposed of\(^4\). The court has emphasized that there should be compensatory mechanism to deal with the AIDS in case of negligence on the part of the blood banks/hospitals by way of free facilities and free access to State funded health institutions\(^5\) and it has been also stated that there should be strict vigilance on licensed blood banks with reference to pre-blood transfusion testing for HIV+ and there should be effective educational and training programmes for those who manage the blood banks\(^6\). And finally, it has been stated that the hospitals and nursing homes should be directed to dispose of their bio-medical waste in terms of Bio-Medical Waste (Management and Handling) Rules 1998 and they shall strictly comply with the norms specified therein and such hospitals shall be directed to obtain the necessary authorization for disposal of the waste from the Pollution Control Board\(^7\).

In the instant case law the court has clearly dealt with each facts of the case and also came across the mental and physical agony and awarded compensation. But whether mere sum of Rs. One Lakh would really solve the problem is a million dollar question! When the health of a person cannot be restored through the compensation then, what is the use of such compensation? The real emphasis lies in the bio-medical waste management and proper care to be taken by medical and paramedical staff for their services. The court has failed to justify the issue in this case regarding valuable health of an innocent person and required mandatory ‘duty of care’ of the hospital authorities while giving the ultimate decision.

\(^{1}\) AIR 2001 Andhra Pradesh 502 at Para 67 of the Judgment.
\(^{2}\) Ibid at Para 68 of the Judgment.
\(^{3}\) Ibid at Para 68(2) of the Judgment.
\(^{4}\) Ibid at Para 68(3) of the Judgment.
\(^{5}\) Ibid at Para 68(8) of the Judgment.
\(^{6}\) Ibid at Para 68(11) of the Judgment.
\(^{7}\) Ibid at Para 68(17) of the Judgment.
The court would have gone a bit further to punish the hospital authorities by the *Order of Closure* and that would have been the severe punishment to all hospital personnel. This would have created consciousness and realization in them where ever they joined as medical or paramedical staffs that their primary duty would be ‘*duty of care*’ forever. And this would have also been the dare example to all the health care establishment throughout the country.

### 2.5 IMPACT OF BIO-MEDICAL WASTE AND A BRIEF NOTE ON FEW CASE STUDIES.

A case study is important in the present context because the very essence of the subject (Bio-Medical Waste) could be noted through various studies conducted and analyzed by different persons on the same subject-matter and its effect, management, influence, impact, working strategy, implementability, result of the subject matter, approaches of the directly influenced persons and public at large and many more direct and indirect issues could be clearly understood.

1. This case study\(^1\) has aimed at to recognize the existing practice of biomedical solid waste handling and disposal methods adopted by the health care units and to provide suggestions for improvement. The investigation revealed that most of the hospitals and nursing homes were devoid of implementation of biomedical waste disposal. This study was conducted in the Guwahati city area with the objective to look at the status of biomedical solid waste disposal in the hospital and nursing homes.

   The study was conducted with very systematic manner with questionnaire survey to provider of medical services, handling and disposing medical waste handlers, hospital management authorities on various issues like management of biomedical wastes etc.

   The discussion and recommendation of the present study is as follows:

   1. The study survey was conducted on 58 hospitals and nursing homes in Guwahati city and the study covered these health care establishment. This study gave an insight

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regarding the different biomedical solid waste disposal practices adopted by the hospitals and nursing homes in Guwahati city.

2. Out of 58 hospitals surveyed, 5 were under Government sector, 52 were under private sector and one was a public sector hospital. While only 37 nursing homes had registered under State Government Health Regulation Act, the rest of private health units were yet to be registered. This showed laxity on the part of concerned authority, which could hamper the effective implementation of the biomedical waste disposal rules. This would adversely affect the economy of the state too as a result of loss of revenue.

3. The segregation and collection of solid waste was done daily or within 48 hours of generation in all the hospitals and nursing homes which were usually collected manually, while the 38 units used close containers, 18 units used the open container for disposal of their solid waste. The remaining 2 units used both open and a closed container. The use of open container and manual collection system should be discouraged and stopped so as to avoid spreading of infection keeping in view of the health of waste collectors.

4. Whereas the segregation of hospital solid waste is concerned it was recorded practice in 39 (67.24%) of the total health units surveyed, while the rest of 19 (32.76%) units responded negatively. Among 39 units only 11 units used the colour coded bags. This showed non-adherence to standard norms as prescribed by the Bio-Medical Waste Management rule regarding the use of specific color coded container for specific type of wastes\(^1\).

5. Out of 58 health units studied, 14 followed the process of chemical disinfections and 5 units followed autoclaving method for sterilization of their infectious (e.g., bags, cotton, gloves, bandage etc.) and sharp (e.g., needle, blade etc.) solid wastes. Rest of the Units did not have any systematic record of the method of sterilization.

6. In case of incinerator that which is used to burn biomedical waste is concerned, it has been recorded that only 16 hospitals and nursing homes had declared to have this

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facility. Whereas 9 units disposed the ash generated by the incinerator into municipal
dustbins, 7 units followed the procedure of sanitary land filling. Out of 16
incinerators, 9 units had double chambered. The other 7 units had the single
chambered incinerator, which is not recommended in view of improper combustion
producing harmful gas.

7. For disposal of general, office and kitchen solid waste 44 units used the open burning
while 10 units dumped it into municipal dustbin, 3 units used deep burial and one unit
used landfill as the method of disposal.

8. For disposal of sharp wastes, 19 units used shredding, each of 9 units used
incineration, open burning and deep burial while the 10 units disposed in municipal
dustbin.

9. For disposal of pathological and infectious solid wastes, 15 units disposed them into
municipal dustbins, 9 units used incineration and 5 units used deep burial method.
The rest of the units adopted open burning as the method of disposal of pathological
or infectious waste. This is considered to be unhygienic and unscientific.

10. The study recommended registration of health establishments should be made
compulsory and effective under the state legislation for effective implementation of

11. The study suggested segregation of wastes and its disposal should be more effective
to prevent the spreading of infections.

Finally, the study reveals the loopholes in the effective implementation of the

Therefore this case study has revealed that Bio-Medical Waste (Rules) 1998 has
to be more effectively implemented in our country. From the generation to disposal, a
systematic methodology is still lagging behind which was noted in the study of Guwahati
city\textsuperscript{1} and it represents the state of poor implementation across the country as an example.
Thus, the impact on health and environment of Bio-Medical Waste is highlighted through

\textsuperscript{1} For detail information See Poll res. 27(2):335-338, Enviromedia, (2008).
this case studies directly and indirectly that which is really creating awareness among implementers, planners, various committees, lawyers, general public and so on.

2. In this case study a waste audit was initiated to assess the existing biomedical waste management system under the lights of the provisions made in Biomedical Waste (Management and Handling) Rules in 1998 in an Indian public hospital. The amount of infectious and non-infectious waste generated was quantitively estimated in different sectors. The waste generation rate ranged between 0.0626 and 0.0813 kg bed/day. It was estimated that annually about 78 tons of biomedical solid waste and 6935 L of biomedical liquid waste were generated. The characterization of liquid waste revealed that the physico-chemical parameters are well below the permissible limits. The general waste from hospital includes food waste (30-32%), paper (15-17%), plastic (26-29%), yard waste (16-18%), glass (5-8%) and metals (1.3-1.7%). During the study, it was observed that most of the wastes were collected in mixed form and disposed of along with non-infectious wastes. The shortcomings of the existing waste management system were identified through the systematic study.

The present case study used appropriate material and methods which are as follows:

1. The waste audit was carried out in three distinct phases at the study area. In the first phase, initial walkthrough was conducted to various departments to identify the types of waste generated and records of wards, operation theatres and other available data were collected. The waste generated from various sectors in the study area was quantified. The key staff of each ward/laboratory/department was explained about the nature of assistance that was needed to quantify the wastes during the study period. The plastic bags were then distributed to collect the waste generated from each area. On the next day morning the bags were quantified before disposal.

2. The second phase was the assessment of the existing waste management practices in terms of segregation, collection, transportation, treatment and disposal of waste. Observations were conducted during wastes handling process to assess its compliance
with standard legal norms and procedures as per the Biomedical Waste (Management and Handling (Rules 1998 (MOEF, 1998).

3. In the third phase, the model ward and laboratory were chosen and the training was imparted to the staff of that ward area to set up a pilot waste management system. The composition of non-hazardous wastes was determined in order to evaluate the possible waste minimization options.

Finally, a written waste management plan was prepared with cost saving potential to overcome the shortcomings in the existing waste management system.

Assessment of existing waste management practices:

Observations were made during waste handling process and questions were asked to the staff in charge regarding the care taken in handling wastes. It was observed that most of the wastes were collected in mixed form. The poor awareness was shown by the health care workers while handling wastes. At the study area, the waste was partially segregated, according to its characteristics, at the point of generation mainly from patient care areas. It was noted that while handling some waste, handlers were not using their protective equipment.

The collected biomedical waste in a day was stored in a temporary storage area before collected by corporation vehicle for disposal in dumpsite. The trolleys were used to collect waste from patient care areas and for off-site transportation vans were used to transport the waste to disposal site. The treatment facilities available on-site were autoclaving and laundry. Autoclaving was used to sterilize waste items, such as aprons, gloves, bed linings and soiled clothes. Needle cutters were used to mutilate the needles and sodium hypochlorite solution containers were used to chemically disinfect the sharp items before disposal. Deed burial is the only option used to dispose the biomedical waste generated from the hospital. The existing wastes management system implemented in the hospital was far from the satisfactory and the objectives laid down by the hospital were scarcely achieved.

In the Proposed waste management plan the objective of the proposed waste management plan was to reduce the amount of infectious waste by segregating it at the
point of generation from the general waste and handling infectious waste to a common treatment facility for its final treatment and disposal. The proposed plan addresses the various components of waste management. The components are source segregation, waste collection, and temporary storage, and transportation, waste treatment and disposal, waste minimization options, health and safety measures, manpower required, infrastructure required, roles and responsibilities, maintenance of records, accident reporting and training and the study was concluded by stating that in general, biomedical waste management is no extremely based on human factor. But it is also strongly influenced by economic conditions of the hospital. This study identified the solid and liquid biomedical waste generation rate as 0.0747 kg/patient/day and 0.137 L/patient respectively. In this study, it was seen that hazardous wastes collected were stored and transported together with non-hazardous wastes. The shortcomings in the existing waste management system were identified. The waste management system was proposed to address all the issues related to waste handling and management. Handling hazardous wastes to a common treatment facility was considered to be more safe and appropriate treatment option.

Therefore after observing this case study it could be noted that one of the public hospitals in India has been identified to have very poor management of biomedical waste. It is equally important to mention that public hospitals are more frequently visited by patients than private hospitals. Hence, it is highly important to management biomedical wastes in such large hospitals. If this performance is shown in future it would really be very pathetic condition of the general public as its adverse effect would be on directly upon health and environment.

This is one of the case studies\textsuperscript{1} that have given satisfactory result in maintaining upto date records and good management of biomedical waste in the present context. It’s also appreciable to note such institutions which has respected and adhered to the law of the land in matter concerned to Management of biomedical waste (Bio-medical waste Rules 1998).

\textsuperscript{1} BIOMEDICAL SOLID WASTE MANAGEMENT IN AN INDIAN HOSPITAL: A CASE STUDY Gayathri v. Patil-Institute of Pharmacy, Bundelkand University, Indain 284, 128, India. Kamala Pokhrel-Hospital Administration, KLE Society’s JN Medical College, Belgaum 590 010, India. www.Sciencedirect.com.
Looking into the existing scenario of biomedical waste management in the country it was thought to undertake a study to: (i) assess the human factor in handling and treatment of clinical waste, i.e., to study the existing modus operandi and its compliance with the Standard Procedures of the Biomedical Waste Management Rules as per EPA 1986 and (ii) quantitatively determine the amount of non-infectious and infectious waste in various blocks of a recently built, multi-specialty, high-technology hospital known for its most advanced diagnostic and surgical specialties. The study lasted a period of 3 months.

Hospital study center profile The KLE Society’s 1000-bed Hospital and Medical Research Center, Belgaum, that has all basic specialties including General Medicine, General Surgery, Orthopedics, ENT, Obstetrics & Gynecology, Ophthalmology, Pediatrics and Psychiatry. In addition, this hospital offers super-specialty services in Cardiology, Cardiovascular and Thoracic Surgery, Urology, Nephrology, Neurology, Neuro-Surgery, Laparoscopic Surgery, Pediatric Surgery, Neonatology and Gastroenterology. These clinical services are comprehensively supported by diagnostic and support facilities like CT Scan, _C_ Arm with Image Intensifier 800 MA, X-ray machine with Image Intensifier, 500 MA mobile X-ray, various endoscopes, Ultrasoundography, Gamma Camera for thyroid, brain, bone and others. The multi-specialty teaching hospital is claimed to be meticulously built, planned, painstakingly designed using modern scientific knowledge-based technology and equipped by its young and dynamic Chairman, Shri. G.V. Patil, K. Pokhrel and Prabhakar Kore at a cost of nearly 100 crores (220 million USD), and is attached to Jawaharlal Nehru Medical College. It has recently collaborated with Illinois University Chicago and Sunderland University UK as part of an exchange programme in the fields of Medical and Pharmaceutical Education (KLES Hospital & Medical Research Center, 2004).

The objectives of this study were: (i) to assess the waste handling and treatment system of hospital bio-medical solid waste and its mandatory compliance with Regulatory Notifications for 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 and (ii) to quantitatively estimate the amount of non-
infectious and infectious waste generated in different wards/sections. During the study, it was observed that: (i) the personnel working under the occupier (who has control over the institution to take all steps to ensure biomedical waste is handled without any adverse effects to human health and the environment) were trained to take adequate precautionary measures in handling these bio-hazardous waste materials, (ii) the process of segregation, collection, transport, storage and final disposal of infectious waste was done in compliance with the Standard Procedures, (iii) the final disposal was by incineration in accordance to EPA Rules 1998, (iv) the non-infectious waste was collected separately in different containers and treated as general waste, and (v) on an average about 520 kg of non-infectious 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). This hospital also extends its facility to the neighboring clinics and hospitals by treating their produced waste for incineration.

At the study center, the management of waste was conducted as follows:

The case study was assessed of operating procedures and a general survey of the operating procedures practiced in handling and treatment of solid waste was performed to assess its compliance with Standard Legal Norms and Procedures as per the Bio-Medical Waste Management Rules 1998, next Quantitative determination of waste was done as the supporting staff of each ward/laboratory/department was briefed over the nature of assistance and support. The waste was segregated separately, according to its characteristics, at the point of generation, mainly from the patient care areas. The hospital used color-coded, high-density polyethylene bags for easy identification and segregation of bio-medical solid waste. Non-infectious and domestic type of waste was collected in black polyethylene bags, placed in bins while the infectious wastes was collected in red, yellow and blue color-coded polyethylene bags placed within blue high-density polyethylene bags labeled with a bio-hazardous infectious materials symbol in specific bins. The quantities of infectious and non-infectious solid waste were recorded in two places: inside the incinerator room and outside the incinerator room for infectious and non-infectious wastes, respectively.
A simple dictum was followed in the final disposal of hospital waste: ‘‘infectious waste is subjected to treatment with either heat or chemicals and non-infectious waste need not be treated.’’ Bio-medical solid waste comprising: (i) human anatomical waste, (ii) microbial and biotechnology waste, (iii) sharps, (iv) soiled waste, (v) solid waste and (vi) discarded medicines and cytotoxic drugs were collected in red, yellow and blue color-coded high-density polyethylene bags and disposed of in an incinerator. The local municipal authorities transported the segregated non-hazardous general waste collected in black bags every other day for suitable disposal.

Both types of waste were collected twice a day, once in the morning before 8 am and once in the evening before 6 pm. However, the waste from the Operation Theater (OT) and Intensive Care Units (ICU) was collected more often, depending on the number of operations and cases attended in any particular day. All containers kept for collection of hazardous wastes were labeled with biohazard/cytotoxic symbols while other containers for non-hazardous wastes were not labeled. Infectious waste was packaged to: (i) protect waste handlers and the public from possible injury and disease that could result from exposure to the waste and (ii) avoid attraction to rodents and vermin. The integrity of packaging was preserved during handling, storage, transportation and treatment. Objects that are capable of puncturing or cutting including syringes with needles, scalpels, blades, pipettes and broken glass, were put in puncture-proof containers. The needle tips were first destroyed by shredding. Later, these materials were disinfected prior to incineration by soaking them for a period of at least 30 min in a freshly prepared 1% hypochlorite solution before discarding them in the bins.

Final disposal of waste, Non-infectious waste was separately collected and transported in the large municipal bins to be removed by the city municipal authorities, and then it was followed by Treatment of infectious biomedical solid waste where the final disposal of infectious bio-medical waste is carried out by incineration. Edstrom Hydrolytic Incinerator Model PY-300 equipped with a 30-m high chimney with a load capacity of 1000 kg and 150-kg/h incineration rates, operates using an oil-blast technique. The minimum operating temperature maintained in the incinerator is 800 °C over an 12-h incinerating cycle (from 8 AM to 8 PM), having a break period of 12 h for cooling and emptying the accumulated ash, before a fresh load of bio-medical waste is inserted.
During incineration, the door of the incinerator is periodically opened and the waste material is turned upside down for complete incineration of the waste matter. The last load of bio-medical waste that is charged in the incinerator in a particular day is fed at least 2 h prior to start of the cooling cycle so that no part of the bio-medical waste is left unburned. The ash generated in the incinerator is removed from the incinerator every day and stored outside the incinerator room. Periodically, after accumulation of a sufficient quantity of ash, the material is transported to be dumped in pits, away from the populated area.

The incinerator room was located at the rear of the hospital, separated from the main building with sufficient space for easy movement of the trolleys and vans carrying the waste directly into the room where the segregated solid biomedical waste could be unloaded for incineration. It was observed that the hospital was extending its incineration facility at a very nominal price to the clinics and nursing homes in the city and in nearby areas with a dedicated team of staff for transport and collection of biomedical wastes for incineration at its site, once a day, every day. The operating conditions were found to be well monitored with periodic checks of the temperature of incineration as per the EPA Rules 1998. This institution has been rendering its services since June 1996 and until the date of the study period, no complaints had been made. However, a method has not been adopted to determine if the incineration process is complete except that the last load is fed two hours prior to the end of the burning cycle of the day and that the temperature is automatically and constantly maintained at 800 _C during incineration. This observation was very positive compared to a study undertaken in Delhi, India which reported that the low quality incinerators that have been installed in many hospitals are causing more harm than good (Bio-Medical Wastes, 2004) because they operate at temperatures below 300 _C and discharge toxic emissions polluting the environment and causing a major public health hazard, and do not meet the standards set forth by the Bio-medical Waste Rules which states that the combustion efficiency must be at least 99% with zero emission standards of dioxins, furans, heavy metal vapors, harmful particles, by Bio-medical Rules (Management and Handling), 1998.

The Results were evolved and Observations were made during the waste handling process and questions were asked to the staff in charge regarding the care taken in
handling wastes. The explanation given by staff was that they were handling biohazardous materials and that if they were careless it could be injurious to them and to others, and also could cause the spread of infection or disease. Staff further added that there could be serious ramifications on the human health in the community, which might spread to a larger area.

Collection, replacement of empty color-coded bags and transportation were systematically carried out. The collection of infectious and non-infectious wastes was undertaken by two teams of two members each, one for pulling the cart and distributing empty polyethylene bags and the other member for sealing the bags, putting the bags into the cart and replacing the bins with polyethylene bags. The staff was aware of the potential hazards of the material they were handling and were found to take requisite protective measures. They wore impervious gloves and masks during collection of infectious waste, segregation of various color-coded containers and transporting waste in the designated cart, taking adequate precaution to prevent any spillage from the plastic bags. Upon questioning, it was found that the staff had been instructed to report any injury during material handling to the medical authorities in charge.

Based on the available records, it was determined that the Hospital and Medical Research Center, Belgaum regularly submitted an Annual Report through prescribed authority. The hospital did not have any records of any accidents.

Waste management procedures the personnel engaged in the process of segregation, handling and transport of waste were found to be skilled for the type of job they were doing and took adequate safety measures to protect them and prevent spillage, as they were aware of the potential hazards involved in this process. Paramedic and medical staff working in the hospital disposed of the infectious waste in designated containers which conformed to the guidelines given by EPA Rules 1998 (Notification, 1998). It was a general observation that the bin size was sufficient and the bins were always emptied before it was filled to the brim.

This case study is again one of the important examples of the good management of biomedical in Karnataka, India and it really sets a wonderful image and impression on the Bio-Medical Waste Rules 1998 and its provisions. It could be further stated that if
the rules and procedures are correctly followed than every health care establishments contribute its concern to health and environment. And undoubtedly there shall be good impact on environment.

3. In this case study\(^1\) it has been stated that, biomedical waste management is receiving greater attention due to recent regulations of the Biomedical Wastes (Management & Handling Rules, 1998). Inadequate management of biomedical waste can be associated with risks to healthcare workers, patients, communities and their environment. The present study was conducted to assess the quantities and proportions of different constituents of wastes, their handling, treatment and disposal methods in different health-care settings. Various health care units were surveyed using a modified survey questionnaire for waste management. This questionnaire was obtained from the World Health Organization (WHO), with the aim of assessing the processing systems for biomedical waste disposal. Hazards associated with poor biomedical waste management and shortcomings in the existing system were identified. The development of waste management policies, plans, and protocols are recommended, in addition to establishing training programs on proper waste management for all healthcare workers.

A study was conducted in different health care settings. Data were collected from various areas of hospitals. Among the hospitals studied, all of them were considered to be large hospitals based on the number of beds, as each had more than 150 beds.

The quantity of waste generated in health care settings should be known while making a good waste management system. Hence, the quantities of different categories of waste have to be estimated by discussions, interviews and by physical checks. The quantities generated vary from hospital to hospital and depend on the type of health-care facility and local economic conditions. The waste quantities were physically weighed in different hospitals having specialized units. The waste quantities are estimated by assuming 100% bed occupancy in the hospital. Health care wastes are categorized into two types such as infectious and non-infectious. Infectious waste includes all those

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\(^1\) A CASE STUDY OF BIOMEDICAL WASTE MANAGEMENT IN HOSPITALS K.V. Radha (Corresponding author), K.Kalaivani, R.Lavany, Department of Chemical Engineering, Anna University, Chennai 600025, India, Global Journal of Health Science, Vol.1, No. April 2009
medical wastes, which have the potential to transmit viral, bacterial or parasitic diseases. It includes both human and animal infectious wastes and waste generated in laboratories and veterinary practice. These wastes are hazardous in nature. Non infectious wastes are generated from packaging, food preparations and visitors activities. This waste is large compared to infectious waste. A large fraction is potentially recyclable but may be contaminated with infectious agents. This has to be separately stored and sterilized before sending for recycling.

The total hospital waste generated, approximately 10% is hazardous, 85% is general (non risk) waste while a small percentage 5% is labeled as highly hazardous. Currently, all the hospital biomedical waste is being disposed along with municipal solid waste. The untreated liquid waste from the health institutions is let into drainage. Normally the waste is collected in open containers without disinfection. Bandages, cotton and other items used to absorb body fluids are collected in plastic or other non-specified containers. Waste is collected in mixed form. Some hospitals in the country have developed their own system of color coding. Waste sharps are discarded without disinfection and mutilation, which may result in their being, re-used thus spreading an infection. The waste collection and transportation workers in the hospital segregate the recyclable material for sale. In a similar way, all disposable plastic items are segregated by the waste pickers, from where the waste is deposited either inside the hospital grounds, or outside in the community bin for further transportation and disposal along with municipal solid waste. Since the infectious waste gets mixed with municipal solid waste, it has potential to make the whole lot infectious in adverse environmental conditions.

Most biomedical waste generated from health care facilities are at present, collected without segregation into infectious and non-infectious categories and are disposed in municipal bins located either inside or outside the facility premises. Wastes from operation theatres, wards and pathological laboratories are disposed of without any disinfection/sterilization. Amputated body parts, anatomical wastes, and other highly infectious wastes are incinerated wherever incinerators are available; the remainder is burnt in some corner of the hospital grounds, mostly in open pits.
Medical facilities in urban centers are improving faster than those in the rural areas due to rapid urbanization. Waste management systems in the urban areas are already overburdened. Hence, an additional load due to mixing of infectious waste from HCEs aggravates the problem. Separate systems for disposal of HCE waste are available in only a few establishments. The shortcomings in the existing system are: The segregation of waste in almost all hospitals is not satisfactory.

a) Color-coding for various categories of waste was not followed.

b) The storage of bio-medical waste is not in isolated area and proper hygiene was not maintained.

c) Personal protective equipment and accessories are not provided.

d) Most of the hospitals did not have proper waste treatment and disposal facilities. In the cities where common treatment facilities have come up, many medical establishments are yet to join the common facility.

e) Most of the incinerators are not properly operated and maintained, resulting in poor performance.

f) Sometimes plastics are also incinerated leading to possible emission of harmful gases.

g) General awareness among the hospital staff regarding bio-medical waste was lacking.

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

Finally, the study concluded by stating that the premier hospital is severely lacking in actions to dispose of its waste and uphold its statutory responsibilities. This is due to the lack of education, awareness and trained personnel to manage the waste in the hospital, as well as the paucity of the funds available to proper waste management system. The results of the study demonstrate the need for strict enforcement of legal provisions and a better environmental management system for the disposal of biomedical waste in hospitals as well as other healthcare establishments. A policy needs to be formulated based on ‘reduce, recover, reuse and dispose’. The study concludes that healthcare waste management should go beyond data compilation, enforcement of regulations and acquisition of better equipment. It should be supported through appropriate education, training and the commitment of the healthcare staff, management and healthcare managers within an effective policy and legislative framework.

2.6 CONCLUSION

The bio-medical waste is highly hazardous in nature and it can prove fatal if not properly handled and disposed of systematically. The ill-effect of bio-medical waste was un-noticed till 1988 Beach wash ups of U.S.A. The growth of knowledge regarding biomedical waste started growing when dreadful diseases like AIDS and Hepatitis B emerged. Then it is not only the concerned authorities of the hospital who started to create awareness among them, but also the whole society (general public) became cautious pertaining to this issue. But still till date it could be noticed mushrooming hazardous effect of bio-medical wastes due to improper management of bio-medical wastes.

This chapter is the foundation or base of the thesis as it has vast information and detailed study regarding impact of bio-medical waste on health and environment. All the remaining chapters have one or the other connecting issues to this chapter alone. The
The analytical conclusion of this chapter is that the issues of bio-medical wastes cannot be a part of negligence any more. Everybody has the responsibility towards proper management of bio-medical wastes. As bio-medical waste is considered the most hazardous waste under the studies of WHO, U.S and UK it should be implied that it has the same implications throughout the world. All are facing the same problem in managing the health care wastes. It could also be considered as global issue and unsolved problem. This is most peculiar problem where no barrier of rich and poor, educated and uneducated, smart and coward, skilled and unskilled, clever and innocent and so on are not taken into consideration in order to manage BMW.

This can affect anybody any moment. The bio-medical waste has no difference between developed, developing and under developed countries. And it could be noticed that this issue of management of bio-medical waste could not be perfectly handling by either of the countries. So it can be analysed that the management is very difficult. The only way left is ‘ought to practice’ good bio-medical waste management skill and it’s the only remedy too. That is what the chapter highlights by gathering the information regarding the bio-medical waste management. The impact is very bad as the mention of different practices of bio-medical waste management along with different countries (U.K. and U.S.A) and international organization (WHO) and Indian study all have clearly mentioned the adverse effect of medical wastes and it is irreparable and irreversible. The total study has shown the equal status of BMW is prevailing among the three countries and high precautionary measures are required. The case laws and case studies also shows the impact of bio-medical waste and have stated that bio-medical wastes should not be taken lightly as a negligible issue as it can prove hazardous to whole environment.

The case laws have indiscriminately given positive attitude towards protection of health and environment towards protection of health and environment in dealing with the issues of bio-medical waste management. The various decisions have taken cognizance appropriate issues and have Ordered and given Directions pertaining to proper management of BMW. And finally, the case studies that which have been mentioned in
the chapter are studied in different perspective under different branches of study (Engineering(Environmental Science), Environmental Studies, Hospital Administration etc.).

These branches may hold distinct approaches but when it comes to bio-medical waste management, these branches indicate (the practice, management, Administration, Segregation to final disposal) single mode of application that draws an unique conclusion that is the “best practice” to be adopted to manage bio-medical waste without any shortcuts or negligence.

Therefore, all these mentioned issues play a vital role in managing best biomedical waste practice.