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Emerging Issues in Bio-Medical Waste Management

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PREFACE

The Goal of "Health for All" by 2000 A.D. adopted at the Alma Ata Conference in 1978 today appears to be beyond the horizon. Over the last three decades rapid urbanization is straining the health delivery system all over India. Due to a combination of lack of know-how and enforcement, bio-medical waste is being disposed off indiscriminately. The entire operation and maintenance seems like a losing battle. Today in a 'throw-away-society', it is a veritable hell-a city littered with garbage and filth.

A large variety of infectious material is churned out in hospitals. However, compared to the municipal waste the quantity of bio-medical waste is relatively low. Tracking of hazardous, contaminated medical waste is often complicated by a lack of available records on waste generation. This results from medical waste being mixed with non-infectious municipal waste and from disposal of potentially hazardous waste into the sewer.

Though the Bio-medical Waste (Management and Handling) Rules, 1998,has made it mandatory for all medical institutions to segregate medical waste and adopt different treatment options, the response is lukewarm. A significant characteristic of the modern hospital is that it has been and will continue to be a rapidly changing institution. Not only are the diagnostic and treatment facilities drastically improving, but they are witnessing an increase in the quantum of clinical waste generated. Today, the hospitals are facing fresh challenges in treating and disposing medical waste, without disturbing the '*hospital ecosystem*' in particular and the landscape as a whole.

Although much is said than done, scientific and universal bio-medical waste strategies are in a nascent stage. It has yet to take a structured form, evolving a new set of priorities. The need of the hour is to find solutions centered in segregation at source, waste minimization and non-commercialization of bio-medical waste rather

than merely emphasis on end-of-pipe technologies. The problem of handling bio-medical waste is a gigantic environmental threat, which is of growing concern, unless remedial steps are taken in right earnest and in time.

The problem is that future of health care really exists only on PowerPoint. We seem to jump from one crisis to another without making a serious attempt to implement the notifications spelled out in black and white. We talk about a change, even though we do more wheel spinning than changing. We have an influx of new medical technologies which are instrumental in not only decreasing the death rate but also help to change the nature of biomedical waste, rendering it non-infectious.

But today's health care system is plagued with problems of cost, quality, access and above all dangers posed by the waste churned by the medical institutions. And they seem to be getting worse.

The reason we are dazed and confused about the future of health care and biomedical waste in particular is that we have never connected all the dots together. Making connections requires initiation and leadership.

This would require active participation of all stakeholders. The thrust of bio-medical waste management programme should aim at empowering people at all levels, so that the benefits can trickle down not only to all medical establishments but also to the community as a whole. It is then we can build a waste management system that is coherent and sustainable. It might not be what we have wanted, but at least it would be better than what we have.

This paper is a humble attempt to provoke, inflame and excite all readers. Change is not necessarily marked by action; a new thought process in its self is a change.

The first three sections of the discussion paper deals with the nature of the problem of biomedical waste management and what are the initiatives taken by both the government and non-governmental organizations. The latter part of this section deals with the categories, characteristics and above all the dangers posed by clinical waste.

Section four, provides a snapshot of the background of bio-medical waste management in India, with greater details of this crisis in two of the metropolitan cities, viz., Calcutta and Delhi. The following section five, deals with the legal and institutional framework of biomedical waste, dealing in detail with the rules and standards set by the Central Pollution Control Board.

Section six, provides a detailed study of the various phases of biomedical waste management in the study area, viz., Safdarjang Hospital, Delhi and Nil Ratan Sarkar Hospital, Calcutta. It compares the waste management scenario in both the hospitals and analysis the ward design with respect to location of waste containers. The various technologies and management strategies for hazardous waste control, role of the private sector in dealing with the biomedical waste problem and the cost-benefit analysis have been addressed in section seven.

Section eight and nine focus on the biomedical waste problem from the angle of public health, commercialization and the unwanted recycling of clinical waste. Section ten offers certain recommendations, were the answer to this problem might lie.

Acknowledgments

I take great pleasure in thanking all the people who made the completion of this paper easier than it might have been otherwise. First and foremost I am grateful to Dr. Sukla Bhaduri, Reader, Department of Geography, University of Calcutta without whose encouragement and guidance this work would have been impossible.

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My sincere thanks goes out to Sister Tina Farias, Principal, Loreto College, Calcutta who has always been supportive in all my endeavors.

I owe a deep sense of gratitude to my parents, family and friends for their constant encouragement, understanding, forbearance and untiring help, which made this work possible.

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EMERGING ISSUES IN
BIO-MEDICAL WASTE MANAGEMENT

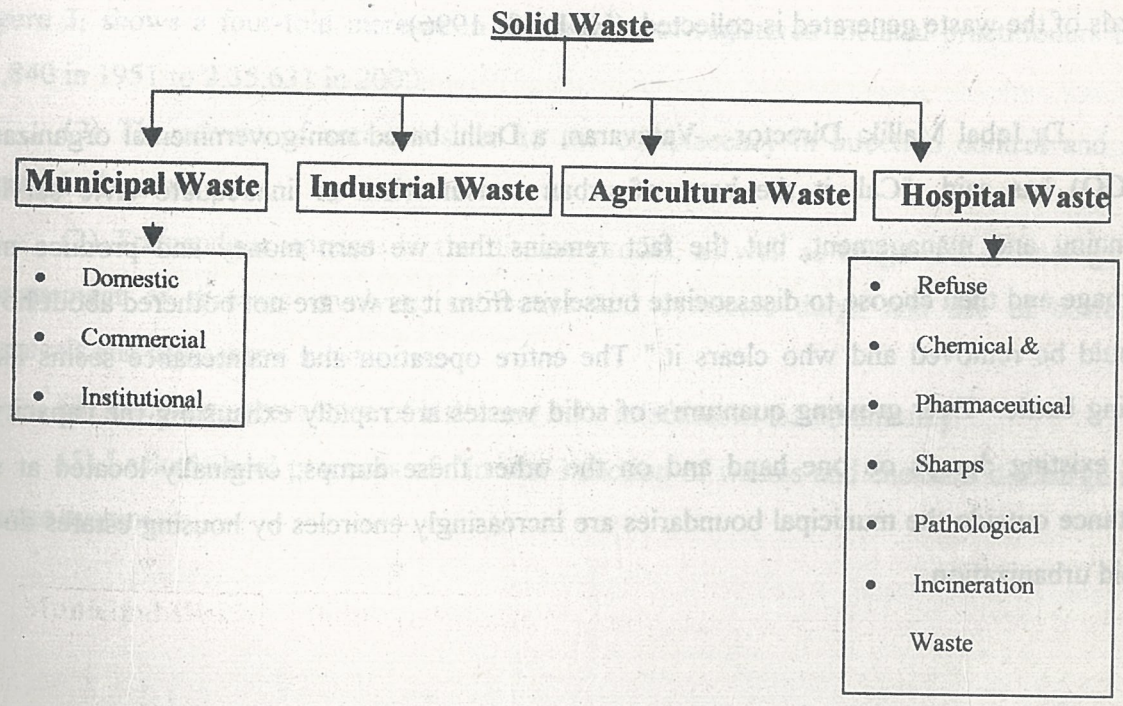
1. Introduction

Rapid urbanization is straining the service delivery systems in the largest of Indian cities. The process of civilized living has been creating mountains of solid waste, converting major portions of the area into a land of scum. Infrastructure systems are incapable of adequately collecting, transporting and disposing solid waste. Government of India's emphasis on the need for multi-pronged efforts to protect the environment due to deteriorating conditions of urban areas has called for special efforts towards the provisions of the essential infrastructure services like water supply, sewerage, drainage and above all solid waste management.

Solid waste does not only imply household garbage or street sweepings. Figure 1, illustrates the various components of solid waste.

Figure 1

Types Of Solid Waste



(1) Municipal Solid Waste

- **Domestic Waste** - Kitchen left over, papers, plastics, rags, metal etc.
- **Street Sweepings** - dust, leaves, plastic, rubber
- **Commercial and Institutional waste** - paper, plastics, cardboard, packaging material from offices and shops, left over food from restaurants and vegetable waste

(2) Industrial Waste

- Scrap metal, alloys, glass, plastics and chemicals

(3) Agricultural Waste

- Vegetable, crop cuttings and dairy farm waster

(4) Hospital Waste

- Bandages, infected linen, vials, syringes etc.

(Source: HUDCO, 1990)

Today, in a 'throw-away society', it is a veritable hell - a city littered with garbage and filth. An alarming percentage of this waste lies open, like festering sores wherever one sets his eyes on. The traditional role of municipalities to keep the cities clean, collect garbage and ensure its safe disposal is not performed seriously. It is common to find over 50% of the municipal finance and manpower committed to this single function. Yet, only half to two thirds of the waste generated is collected. (HUDCO, 1996)

Dr.Iqbal Mallik, Director - Vatavaran, a Delhi based non-governmental organization (NGO) has said, "Call it the bane of urban consumerism or inadequate civic services, planning and management, but the fact remains that we earn money and produce more garbage and then choose to disassociate ourselves from it as we are not bothered about how it should be removed and who clears it." The entire operation and maintenance seems like a losing battle. Ever growing quantum's of solid wastes are rapidly exhausting the capacity of the existing dumps on one hand and on the other these dumps, originally located at safe distance outside the municipal boundaries are increasingly encircles by housing estates due to rapid urbanization.

A lot has been said and done towards management of municipal waste in our country. But within this subject, hospital waste has been the most neglected concern. Through the quantum of municipal waste is almost five times that of hospital waste. The potentiality of the latter in both venture generation and disease transmission is much higher. The hazardous part of hospital (medical) waste comprising infectious biomedical and radioactive material as well as sharps (needles, knives, scalpels etc.) constitute a grave risk if it is not properly treated/disposed or is allowed to get mixed with other municipal waste. Its propensity to encourage growth of pathogens and other vectors and its ability to contaminate the non-hazardous municipal waste jeopardizes the efforts undertaken for municipal waste management.

Hospital wastes are always considered as potentially hazardous. Therefore, their safe collection, transportation and disposal at the site or in a common facility is absolutely essential. Due to the rapidly changing scenario in health care, involving but not limit to the following reasons, the urgency is felt to evolve and implement waste management strategies for safe, sustainable and cost effective methods of hospital waste disposal.

(1) Proliferation and wide spectrum of health care centers: large and small hospitals, nursing homes, clinics, primary health centers etc., Figure 2 clearly illustrates a substantial increase in the total number of hospitals from 3968 in 1971 to 11,254 in 2001. Similarly Figure 3, shows a four-fold increase in the number of registered medical practitioners from 61,840 in 1951 to 2,35,631 in 2000.

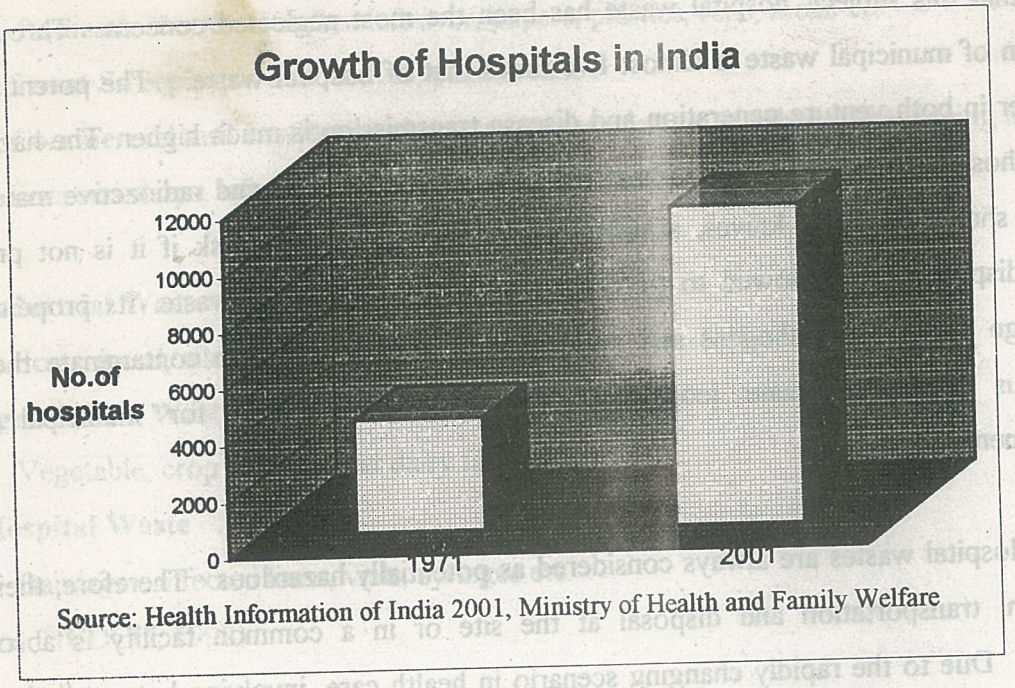
(2) The advent of antibiotics led to the complacency in infection control and safe disposal of wastes.

(3) Tremendous upraises in the disease profile, as well as drugs and technology for management of diseases involving antibiotics and cytotoxic durgs and use of corrosive chemicals and radioactive substances.

(4) The rising prevalence of HBV and HIV infection in the community.

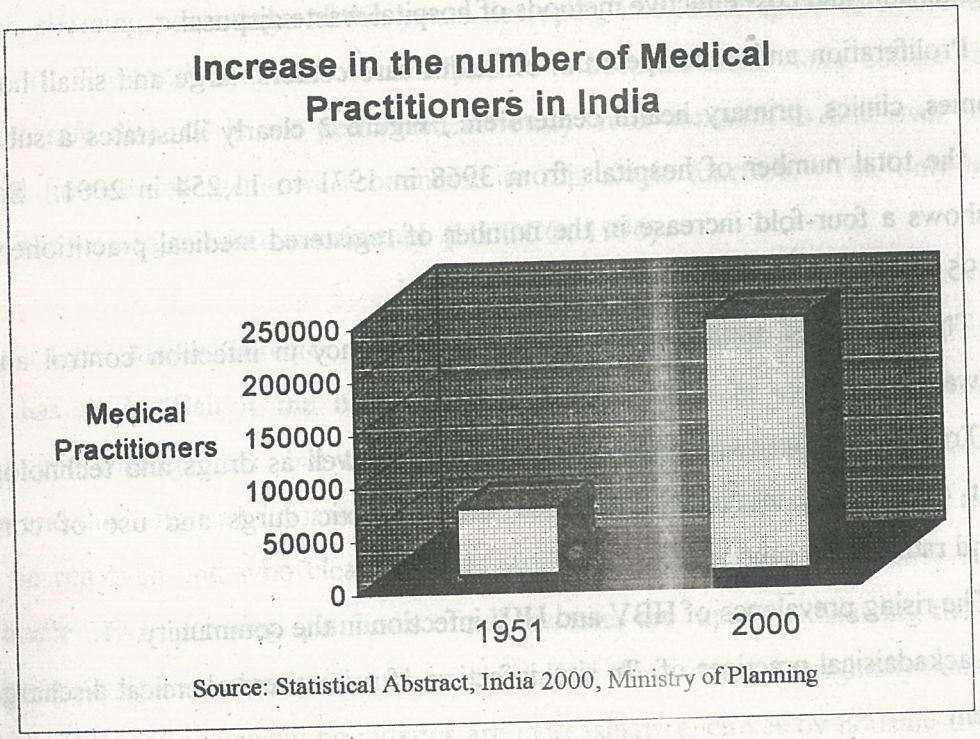
(5) Lackadaisical practices of 'In situ' infection of wastes and chemical discharge into sewage system.

Figure 2



Source: Health Information of India 2001, Ministry of Health and Family Welfare

Figure 3



Source: Statistical Abstract, India 2000, Ministry of Planning

2. Nature Of The Problem Of Hospital Waste

The scene is familiar outside several hospitals in the country-pigs and dogs sniffing at and digging their faces into piles of garbage and heaps of infectious material lying outside the compound walls. From paper scrap to cardboard boxes, from plastic bottles of I.V bags and catheters, from batteries to broken thermometers, from used bandages to blood soaked surgical gowns. These are just a few examples of what comprises the tonnes of solid waste produced by the hospitals every day. The sheet bulk comprises the tonnes of solid waste produced by hospitals every day. The sheer bulk and the long-and-short term effect this waste has on environment is unthinkable.

Pedestrians pass by and vehicles move on, but municipal garbage disposal trucks do not clear the waste for days at end, creating a major health problem in the process. Although the Notification of rules to regulate bio-medical wastes was issued by Ministry of Environment and Forests in April ,1995, hospitals and nursing homes all over the country are yet to react to it seriously thus posing constraints to the safe and rational management of hospital waste.

The problem and clinical waste disposal has acquired gargantuan proportions today. But estimates of the volume of medical waste generated in India are imprecise. In the three metropolitans of Mumbai, Delhi and Chennai it is estimated that medical waste ranges from 0.85Kg to 2.25 Kg per hospital or clinic bed per day. Estimates very because in most cases, medical waste is neither weighed not segregated and some estimates do not include small clinics (fewer then 10 beds) as well as several private clinicians.

The share of infectious and potential medical waste is unknown. Estimates made by Hospital infection Control Committee member varied from 25%-85%, depending on whether the hospitals specialized in treating infectious diseases. The estimates of the exact proportion of infectious hospital waste and potential hazardous hospital waste have no meaning, since the lack of waste segregation eventually contaminates all wastes at either the pick up bins or

disposal sites. About 98.3 metric tonnes of contaminated infected material are disposed off the municipal disposal sites in the 3 metropolitan cities each day.

A 1993 Joint study by Government of India and United Nations Development Programme (UNDP) - World Bank found that 1.5% of the total solid waste is generated by hospitals, nursing homes and dispensaries.

Table 1

Estimates Of Medical And Infected Waste In 4 Municipalities (Metric Tonnes/Day)

Municipality	Solid waste	Medical waste	Infectious waste
Mumbai	5000	75.0	37.5
Delhi	4600	69.0	34.5
Chennai	3500	25.2	26.3
Calcutta	4500	72.4	35.5
Total	13100	169.2	98.3

(Source: UNDP-World Bank, 1996)

Medical waste in India is only categorized as solid waste, excluded from this categorization are potentially infected blood and body fluids, such as those entering the drainage system from post-mortems. For example, one major hospital on an average conducts 5 post-mortems per day. An estimate 2.5 liters of blood and body fluids are released during each procedure, thus entering more then 4000 liters of potentially infected fluid into the drainage system each year (World Bank, 1996). This figure does not include the common practice observed in hospitals of rinsing into the sink or drain potentially infected culture, laboratory instruments, slides and fabrics.

Over the last couples of years, there has been growing concern about problems associated with waste management. The country woke up with a jolt to realize face dire consequences when plague and dengue broke out in 1992 and 1994 respectively over vast

stretches. The intense publicity and wide coverage of these events has been successful in attracting considerable attention to the issue of solid waste management with greater emphasis to hospital waste.

Hospitals, which play an important role in preventing the proliferation of disease and save valuable human lives, also have the potential to pollute the environment if infectious and bio-medical waste generated by them is not properly treated and subsequently disposed.

Thus, it is an area, which calls for immediate action and needs to be addressed with utmost sincerity by not only the municipal body of the sanitation staff in isolation, but by academicians and each one of us collectively. The responsibility of safe guarding our environment from the onslaught of continuous and irrational management of waste should rest on the community as a whole.

After several years of sponsoring and providing technological assistance to may health programmes many of which generate considerable infectious waste, it is only on the most recent of World Bank-assisted Projects (Health System II Project in Karnataka, Punjab and West Bengal) that components for training in hospital waste have been included. It has been reported by Central Pollution Control Board that most government and international communities have neglected medical waste issue.

Hospital waste management is a complex technological area, where a large number of actors need to be involved to look into the multi-dimensional aspects and complexities of the problems. Though delayed, positive steps have been taken by the government, non-governmental organization and several academicians in this area.

2.1 Government Responses

The Indian government has initiated a number of activities to address the public health hazards of hospital waste exposures.

- A Committee on Urban solid waste management has been formed in October 1994 to assess the impact of current solid waste management practices on the general health of the community. The interim meeting in April, 1995 reported technological options for the safe collection, transportation and disposal of urban solid waste. The next task is to identify the potential of hospital waste include in the solid waste and their associated public health risks.

- In April, 1995 Ministry of Health and Family welfare collaborated with World Health Organization for a workshop on sanitation and environmental health. It involved NGOs and voluntary agencies in sanitation efforts and developing technology for disposal of hospital waste.

- The Ministry of Environment and Forests have drafted rules for bio-medical waste management, which has been recently published in the Gazette of India October 27, 1997. The Ministry is also surveying hazardous waste generation and tracking practices in hospital, clinics and blood banks.

- The All India Institute of Hygiene and Public Health (AIIHPH) assisted by the experts at the West Bengal Pollution Control Board and the Natural Environmental and Engineering Research Institute, Nagpur, has published a Report, which has carried out an assessment of solid waste generated and managed in medical institution in West Bengal. The study has revealed that the hospitals in the state are turning hazardous because of the poor treatment of medical waste. The use of incinerators to destroy medical waste has been recommended by the AIIHPH as a remedial measure.

- Dr. Alok Ghosh, Assistant Director, Health Services (Project), Government of West Bengal has been actively involved in reviewing the waste management system in almost 52 hospitals all over West Bengal. He has emphasized on the urgent need for training of personnel involved in waste handling process. In order to achieve this formidable task he has visited the selected hospitals and created awareness and imparted the required training to those who are in day-to-day contact with infectious waste.

West Bengal Health Systems Development Project (WBHSDP) is committed to develop a low cost-effective and sustainable health care management system as a part of improving service quality and effectiveness at the secondary level health care institutions of the state.

Though there are some genuine constraints (absolutely new concept, multisectoral, complex, cost intensive, related with change of behaviour) the development process is going on steadily in consultation with the State regulatory authority i.e. West Bengal Pollution Control Board (WBPCB).

2.2 Non-Governmental Responses

- Dr. Iqbal Mallik, a renowned medical psychologist, making a case study of Delhi's hospital waste, has recommended a strict regimen of waste management and enlightened consciousness as necessary safeguard against irresponsible waste disposal.

- Dr. P.D.Grover (Ex-Prof. IIT, Delhi) has provided an overview of the hospital waste management scenario in India. He has highlighted the present dismal scenario and the management imperatives required due to the lackadaisical attitudes of agencies, concerned about after effects of Incineration, prevalence of HIV, HBV infection and rapid proliferation of health care facilities. He has categorized waste, which comprises only 20% of the total hospital waste and described the major technologies like incineration, autoclaving, mechanical/chemical treatment and microwaving which can be used to treat this waste.

- Institute of Public Health Engineers (IPHE) and Tata Consultancy Services in collaboration with Government of West Bengal and World Bank have carried out extensive survey of the waste management scenario of a number of hospitals, primarily district and state general hospitals.IPHE has conducted a Waste audit and stressed on the urgent need of quantification of different categories of clinical waste. They have developed health education materials like posters and pamphlets, which have been circulated in all the selected hospitals.

- Dr.Laxmi Raghupathy, Joint Director, Ministry of Environment and Forests has dealt with the technical aspects of bio-medical waste management and has highlighted some significant aspects of the draft Bio-medical waste (Management and Handling) Rules, 1997.

- Disha a Calcutta based NGO in close association with like minded individuals (academicians, research scholars, doctors) have analyzed and reviewed the Biomedical Waste (Management and Handling) Rules, 1998 and 2000 in minute details. A memorandum suggesting certain changes in the existing rules has been prepared and forwarded to Health Secretary, Mr.Asim Burman.

- Dr. Harbans S. Wasir, Chief Cardiologist and Medical Director, Batra Hospital and Medical Research Center in his paper `Sound Hospital Waste Management' has thought it essential for the doctors to be aware of the fate or end use of the waste being generated in the wards and operation theaters. He has emphasized on segregation, avoiding the use of antibiotics as panacea of all problems and common waste disposal facility. He has concluded by emphasizing on the need for a holistic approach and polluter pays principle.

- Dr. Kalpana Balakrishnan, S.R. Medical College, Chennai, has highlighted the apathy of most hospitals and the initiatives being made by SR Medical College. According to her, training is mandatory for hospital staff. Occupational surveillance through immunization, health check ups form on integral part of the hospital's operations.

- Drug Action Forum, Calcutta were the catalysts of a project undertaken by the Department of Science and Technology in1997 which studied the practices and problems of Hospital waste management in Calcutta city with special reference to Howrah General Hospital and M.R.Bangur Hospital, West Bengal.

- Ravi Agrawal of Srishti-a Delhi based NGO has emphasized that the proper disposal of hospital waste is a management problem rather than a technological problem. He

has stressed on the need for segregation of waste, on site disinfection and off-site disposal. He has further reiterated the need for centralized treatment facilities as the actual quantum of infectious waste is small and the investment needs for treatment are high.

- Compare to the voluminous literature published on solid management, the study on hospital waste management seems mini scale. Though the quantum of municipal waste is almost five times that of hospital waste, the potentiality of the latter in both vector generation and disease transmission is much higher. It is this very infectious and contaminated nature of waste that calls for further investigation.

All the above mentioned studies have if not completely curbed generated considerable awareness on this sensitive issue, which to a great extent wield enough resistance to hold at bay any action which would accelerate environmental degradation.

This study is a small and humble contribution towards the overall picture of waste management in various hospitals, with special reference to Safdarjang Hospital, Delhi and Nil Ratan Sarkar Medical College Hospital, Calcutta.

2.3 Objectives Of The Study

(i) To document and examine the extent of hospital waste management problem in India.

(ii) To determine the composition and characteristics (physical, chemical and biological) of hospital waste at various source of the case study hospital.

(iii) To describe the existing system of storage, collection, transportation and disposal of the medical waste.

(iv) To determine the deficiency of the existing system of the hospital waste management.

(v) Examine the health hazards and risks involved for the hospital staff, patients, visitors, ragpickers and community as a whole.

(vi) Recommendations for the rational disposal of waste and reduction of health risks.

2.4 Methodology Adopted For Study

The following methodology was adopted while carrying out the survey :

I Initially literature survey was carried out, in order to provide a better insight to the nature and problems of hospital waste.

II On the basis of secondary data, direct empirical observations were made of the study area. This helped to critically analyse the present system and propose an alternative.

III In order to obtain information about the various hospital waste management practices (collection, transportation, treatment and disposal), the hospital sanitation staff, Class IV workers, patient and ragpickers were interviewed. This was carried out with the help of questionnaires.

IV The primary data collected was then processed with the aid of statistical methods like bar graphs and pie-charts. Mathematical formula was used to derive the Combustion efficiency.

V Schematic diagrams and flow charts were drawn illustrating the existing situation of hospital waste management.

VI Simultaneously recommendations were cited, in order to minimize if not curb the various constraints faced during hospital waste management.

3. Definition Of Hospital Waste

Hospital Waste can be defined as infectious waste, which is hazardous, as it is contaminated with disease causing pathogens. The human and animal wastes along with items saturated or dripping with, blood and body fluids, discarded medical equipments, soiled cotton, plasters and dressing, surgical and autopsy wastes, can all become a major health hazard, as they provide fertile environs for bacteria, virus and other micro-organisms to multiply (Baldwin, 1989).

The list of diseases caused due to improper disposal and treatment of hospital waste is endless but majority of them are deadly like Acquired Immuno Deficiency Syndrome (AIDS), Hepatitis B, Bronchitis, Tuberculosis, Skin and Eye disorders.

The infectious potential of waste depends upon:

(i) the presence of pathogens of sufficient virulence and quantity.

(ii) the mode of entry, and

(iii) the resistance of the host.

3.1 Categories Of Hospital Waste

Hospital waste is classified according to World Health Organization (WHO) guidelines into the following six categories, as shown in Table 2.This clearly illustrates the categorization and the characterization of various wastes. Each type of hospital waste has a different nature and varying levels of risks attached to it. Initially, there were no written National rules or guidelines, which could govern the hospitals as to how to dispose of their wastes. But several studies indicating the endless dangers of hospital waste have brought the issue to the limelight, thereby highlighting the magnitude of the dumping grounds, which keep gaining in girth and height everyday. Figure 4 shows the various components of Health Care Waste in the developing countries.

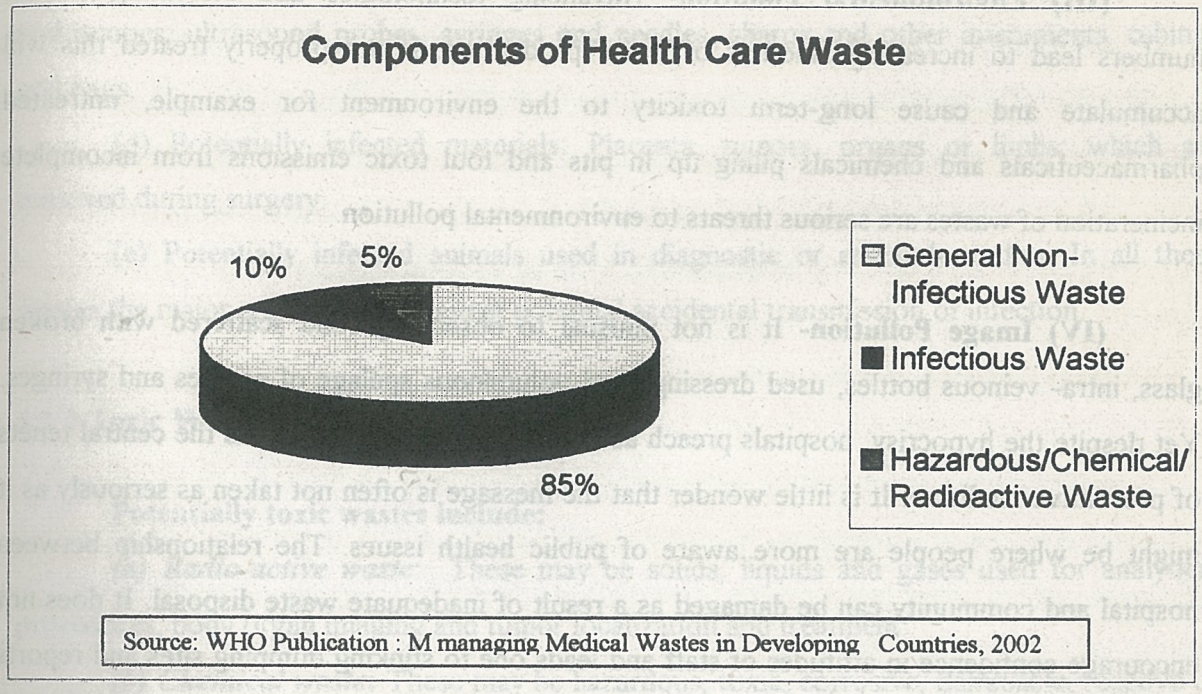
Table 2

Categories of Bio-Medical Waste

WASTE TYPE	NATURE	EXAMPLES	RISKS
1) GENERAL	Household type garbage	Kitchen waste, paper, packing, cards etc.	Minimal
2) CHEMICAL AND PHARMACEUTICAL	Waste Chemical or pharmaceutical products, including the packaging in which they are bought, disposed or used. Mostly produced in labs, pharmacy, wards, OT and other clinical areas	Used lab reagents, used X-Ray developer, used, spilled, outdated & no longer required drugs. Plastic drug packaging, glass, plastic chemical containers, empty I.V. bottles	Minimal immediate risk, but maybe toxic in large quantities. Long term chronic high risk Plastics produce toxic fumes if burnt in irregular manner
3) SHARPS	Waste which can cut or perforate skin	Needles (Syringes since attached to the needle) Broken glass (microscope slides, broken bottles) Scalpel blades	Very high risk-skin is vital barrier against infection &piercing it could allow direct access of potential pathogens to tissue or even to the blood stream
4) PATHOLOGICAL	(i) Human tissue (ii) Body fluids (iii) Lab Culture and Clinical specimens (iv) Materials in contact with (i), (ii) and (iii)	(i) Amputated body parts; tissue removed during surgery; placenta from childbirth (ii) Blood urine, vomitus (iii) Blood soaked surgical drapes; soiled bed sheets; used dressings; catheter tubing; rubber gloves	Moderate risk may encourage vector generation if left to decompose in an uncontrolled way
5) INFECTIOUS	Sub-categories as for pathological waste,with sufficient virulence & insufficient quantities so that exposure could result in disease in a susceptible host	As for pathological waste, but from patients,with infectious diseases,eg. AIDS, Tuberculosis,Hepatitis B	High risks. Pathogens may cross to the new host
6) OTHERS		Radioactive material used in diagnosis \ treatment Pressurised gas cylinders	Variable

(Source: Kerac, M., 1992. Hospital Waste in India)

Figure 4



Source: WHO Publication : M managing Medical Wastes in Developing Countries, 2002

3.2 Dangers Of Hospital Waste

(I) Reservoir of infection- Human Immuno Virus (HIV) and Hepatitis viruses spearhead an extensive list of infections and diseases documented to have spread through HIV blood, body fluids and secretions harbor most viruses, bacteria and parasites. This passes via a number of human contacts all of which are potential "recepeints" of the infection. For example, a washerman can be infected by blood soaked linen. Other including visitors to the hospital and the immediate community can be affected by contaminated over flowing water supply and vector contacts.

(II) Vector generation- Unsanitary dumping grounds or stagnant water often become breeding grounds for files, mosquitoes, insects and rodents. Such vectors help maintaining already established disease cycles.

(III) Environmental Pollution- Advancing technologies and increasing patient numbers lead to increasing amounts of waste production. If not properly treated this will accumulate and cause long-term toxicity to the environment for example, untreated pharmaceuticals and chemicals piling up in pits and foul toxic emissions from incomplete incineration of wastes are serious threats to environmental pollution.

(IV) Image Pollution- It is not unusual to observe ground scattered with broken glass, intra- veinous bottles, used dressings and voluminous spillage of needles and syringes. Yet despite the hypocrisy, hospitals preach about cleanliness and hygiene as the central tenets of preventive medicine. It is little wonder that the message is often not taken as seriously as it might be where people are more aware of public health issues. The relationship between hospital and community can be damaged as a result of inadequate waste disposal. It does not encourage confidence in attitudes of staff and leads one to stinking dumping sites and reports like cats and dogs run away with easily accessible amputated body parts and surgical waste.

3.3 Characteristics Of Wastes

It is essential to realize that 85% of the waste generated from hospitals/health care units is non-hazardous wastes and similar to the household waste, mainly of kitchen waste products, packaging etc. This can be segregated at source and disposed through the usual channels of household waste disposal of the remainder; about 10% is infectious and 5% as non-infectious but potentially toxic waste.

3.3.1 Infectious Waste

Potentially infectious wastes from patients care include:

(a) Dressings and swabs, contaminated with blood/body fluids.

(b) Laboratory waste including laboratory samples, cultures stocks of infectious agent, laboratory glassware.

(c) Instruments used in patient care: Those range from diagnostic equipment such as endoscopes, ultrasound probes, syringes and needles, sharps and other instruments, tubings and bags.

(d) Potentially infected materials: Placenta, tumors, organs or limbs, which are removed during surgery.

(e) Potentially infected animals used in diagnostic or research studies. In all these wastes the major concern is to prevent potential accidental transmission of infection.

3.3.2 Toxic Wastes

Potentially toxic wastes include:

(a) Radio-active waste: These may be solids, liquids and gases used for analytical procedures, body organ imaging and tumor localization and treatment.

***(b) Chemical waste*:** These may be hazardous, toxic, corrosive, flammable, reactive or genotoxic.

***(c) Pharmaceutical agents*:** These may enter hospital because there were surplus stock, spillage or contamination was detected or the expiry date was over.

3.4 Quantum Of Wastes

There are no reliable figures about the quantum of waste generated per person per day. Available data from developed countries indicate that even in these countries there is wide range of waste generated, 1-5 kg. of solid waste per person per day. Available meager data on quantum of waste generated in some developing countries indicates the range is essentially similar, but the figures are substantially lower than those of developed countries. It is estimated that most in-patient may generate 1-2 kg. of wastes per day per bed. Accordingly, the infectious waste is 250-500 grams per day per bed. (Planning commission, 1995)

In West Bengal, All India Institute of Hygiene and Public Health have formulated a waste audit for a few Calcutta hospitals. Yet another significant breakthrough in quantification of various categories of medical waste has been undertaken in some urban and rural health care institutions by the West Bengal Health Systems Development Project in early 1999 in collaboration with TCS.According to this project General waste constitutes about 62% (52.29% to 63.59%) and infectious Medical waste comprises 38%.

4. Background of Hospital Waste Management in India

Over the last couple of years, there has been growing concern about the problems associated with waste management and the country woke up with a jolt to realize and face dire consequences when plague broke out in Surat in 1994.The publicity and wide coverage of the event has been able to attract considerable attention to the issue of solid waste management, with special reference to hospital waste management. Inspite of this, the problem seems to be insurmountable due to, resource constraints and lack of awareness.

4.1 Background of Clinical Waste Management in Calcutta

The Calcutta Municipal Corporation has an area of 187.33 kms and has to provide services to about 8 million people. The entire corporation area has been divided into 141 wards. The Solid Waste Management Department which provides services to collect and dispose municipal waste and clinical waste has strength of nearly 15,000 persons of various categories, out of which about 13,000 are assigned primarily for cleaning services.

It was the practice of all hospitals, nursing homes, laboratories, clinics, etc. to store all types of waste generated in the above mentioned establishments together in the vats \ containers. CMC vehicles were in charge of collecting, transporting and disposing the same. These wastes were disposed off together with the general garbage collected from domestic and commercial areas. The medical waste included infectious material like amputed body parts, body fluids removed during treatment, surgery or autopsy, laboratory culture, human

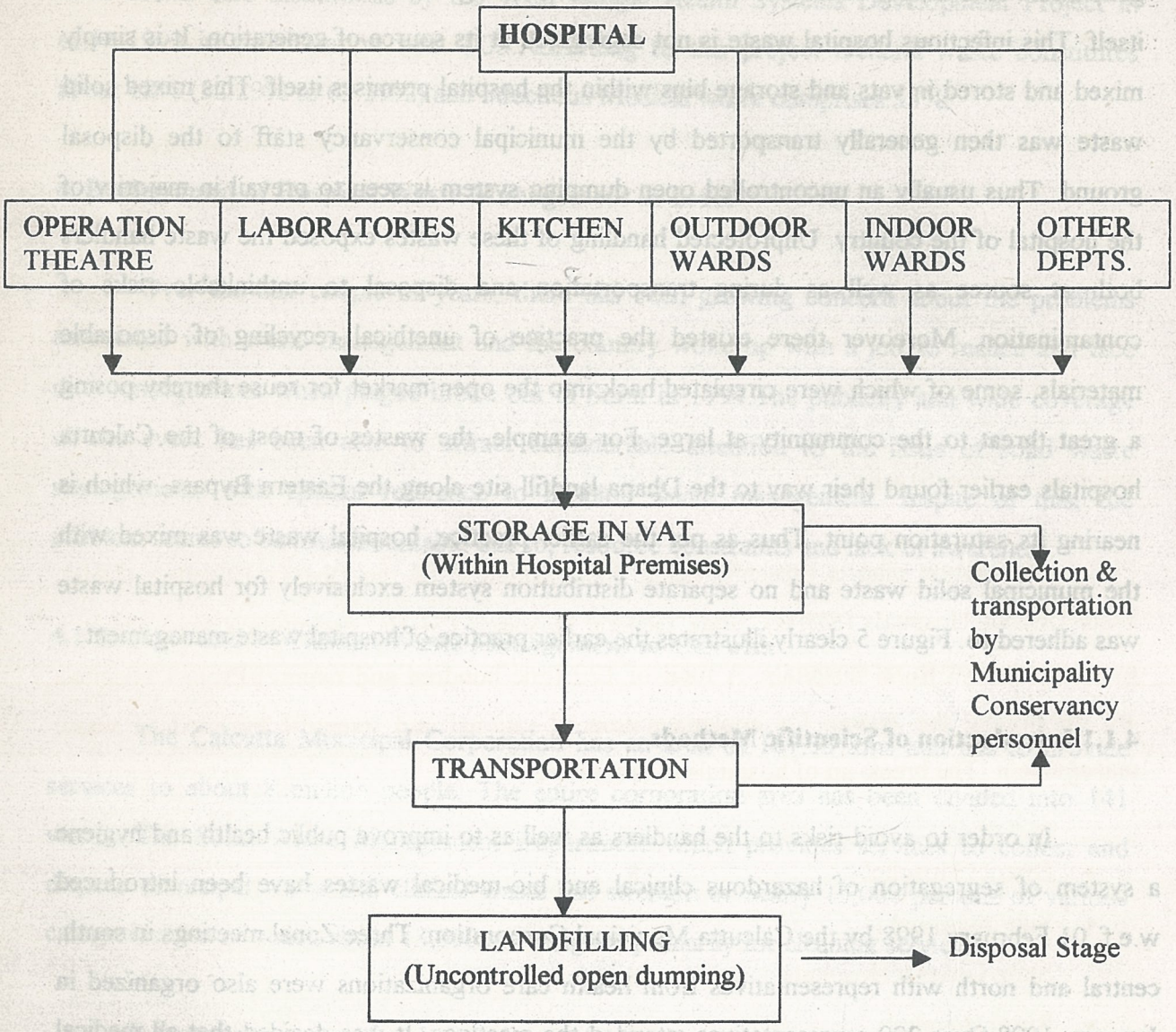
culture waste from production of biological requirements, needles, syringes, blood and pus soiled dressings, linen and beddings, catheters, plastic conduits, isolated wastes from communicable diseases etc. This infectious hospital waste is not segregated at its source of generation. It is simply mixed and stored in vats and storage bins within the hospital premises itself. This infectious hospital waste is not segregated at its source of generation. It is simply mixed and stored in vats and storage bins within the hospital premises itself. This mixed solid waste was then generally transported by the municipal conservancy staff to the disposal ground. Thus usually an uncontrolled open dumping system is seen to prevail in majority of the hospital of the country. Unprotected handling of these wastes exposed the waste handlers both at source as well as during transportation and disposal to unthinkable risks of contamination. Moreover there existed the practice of unethical recycling of disposable materials, some of which were circulated back into the open market for reuse thereby posing a great threat to the community at large. For example, the wastes of most of the Calcutta hospitals earlier found their way to the Dhapa landfill site along the Eastern Bypass, which is nearing its saturation point. Thus as per the earlier practice, hospital waste was mixed with the municipal solid waste and no separate distribution system exclusively for hospital waste was adhered to. Figure 5 clearly illustrates the earlier practice of hospital waste management.

4.1.1 Introduction of Scientific Methods

In order to avoid risks to the handlers as well as to improve public health and hygiene a system of segregation of hazardous clinical and bio-medical wastes have been introduced w.e.f. 01 February 1998 by the Calcutta Municipal Corporation. Three Zonal meetings in south, central and north with representatives from health care organizations were also organized in January, 1998.Over 200 representatives attended the meetings. It was decided that all medical institutions will have to pay extra charges for the proposed scientific system since it would involve protection to waste handlers, special closed vehicles and designing of a special disposal ground in order to prevent leachate as well as scavenging. The objectives behind this directive were:

Figure 5

Practice Of Hospital Waste Management



Source: All India Institute of Hygiene and Public Health, 1997

- To ensure protection and precaution at all levels of handling of hazardous wastes be it at source, during transportation or at the disposal site.
- To prevent unauthorized recycling of all kinds of wastes generated out of the health care system.
- It was essentially this problem of irrational management, which called for the adoption of an effective management system.
- To arrange scientific system of modified sanitary landfill so that leachate from these wastes do not contaminate subsoil water table.

The cumulative effect of all the above mentioned objectives would ensure substantial improvement in public health, particularly against diseases like AIDS, Gastroenteritis, Tuberculosis, Hepatitis, etc.

Implementation Status

This action plan is presently being implemented in all the District Hospitals (DHs), State District Hospitals (SDHs), State General Hospitals (SGHs, excepting a few) and in a good number of Rural hospitals. A total of 120 (one hundred and twenty) Project hospitals are developing the system for implementation of rational and scientific bio-medical waste management. The break-up of hospitals is as follows:

- District Hospital : 18
- Sub-divisional / State General Hospitals : 58
- Rural Hospitals : 44

Work has also been initiated (training completed and logistics procurement processes etc. have been initiated) in additional 38 project hospitals.

Analysis of various steps:

- ❖ 41% institutions are practicing four types of categorization, 46% are practicing three types of categorization and 13% are practicing two types of categorization. There is still more scope to improve the segregation practice.
- ❖ 95% of the institutions are using Syringe and Needle cutters.
- ❖ On-site sharps decontamination is practiced by 45% institutions.
- ❖ Dedicated trolley for medical waste, required for internal transportation, are in use in 85% institutions.
- ❖ Personal protective equipment (for sweepers) has been provided to 82% institutions but only a few are using it routinely.
- ❖ Secured storing of medical waste is being done in 86% Municipal area institutions (70% bicoloured storage Vat and 16% temporary secured storing).
- ❖ Only 16% Municipalities are transporting the wastes (external transportation) in segregated manner.

Figure 6, illustrates the existing management of bio-medical waste in the Project hospitals under the West Bengal Health Systems Development Project.

Final Disposal

A. *Treatment equipment*

Waste Autoclaves (three) and Waste Microwaves (two) installed by the PMC are working satisfactorily. Evaluation of functioning has been done and Waste Autoclave was found to be cost-effective. PMC is procuring 11 more waste autoclaves for on-site decontamination for the institutions having 400 beds and above. Supply is expected to be completed by the first week of September 2002.

B. *Deep Burial Pit*

➢ **Municipal areas:**

- ❖ 28 hospital's waste is currently being disposed off in specially designed Deep Burial Pits (in 21 Municipal areas), approved by West Bengal Pollution Control Board. In four Municipal areas Campus Pits have been constructed.
- ❖ 11 Municipal Deep Burial Pits and 2 Campus Pits are under construction.

- A total of 32 Municipalities are involved in the programme.

➢ **Rural areas:**

- In 18 Rural hospitals bio-medical waste is currently being disposed off in the WBPCB approved specially designed Campus Pits.
- 20 Pits are under construction.

Using the Hospital Waste Autoclave as a Common Waste Treatment Facility (CWTF)

Steps are being taken to use the Waste Autoclave of JNM Hospital, Kalyani as a common treatment facility for the Private Health care establishments. The revenue to be generated will be utilized for operation and maintenance of the said equipment.

Anatomical and Liquid Waste Recycling:

- Placentas from 20 health care institutions are being sold. Besides generation of Government revenue, the cost of infrastructural arrangement for anatomical waste disposal are also being saved.

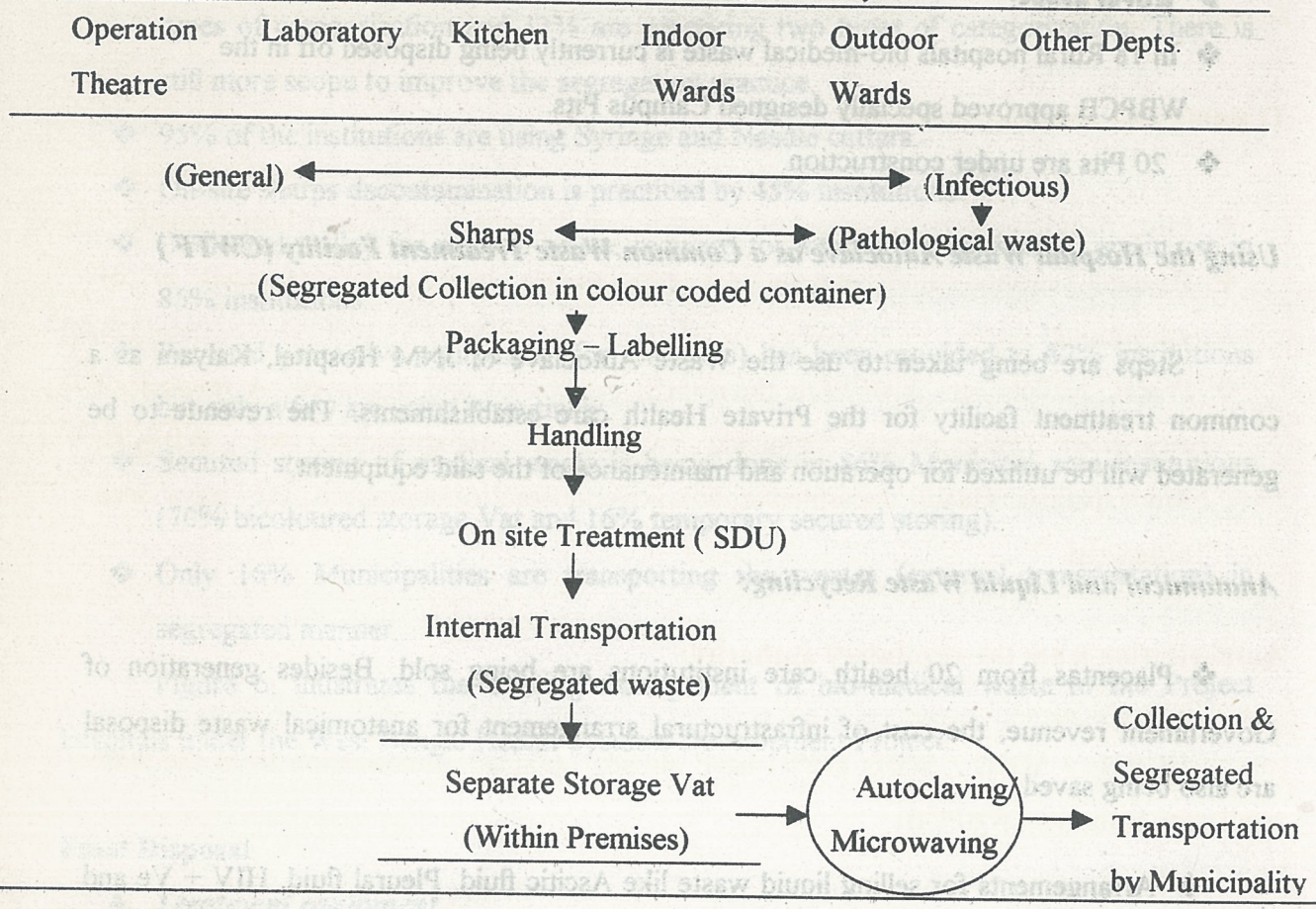
- Arrangements for selling liquid waste like Ascitic fluid, Pleural fluid, HIV + Ve and HBV + ve blood, Meconium etc. are nearly finalized. Besides regulatory compliance, government revenue will be generated without any infrastructural arrangement.

Waste Minimization:

With the view of minimizing risks as well as to reduce the overall waste volume generated from each hospital that need to be handled routinely emphasis has been given on reuse of selected health care waste materials (eg. Use of sterilized glass syringes in place of disposable etc.), as well as on substitution (eg.mercury to electronic thermometer, herbal disinfectants in place of Phenyle etc.).

Figure 6

Health Care Waste Management System



Final Disposal:

A . Urban	Landfilling (Sanitary)	→	Disposal by Municipality
	* Deep Burial (for infectious & hazardous)	→	Disposal by Municipality
B . Rural	* Trench Composting for General waste	→	By WBHSDP
	* Campus disposal for Infectious & hazardous waste	→	By WBHSDP

(Source: Institute of Public Health Engineers, 2002)

World Health Organisation (WHO) has mentioned this strategy of using glass syringes in place of disposable syringes in their Web Site – *www.who.int/inf-fs/en/fact253.html*

Training and awareness activities:

- More than 9300 health care and other concerned department staff have been trained.
- Hospital specific staff motivational programmes have been organized in 84 institutions
- Poster, leaflets etc. have been developed, distributed and displayed. A number of awareness programmes involving concerned departments like WBPCB, Municipalities, Health departments, non-governmental organizations, etc., have been organized.

Authorisation from the regulatory authority:

58 DHs / SDHs / SGHs (76%) have already obtained authorization from the state regulatory authority (WBPCB)

Pilot programme for the Private Health Care institutions:

WBHSDP has developed the system amongst the private health care institutions in one municipal area – this can be a model for developing the system in other municipal areas. Private health care establishments agreed to use hospital waste Autoclave as a common waste treatment facility (against user charges).

Extending support to other institutions:

- WBHSDP is providing technical support in developing the system in the tertiary health institutions of the state

- ❖ WBHSDP is helping Calcutta Metropolitan Development Authority (CMDA), ESI and other private hospitals in developing the system
- ❖ WBHSDP is also working closely with the other externally aided project like Kfw-Gtz project

Technical Advisory Committee:

A technical advisory committee consisting of experts from various concerned departments (All India Institute of Hygiene and Public Health, Central Pollution Control Board, WBPCB, Municipality, Public Works Department, School of Tropical Medicine etc.) are guiding the WBHSDP in developing the programme.

Liaison with the State regulatory authority:

A good liaison is being maintained with the State regulatory authority (i.e. WBPCB). Final disposal options (may be treatment equipment or land disposal are being finalized after necessary discussion with them.

Hospital specific Action Plan:

An individual waste audit, hospital specific action plan is under way. This would provide a valuable insight to the various categories of bio-medical waste and their respective quantums. (West Bengal Health Systems Development Project, 2002)

Transportation

The system was started initially with one vehicle of CMC and three vehicles from non-governmental organizations. At present all medical establishments all over Calcutta, including big Government and private hospitals are being attended by eleven vehicles. By March 17, 1998, services in Central and North Calcutta started in a big way. Initially the main constraint was the availability of appropriate vehicle for transportation. This problem

has been solved as currently eleven vehicles are specially designed with a fabricated-closed body with lock and key arrangement. With these vehicles CMC is in a better position to provide secured transportation of Bio-medical waste generated in almost 641 health care establishments. Calcutta has a total of 329 hospitals and nursing homes and 312 laboratories and clinics. The total bed strength is nearly 21451. (Solid Waste Management Cell, CMC, 2002). Fig 7, illustrates the present waste management practice undertaken in the selected Project hospitals under WBHSDP.

Disposal

For the purpose of disposal, an expert committee under the Chairmanship of Prof. K.J.Nath, Ex-Director, All India Institute of Public Health and Hygiene, members from the Department of Environment, Government of West Bengal, West Bengal Pollution Control Board and CMC was formed. The committee issued a guideline and advised the layout of the landfill site. Construction was undertaken based on those guidelines. The area has been well protected from all sides as well as from the top to prevent any recycling, animal and bird menace.

Calculation Of Area For Disposal Site

Basis: Depth = 3 Meter

Quantity of waste to be disposed of \ day = 10 Metric tones \ day

Period for which waste is to be disposed = 5 years

Compaction of landfill site = 50 %

Earth coverage on Municipal Sanitary Landfill Site = 10 % of total fill depth

Density of waste = 300 Kg \ m^3

$$\text{Area} = 1 \setminus 3 \frac{(365 \times 101000)}{300} \left(1 - \frac{50}{100}\right) \frac{1}{10^4} \left(1 + \frac{10}{100}\right) = 0.22 \text{ ha} \setminus \text{year}$$

for 5 years = 0.22 x 5 = 1.1 hq.

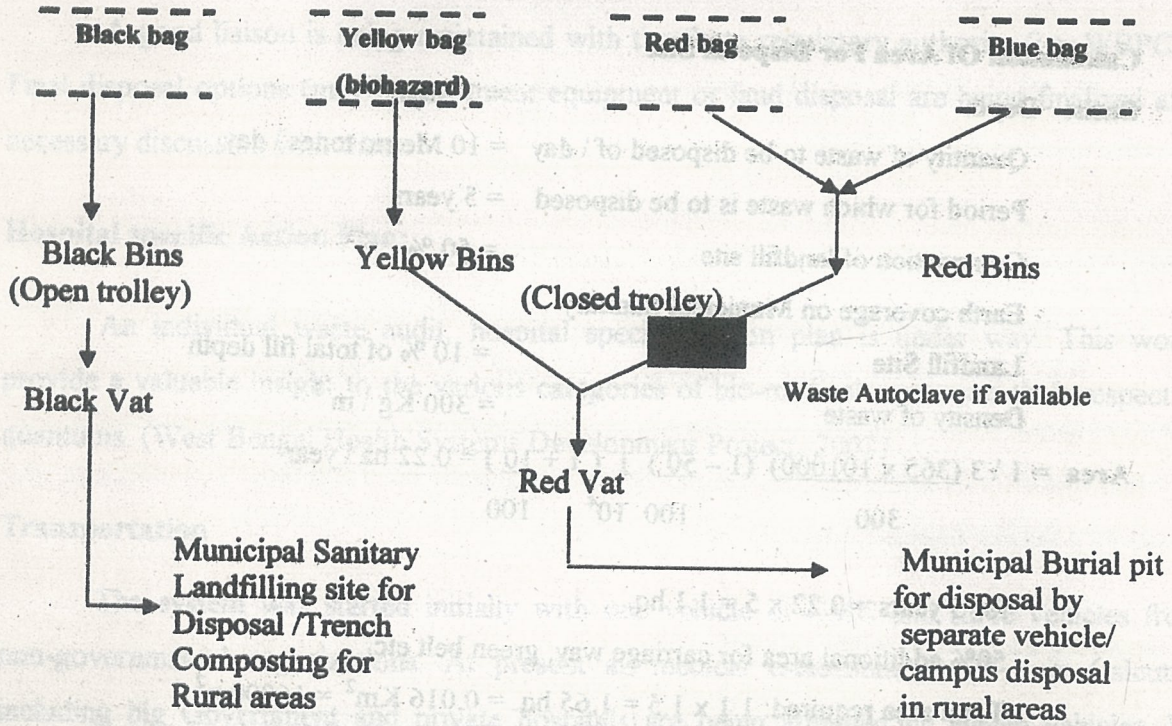
50% additional area for carriage way. green belt etc.

Total area required: 1.1 x 1.5 = 1.65 hq. = 0.016 Km^2 = 16000m^2

Figure 7

Health Care Waste Management

General	Pathological	Infectious (non-sharp)	Sharps
Food waste paper, Cardboard, Floor sweepings, Earthen Vessel, wood, shells.	Human tissue/ organ, body parts, foetus, placenta, blood and body fluids, animal caracus	Solid waste contaminated with blood and body fluids (cotton dressing, soiled plaster cut).Linen, bedding, Gloves, lab. coats. microbiology and bio technology waste isolation ward waste containing disposable items other than waste sharps e.g. tubing, catheter, I.V. Set etc.	Needles, Syringes, scalpel, blade, broken glass, nails and any other items that may cause puncture and cuts.



(Source: West Bengal Health Systems Development Project, Government of West Bengal, 2002)

Economic Costs

In order to meet the cost of transportation and scientific disposal of Bio-medical waste, rates have been approved by the Mayor-in-Council as listed below:

- Hospital \ Nursing Home having 51 and more beds – Rs. 450.00/ bed/ year
- Hospital \ Nursing Home having 50 and less beds - Rs. 400.00/ bed/year
- Laboratories and Clinics producing less than 5 kg. but more than 2 kg.waste daily - Rs. 2000.00/year
- Laboratories and Clinics producing less than 2 kg. Waste daily - Rs. 1200.00/year

(Source: Solid Waste Management Cell, CMC, 2002)

4.2 Biomedical Waste Management Problem In Delhi

Since the last couple of decades Delhi has witnessed a substantial increase in the number of medical institutions from 61 hospitals in 1979 to 77 hospitals in 1991. (Health Information of India , 1991).

Delhi has 43 general and 27 special hospitals. Besides thousands of clinics, polyclinics, dispensaries, nursing homes, local practitioners shops and veterinary hospitals have mushroomed in various residential colonies of the city.

These aseptic sanitoriums are visited by lakhs of people everyday. But neither of them is aware that the syringe with which they are injected could be from a hill of hospital waste lying at the back of the hospital of the life saving fluid which is passing into their veins could be from a bottle which has been originally picked from the heap and recycled back.

Adding further to the magnitude of the problem are the innumerable private medical practitioners who conduct surgeries within their premises and dispose the waste generated by them (bio-medical, surgical, infectious and with a potential of being reused) in Dalaos (dump

enclosures) or nearest municipal bins of the colonies. Although eight percent of the so called good "private hospitals" provide better facilities to the patients than our six percent good government hospitals. However, when waste management is concerned the two barely differ. (Mallik, 1992). Practically all medical practitioners throw disposal syringes in the disposal dumps. Similarly majority of the dispensaries dispose their wastes, which include soiled bandages and plasters behind their boundary walls.

The problem of clinical waste disposal has acquired gargantuan proportions today. In the National Capital Territory of Delhi, comprising Municipal Corporation of Delhi and the New Delhi Municipal Corporation, 5500 metric tonnes of solid waste is produced everyday by residential localities, community centres, bazars and hotels. The hospitals however generate an additional 70 tonnes of waste per day. On an average about 1.5 kgs of waste is produced per bed per day. Of the total waste produced in hospitals, 47% is bio-medical waste, which is hazardous as is contaminated with disease causing pathogens.

During a recent survey of ten government hospitals, five private hospitals, seven small private nursing homes and ten government dispensaries in Delhi by Vatavaran-a Delhi based environmental non-governmental organization, it was found that:

- 20% of these hospitals had "bhattis" (crude large ovens) for incinerators,
- 50% either burned the waste in the open or dumped in landfill sites,
- 10% took their wastes to other hospitals which had incinerator facilities,
- 20% had incinerators.

(Source: Down to Earth, 1996).

Table 3 shows the case of eight hospitals of Delhi, which provides insights about the waste handling authority, the presence or absence of incinerators, segregation practices and the amount of waste collected by ragpickers.

In Delhi's Batra Hospital and Medical Research Center greater emphases is being laid on the segregation of the different types of wastes and on the reduction of the quantity of

Table 3

DELHI HOSPITALS : WAIST-DEEP IN REFUSE

Hospital	Wastes Managed by	Segregation	Incinerator	Amount of waste picked up ragpickers	Pilferaging by Hospital staff	Non-Incinerated Wastes (total)
MEHRAULI TB	Hospital staff	No	Absent	60% infected	None	100% sputum
GURUTEG BAHADUR	Hospital staff	No	Present	10% of saleable biomedical wastes	40% of saleable biomedical wastes	50% of gloves, blood vials, bandages
RAM MANOHAR LOHIA	Hospital staff	No	Present	10% of saleable biomedical waste	30% of saleable biomedical waste	40% syringes, gloves, bottles
SAFDAR-JANG	Hospital staff	Yes	Present	10% of saleable biomedical waste	60% of saleable biomedical waste	60% bottles
AIIMS	Hospital staff	Yes	Present	10% of saleable biomedical waste	40% of saleable biomedical waste	40% bottles
JAI-PRAKASH NARAYAN	Hospital staff	No	Present	20% of saleable biomedical waste	38% of saleable blood vials, waste bandages	58% bottles, syringes,
GB PANT	Hospital staff	No	Present	30% of saleable biomedical waste	20% of saleable biomedical waste	50% dirty linen, bottles, bandages, syringes, gloves
HINDU RAO	Hospital staff	No	Absent	30% of biomedical waste	20% of saleable biomedical waste	50% of linen, bottles, bandages, syringes, gloves

(Source : Down to Earth, 1996)

waste reaching the incinerator. To facilitate segregation, dust bins with pink lining exclusively for anatomical and pathological wastes like organ parts after biopsy and gauze cotton lint soaked in blood and body fluid are to be used. On the other hand black lined dustbins would contain general municipal garbage like paper, plastic and kitchen waste (fruit peelings, egg shells etc). All these pink bags are then to be collected in a larger pink bag in 65 liters bucket with stand, tied and is to be sent to the incinerator.

A series of Srishti reports point out that the incineration process does not destroy matter; it merely changes the clinical composition and toxicity of the hospital wastes burnt. The report argues that by transforming solid toxic wastes into gaseous emissions, incinerators actually increase the volume of waste by mixing it with air and dispersing pollutants into the atmosphere. (Down to Earth, 1996).

According, to researchers from Delhi's GB Pant Hospital, pathogens, which cause Hepatitis B (a chronic and lethal liver ailment carried by 43 million Indians), for instance can remain in the blood at needle-tips or bandages and spread infection for a long time.

At the Delhi based TB Hospital, leftovers from the kitchen find their way into a bin, which has become a breeding ground for the very bacterium which the hospital was set up to demolish. Ailments like Laptospira-a brain infection, germinate at places where hospital wastes mix with household garbage.

Thus certain relevant standards and rules framed by the Ministry of Environment and Forests and endorsed by the Apex court have been issued.

5. Relevant Standards and Rules In India

The Bureau of Indian Standards adopted the Indian standard on 'Solid wastes-Hospital guidelines for management' in February 1989. (HUDCO, 1998). Apart from categorization of hospital wastes into general, chemical, pathological highly infectious, pharmaceutical, laboratory wastes, sharps and pressurized containers, it covered the various hazards and

impact of such wastes on human health. It included broad guidelines for storage, transportation and disposal of these wastes.

Table 4
Container and Colour coding for disposal of Bio-Medical Waste

Waste Category	Waste Class	Type of Container	Colour Coding
Category No.1	Human Anatomical Wastes, blood and body fluids	Single use containers / Plastic holding bags	Red/ Yellow
Category No.2	Animal and Slaughter House waste bags/sac	Single use containers Plastic holding bags	Orange
Category No.3	Microbiology & Biotechnology wastes	Single use containers/ Plastic holding bags	Yellow
Category No.4	Waste sharps	Reusable/single use sturdy container of plastic, glass or metal	Yellow/Blue
Category No.5	Discarded medicines	Reusable/sturdy cardboard/glass/plastic holding bags	Yellow/Blue
Category No.6	Solid Wastes	Plastic bags/sacs	Yellow/Black
Category No.7	Disposable	Reusable/sturdy containers/plastic holding bags	Yellow/Black
Category No.8	Liquid Wastes	NA	NA
Category No.9	Incineration Ash	Plastic bag/Sacs	Black
Category No.10	Chemical Wastes	Sturdy containers/Plastic holding bags	Yellow/Black

Note:
Yellow – Infectious wastes and / or wastes for incineration
Blue – Waste for autoclaving / equivalent treatment Red – Human anatomical wastes for burial
Orange – Animal Wastes for disinfection and burial
Black – Non-infectious wastes for municipal dumps

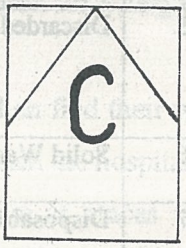
(Source: The Gazette of India, 1997)

The Ministry of Environment and Forests, Government of India, issued draft rules in April, 1995 and again on 30th August (incorporating suggestions). These were further modified and the final draft, 'Bio-medical wastes (Management and Handling) Rules, 1997 was published in the Gazette of India-October 27, 1997.These rules have been recently amended in 2000. Draft rules have been framed for segregation, packaging, storage, transportation, treatment and disposal of various bio-medical wastes. Table 4, shows the containers and colour coding for disposal of bio-medical wastes.

The labels for the bio-medical containers have also been specified by the Apex court and has been illustrated in Table 5.

Table 5

Label for Bio-Medical Wastes Containers

Biohazard Symbol	**Cytotoxic Hazard Symbol**
	

The categories of bio-medical wastes and their disposal options and standards for treatment and disposal of bio-medical waste have been incorporated in Table 6.

Several technical factors make it difficult to compare treatment and disposal alternatives. The goal for each technology is to reduce the probability of release of hazardous constituents, but no technology can offer zero release. Performance capabilities of different technologies must be considered in relative terms: releases that do occur vary in location, quantity and time.

Table 6

Treatment and Disposal Options for Different categories of Bio-Medical Waste

Waste Category	Waste Class	Treatment and Disposal Options
Category No.1	**Human Anatomical Waste, Blood & body fluids** (Human tissues, organs, body parts, body fluids, blood and blood products and items saturated or dripping with blood, body fluids contaminated with blood and body fluids removed during / after treatment, surgery or autopsy or other medical procedures)	If infectious incineration, If non-infectious then burial
Category No.2	**Animal and Slaughter House Wastes** (Animal tissues, organs, body parts, carcasses, bleeding, blood and blood products, items contaminated with blood and fluids, wastes from surgery treatment and autopsy and wastes of experimental animals used in research. Waste generated by veterinary hospitals, colleges, animal houses and livestock farms)	Disinfection and burial for solid, treatment and discharge for fluid
Category No.3 * @	**Microbiology & Biotechnology Waste** (Waste from laboratory cultures,stocks or specimens of micro organisms including genetically engineered micro organisms,live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories,wastes from production of biologicals,toxins,dishes and devices used to transfer of cultures)	Autoclaving / Microwaving and Incineration
Category No.4 #	**Waste Sharps** (Needles,syringes,scalpels,blades,glass etc. that are capable of causing puncture and cuts. This includes both used and unused sharps)	Disinfection and shredding and disposal in landfill/recycling (for PVC plastic and glassware)

Category No.5	**Discarded medicines** (Wastes comprising of outdated contaminated and discarded medicines)	Incineration or destruction and disposal in landfills
Category No.6	**Solid Wastes** (Wastes generated from soiled cotton,dressings,plaster casts,linen,beddings,material contaminated with blood including packaging materials)	If infectious incineration @ If non-infectious autoclaving/microwaving/municipal dumps/land disposal
Category No.7	**Disposables** (Wastes generated from disposable items other than the waste sharps)	Disinfection by chemical treatment/autoclaving/microwaving and shredding and disposal in secured landfill/recycling for PVC / Plastic
Category No.8	**Liquid Wastes** (Wastes generated from laboratory and washing,cleaning,house-keeping and disinfecting activities)	Disinfection by chemical treatment and discharge into drains
Category No.9	**Incineration Ash** (Ash from incineration of any Bio-medical wastes)	Disposal on secured landfill
Category No.10	**Chemical Wastes** (Chemicals used in production of biologicals,chemicals used in disinfection,as insecticides,etc.	Chemical treatment and discharge in drain for liquid sand incineration or land disposal for solids

- Pre-treatment by autoclaving / microwaving

\# Pre-treatment by chemicals 1% hypochlorite or any other chemical reagent in specified

@ No chemical treatment

(Source: The Gazette of India, 1997)

In addition to traditionally used methods of incineration and burial in landfill sites, the other **methods of treatment** of medical waste are outlined as follows:

1. Steam Sterilisation (Autoclaving): Autoclaving combines the effects of heat from saturated steam and increase pressure to inactivate and destroy microorganisms. Autoclaves are constructed of a metal chamber that allows for control of temperature,

pressure and time required to ensure destruction of microbial life. After autoclave treatment waste is usually disposed off at a landfill, a certain part is used for recycling.

2. Chemical disinfection: Method of chemical disinfection could be practiced to human anatomical waste, human blood and body fluids. Disinfectant such as chlorine or chlorine compounds, alcohol, phenotic compounds, iron compounds, formaldehyde etc. may be used for this purpose.

3. Sanitary Landfilling: This could be practiced for disposal of garbage and residue from treatment. Such landfills are to be compacted layer by layer with cover by soil after each day's disposal. Land disposal is a preferred option provided that environmental degradation and community health problem does not arise out of such practice. Landfill site should be lined and protected, thus protecting the contamination of groundwater. Landfill may be scientifically organized to minimize pollution from leaching, to reduce infestation of flies, insects and animals and to facilitate proper use of available land by adequate compaction and controlled spreading of waste. The sides and bottom of the sanitary landfill is sealed with clay, plastic membrane or some other suitable material to contain the movement of leachate from wet garbage to the sub-soil water table. After spreading the waste it is to be compacted with bulldozer to the smallest possible volume and then a layer of soil is spread over the compacted waste material.

4. Recycling: Reuse of energy and resources is what recycling implies. It reduces the load of solid waste at the final disposal site.

5. Incineration: Incineration can be defined as a controlled combustion process for burning solid combustible wastes to gases and residue containing non - combustible material. (Bhinde and Sundaresan, 1989). Incineration should be considered after a complete economic and environmental impact analysis in comparison with other processing methods depending on local conditions.

For well meaning health care facilities this could provide a basis for making plans but in practice, almost nothing materializes. There are flagrant violations of the standard, be it in planning, execution or maintenance. The main problems identified were:

(i) serious attempts were not made for keeping non-hazardous garbage (from kitchen, garden or packaging material) and infected bio-medical/pathological wastes separately,

(ii) allowing hazardous waste to get mixed with municipal garbage,

(iii) occupational hazards to both hospital and municipal waste workers as well as ragpickers,

(iv) grave risk to patients through illegal and unethical re-use of infected material, especially, syringes, needles, tubing, bottles, etc.

(v) poor performance of incinerators leading to air pollution and environmental hazard and

(vi) lack of clear and specific guidelines rules and penal provisions.

These problems were grey areas of hospital waste management, which did not have explicit solutions. It is thus interesting to study the hospital waste scenario in Delhi, which addresses these constraints.

5.1 Biomedical Waste Management Procedure

Biomedical Wastes according to Central Pollution Control Board (C.P.C.B.) Rules

No person shall handle or dispose off any biomedical waste except in accordance with these rules.

5.1.1 Waste Segregation

Waste should be segregated at source. Since 80-85% of the waste is non-infectious and can be disposed easily into the municipal bin, it is important that infected waste component is separated from the non-infectious waste. Mixing of waste will render all the

waste potentially infectious. The clinical and nursing staffs are responsible to ensure that waste is segregated at source.

Awareness and orientation programmes are essential to make the staff aware of their responsibility. Segregation at source is essential, as the different types of waste need different treatment and disposal options. It also makes a safe practice for both the generator and the handler. Schedule1of Biomedical Waste (Management and Handling) Rules, 1998 has classified various types of waste generated, as shown in Table 6.

5.1.2 Packaging and Storage

The packaging of all biomedical waste should be done in sturdy leak resistance containers conforming to the specifications prescribed in Table 4.All containers used for storage of biomedical waste as specified in the above table must be provided with a lid or covered properly.

The wastes segregated should be packed as per Schedule II of Biomedical Waste (Management and Handling) Rules, 1998.

1. Human anatomical waste generated should be packed in a yellow leak proof plastic.
2. Animal wastes should be segregated and disposed in a yellow plastic bag.
3. Microbiology and Biotechnology waste should be packed in a yellow bag or red plastic bag.
4. Waste sharps should always be placed in puncture proof containers. The needle should be mutilated in a needle cutter and treated with disinfectant before placing in a cardboard box which is disposed in the blue \ white translucent bag.
5. Discarded medicines and cytotoxic drugs are packed in a black plastic bag.
6. Soiled waste is packed in a yellow or red plastic bag.
7. Solid waste should be packed in blue \ white translucent bag or red plastic bag.
8. Incineration ash is to be stored in black plastic bag.

9. The solid part of chemical waste should be packed in a black plastic bag.

Sealing of Waste Bags

When waste bags are 3\4 th full they should be sealed by tying the necks with ropes. The disposable sharps container should be sealed with tape.

Location of Containers for Collection of Waste

There should be adequate number of plastic bins of appropriate colour to hold the corresponding colour bags. These onsite receptacles should be located close to the site of generation. Generally three types of containers are required in each station (a) for general waste i.e. those which are stored in black plastic bags-black bins (b) infectious non-sharp waste – yellow\ red bin (c) infectious sharp waste puncture proof white or blue.

Labelling

All bags and containers must be labelled, so that the site of generation of the waste can be identified. This can be done by writing the information on the bag and outer container or by self adhesive labels or tie bags.

5.1.3 Collection of Biomedical Waste

Biomedical waste bags and containers should be removed daily from the wards and departments or even more frequently from operation theatres and labour rooms. Bags and container should not be removed unless they are properly tied, secured and labelled. The waste containers are collected by hospital attendants or *safai-karmacharies.* They collect the bags and transport them in covered wheeled containers or large bins in covered trolleys dedicated for the purpose. The bins or bags will be stored in designated storage area in the

hospital. The bags and containers will be replaced by fresh containers by the attendants and *safai karmacharies*.

Central Storage Area

The waste bags in the large bins or drum containers need to be stored prior to on-site or prior to transport for off-site disposal. Clinical waste storage areas must be separate from general waste storage and should have clear signs indicating "For Clinical Waste Only". The areas should be locked and be under a caretaker who should provide access to the area throughout 24 hours.

The site of storage should be away from the kitchen and food storage areas and from public access and egress routes. It should be easily accessible to internal and off-site transport.

It should be sited on a well-drained hard floored area. It should be well lit and ventilated and kept secure from entry by animals.

5.1.4 Transport Of Biomedical Waste Inside The Hospital

Transport of Biomedical Waste inside the hospital waste routes must be designated to avoid the passage of waste through patient care areas. Dedicated wheel containers, trolleys or carts should be used to transport the waste bins to the main storage areas. They should be cleaned and disinfected in the event of any spillage.

Specification of wheeled containers

(i) The wheeled containers should be designed and constructed so that they do not have sharp edges.

(ii) They should be able to contain any leakage from damaged containers.

(iii) They should be easy to clean, disinfect and drain.

(iv) The waste can be easily loaded, secured and unloaded.

Transport of Clinical Waste to Treatment \ Disposal Unit outside the Hospital

Hazardous waste must never be transported in the same vehicle as general waste. The transportation should be done through vehicles, which are specially constructed for the purpose having the following specifications:

- Have a fully enclosed body lined internally with stainless steel or aluminium to provide smooth and impervious surface which can be cleaned
- The drivers compartment should be separated from the load compartment with a bulk head
- The load compartment should be provided with roof vents for ventilation
- In case a vehicle is not possible, bulk storage containers can be used which can be lifted on to a chasis of a vehicle
- The containers for transportation must be labelled as given in Schedule III and IV of Biomedical Waste (Management and Handling) Rules, 1998

Safety Precautions

It should be ensured that;

(i) Drivers, collectors and other handlers of waste are aware of the nature and risk of the waste

(ii) Written instructions should be provided regarding the procedures to be taken in the event of spillage or accidents

(iii) Protective gears must be provided and instructions regarding the proper use

(iv) Workers should be protected by vaccination against tetanus and hepatitis-B

5.1.5 Treatment and Disposal Options

Chemical Disinfection

Disinfection prior to disposal is required for the following categories of waste:

- Sharp waste
- Disposable infectious plastics
- Infectious glass wares
- Blood and body fluids

The most economical and effective is hypochlorite.For clean conditions available chlorine required is 0.1% and for dirty conditions, available chlorine should be 1.0%.

Autoclaving

The principle of autoclaving is the destruction of micro organisms by steam under pressure. Autoclaves or steam sterilizers are used in health care facilities for sterilization of heat resistant patient care items requiring access to body tissues.

Standards for Autoclaving

The autoclave should be dedicated for the purpose of disinfecting and treating of bio-medical waste. When operating a gravity flow autoclave, medical waste shall be subjected to:

1. a temperature of not less than 121° C and pressure of 15 pounds per square inch (psi) for an autoclave residence time of not less than 45 minutes; or
2. a temperature of not less than 135° C and a pressure of 31 psi for an autoclave residence time of not less than 30 minutes

Medical waste shall not be considered properly treated unless the time, temperature and pressure in monitors indicate that the required time, temperature and pressure were reached during the autoclave process. If for any reason the above mentioned parameters were not

reached, the entire quantity of medical waste must be autoclaved again until the specified temperature, pressure and residence time are achieved.

Recording of operational parameters

Each autoclave should have graphic or computer recording devices, which will automatically and continuously monitor and record dates, time of day, load identification number and operating parameters throughout the entire length of the autoclave cycle.

Validation test

Spore testing:

The autoclave should completely and consistently kill the approved biological indicator at the maximum design capacity of each autoclave unit. Bio-logical indicator for autoclave shall be *Bacillus Stearothermophilus* spores using viais or spore strips, with at least 1x10 to the power 4 spores per millimetre .Under no circumstances will an autoclave have minimum operating parameters less than a residence time of 30 minutes, regardless of temperature and pressure, a temperature less than 121° C or a pressure less than 15 psi.

Routine Test

A chemical indicator strip \ tape that changes colour when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different locations to ensure that the contents of the package have been adequately autoclaved.

Autoclaving is an effective method for treating infectious waste before disposal. A separate autoclave dedicated for waste treatment should be used. Autoclaving is necessary for the treatment of the following types of waste:

1. Waste arisings from microbiology and biotechnology laboratories, which may include highly infectious waste such as cultures. This must be autoclaved in special containers and then sent for disposal.

2. Plastic disposables (infectious) including blood bags, urine bags etc. Autoclave will not cause visible mutilation of some plastics.

Incineration

At the present moment incineration seems to be the most feasible method to treat the infectious waste particularly pathological waste such as anatomical body parts. The aim of incineration is to ensure complete combustion of the waste, producing totally sterile residues and emissions from the stack, which will comply with standards laid down by the Central Pollution Control Board (C.P.C.B.). The volume of waste is greatly reduced to only a handful of ashes.

The C.P.C.B. has recommended two types of incinerators:

(i) Incinerators for individual hospitals \ nursing homes \ medical establishments

(ii) Common incinerator to handle wastes from a number of hospitals \ nursing homes \ pathological laboratories, etc.

Site for Incinerator

Incinerators should be installed at appropriate location to avoid nuisance to patients and neighbourhood.

Legal Framework

For setting up of incinerator, necessary consent shall be obtained from the concerned State Pollution Control Board \ Committee. Special care shall be taken while transporting of wastes from the hospital to the incinerator in closed containers. The protocol for transportation shall be finalized by the local authority in consultation with the State Pollution Control Board Committee. The vehicles carrying wastes should be labelled accordingly. The

hospitals \ nursing homes which are unable to set up incinerators within their premises due to lesser quantum of incinerable waste generation or for other financial constraints, can collectively install common incinerators or avail the incinerator facility of other hospitals through a mutual agreement among themselves.

Specifications for Incinerator (According to Central Pollution Control Board)

The incinerators should meet the following standards:

1) Combustion Efficiency shall be at least 99.99%

It is computed as follows:

$$C.E. = \frac{\%\ CO_2}{\%\ CO_2 + \%CO \times 100}$$

2) The incinerator should consist of two chambers, primary and secondary. The temperature in the primary chamber should be 800° + 50° C while the temperature in the secondary chamber should be 1050° C + 50° C with the minimum 3 % O^2 in the stack gas

3) Particulate matter 100 mg \ Nm^3 (12% CO^2 correction)
4) Sulphur dioxide 150 mg \ Nm^3 (12% CO^2 correction)
5) Nitrogen oxide 450 mg \ Nm^3 (12% CO^2 correction)
6) Hydrogen chloride 50 mg \ Nm^3 (12% CO^2 correction)
7) Minimum stack height shall be 30 m

Disposal of incinerator residue (ash): Ash from incinerator is hazardous in that it may contain high quantities of heavy metals. The removal of ash and residues from incinerator may present a risk to operators from the dust and non-combustible elements. Dust masks, provision of ventilation and dumping down are essential to protect the workers. Special landfills are required for the disposal of incinerator ash.

Mutation \ Destruction \ Shredding

This will cause a reduction in volume of the waste treated and will also effectively prevent its reuse.

It is required for the following type of wastes

(i) Needles and syringes

(ii) Plastic disposables

(iii) Should be done by needle and syringe destroying machines, shredders or macerators, which are placed ideally at site of generation.

Manual destruction is not recommended.

Specifications

(i) Should be able to effectively shred \ macerate \ mutilate one or more items rapidly

(ii) Preferably shred metals and plastics i.e. allow the needle and syringe to be introduced together so that the needle does not have to be removed from the syringe as this may be hazardous. The quality and grade of cutting blades is critical

(iii)Preferably have a disinfecting system to disinfect the shredded waste residue and itself

(iv)Should be covered and must have safety provisions to protect the operator and environment against dust and aerosols

Microwaving

Microwave is suitable for the treatment of most infectious waste with the exception of body parts, human organs and large metal items. Cytotoxic, radioactive wastes and hazardous chemical wastes cannot be treated by microwaving.

Microwave treatment units include an initial destruction phase where it is shredded and sprayed with steam. The moist ground waste is then heated by exposure to 6 microwave irridation units over a two hour period. The process heats the waste to > 90° C.

The indicator organisms to test the system are spores of *Bacillus subtilis* (globigii) 10 4 spores \ ml.

Liquid Waste

Pathological and chemical liquid waste must be appropriately treated before discharge into the sewer.

Chemical waste must first be neutralized with appropriate reagents and then flused into the sewer system.

Standards for Liquid Waste

The effluent generated from the hospital should conform to the following limits:

Parameters	Permissible limits
pH	6.5 – 9.0
Suspended solids	100 mg \ lt
Oil and grease	10 mg \ lt
BOD	30 mg \ lt
COD	250 mg \ lt
Bioassay test	90% survival of fish after 96 hours in100% effluent

These limits are applicable to those hospitals, which are either connected with sewers without terminal sewage treatment plant or connected to public sewers. For discharge into

public source with terminal facilities the general standards as notified under Environment (Protection) Act, 1986 shall be applicable.

Landfilling of Biomedical Waste

If hazardous waste is disposed on a municipal disposal site, control and supervision are difficult. Difficulties are commonly experienced when trying to keep unauthorized persons off the disposal site. Armed guards may even be required to keep scavengers from entering the site. A round the clock security personnel may be necessary. Thus a specially constructed landfilling cell for hazardous waste with closely supervised operation is a viable alternative. Hazardous waste must be immediately buried under 0.5 m of soil.

Site for landfill

(i) Must be authorized by regulating authority

(ii) As clinical waste can cause significant risk to water resources during heavy rainfall, landfill site should not be located near sources of water abstraction

(iii) Should be securely fenced

(iv) Should be far enough from public view

Method to make a sanitary landfill

This is an effective option in waste disposal, if the community hospital has sufficient plot and wishes to operate its own disposal. The functional steps are as follows:

(i) **Dig up a trench**: In case it is a plateau and the ground water level is low, the trench should be dug up wide and long enough along the area. Several trenches can be made according to requirements. Each side of the trench should have 30 degrees slope. The depth and width of trench is recommended at 1.20 x 2.50 m. Soil dug up should be piled up beside and along the trench for convenience in using for covering wastes when required

(ii) **Dump the collected wastes in the trench**: Spread the wastes along the trench with an average thickness of about 50 cms, compact them with tractor or any other kind of pressing machines.

(iii) **Pressing**: Tractors or any kind of compacting machine will be applied to compact the waste as much as possible.

(iv) **Covering:** To cover the surface of the compacted wastes, use soil prepared beside the trench and recompact the covering soil, generally recommended per each layer as thick as 50 cms in as doing, it will prevent foul smell and being disturbed by pests or animals.

Once the trench is filled up, a new trench can be dug up and the procedures followed. The waste being buried in this manner for 2 to 3 years will reduce themselves by 10 to 30 percent. After they have been completely decomposed, the place can be converted into garden, children's playground or health promotion garden.

Landfill Operation

Clinical waste is deposited in specially constructed cells and immediately covered with at least 0.5 m of suitable cover material. This cover serves to protect the clinical waste from machinery operating on the landfill for compaction.

Burial

Pathological waste, anatomical body parts can be buried with plenty of lime at a suitable burial site secure from scavenging animals and securely fenced.

Standards for Deep Burial

I. A pit or trench should be dug about 2 meters deep. It should be half filled with waste then covered with lime within 50 cms of surface, before filling the rest of the pit with soil.

II. It must be ensured that animals do not have any access to burial sites and covers of galvanized iron \ wire meshes may be used.

III. On each occasion, when wastes are added to the pit a layer of 10 cm of soil shall be added to cover the waste.

IV. Burial must be performed under close and dedicated supervision.

V. The deep burial site should be relatively impermeable.

VI. The pits should be distant from habitation and sited so as to ensure that no contamination occurs of any surface water or ground water. The area should not be prone to flooding or erosion.

VII. The location of the deep burial site will be authorized by the prescribed authority.

VIII. The institution shall maintain a record of all pits for deep burial.

5.2 The Need For Effective Waste Management

Good, practical and comprehensive waste management programmes should be implemented in Indian hospitals at the earliest. The above mentioned dangers posed by hospital waste is certainly an eye opener for not only the hospital authorities and the government bodies but also for the community at large. The risks posed by hospital waste can never be totally eradicated but careful planning and prompt execution can significantly reduce them. Inadequate strategies must be tackled before the risks escalate to the extent where major disasters result.

Most good hospitals in the country have incinerators. The immediate requirement would be to update them. This would be the most economical option and the one that will be met with least resistance. The smaller nursing homes and dispensaries can use the incinerators of nearby bigger hospitals or a few extra off-site incinerators can be installed.

It is important that the government does not allow outdated technology and does not go for the mushrooming of incinerators in the city. A simple formula would be to find out how much hospital waste needs to be incinerated in a city and then decide on the number of

incinerators required for the total hospital waste produced. Approximately only 25% needs to be incinerated. For example, about 2000-3000 kgs of hospital waste needs to be incinerated everyday from all medical care facilities in Delhi. Thus 10-15 incinerators of 200 kg capacity would suffice for Delhi. Oversized incinerators must be avoided, as they would be difficult to manage. (Mallik, 1997)

Use of disposal equipment in Indian hospitals has increased the cost of health care many times. If the hospitals can stop the use of plastic equipment and replace it with glass, it would not only stop the problem of disposable items, coming back into circulation, but also the cost of health care would go down. Thus all hospitals need to have proper treatment facilities, which are practically absent at the moment.

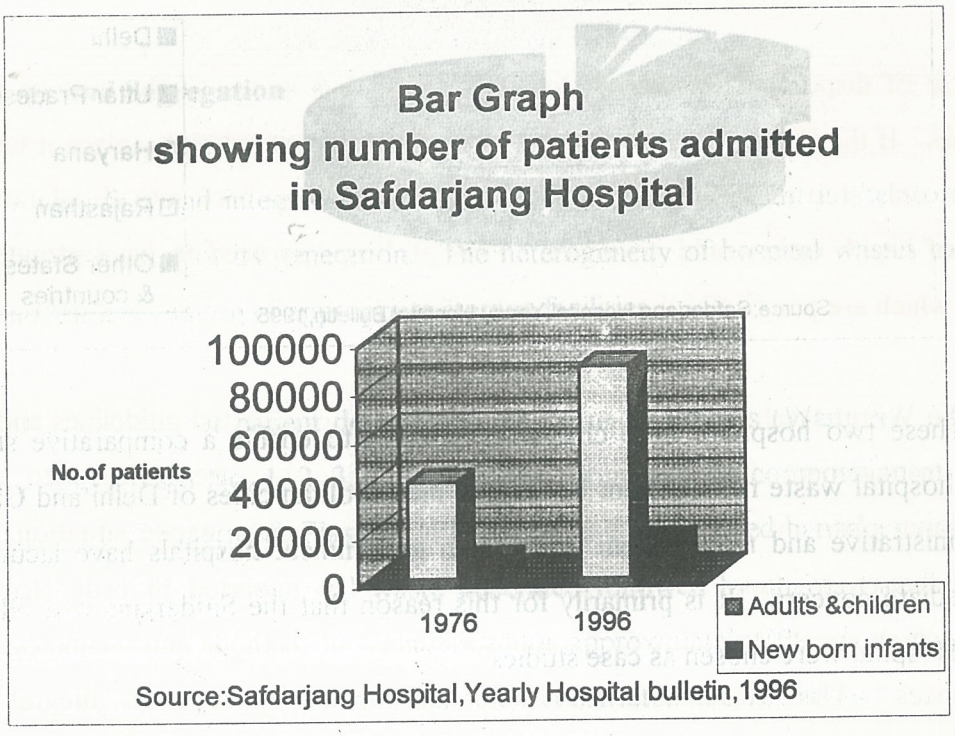
The World Health Organization has exclusively documented guidelines and standards of waste management. Further plans are required to translate these ideas into a workable reality. Such plans must be tailored exclusively to suit India's unique situation. First and foremost awareness, motivation and training should be imparted in order to implement schemes, which should be followed by appropriateness of methods and technologies to local circumstances. Thus sustainability and effective functioning form an integral part of a rational waste management system.

6. Introduction To The Study Area

Safdarjang Hospital a renowned Central Government hospital of Delhi and Nil Ratan Sarkar (NRS) Medical Hospital - Calcutta is selected for the study, where the existing hospital waste management scenario has been analysed. Safdarjang Hospital, located on the Outer Ring Road, was established in 1954 when it comprised of only six out patient departments, viz. Orthopedics, Pediatrics, Gynaecology, Neurology, Medicine and Surgery. Since then the hospital has witnessed a substantial increase in the out patient departments (OPD), totalling to an impressible figure of 27 out patient departments. Presently, the bed strength of this hospital is 1531. (Safdarjang Hospital - Yearly Hospital Statistical Bulletin -

1996). In figure 8, the bar graph illustrates the number of adults and newborn infants admitted in 1976 and 1996.

Figure 8

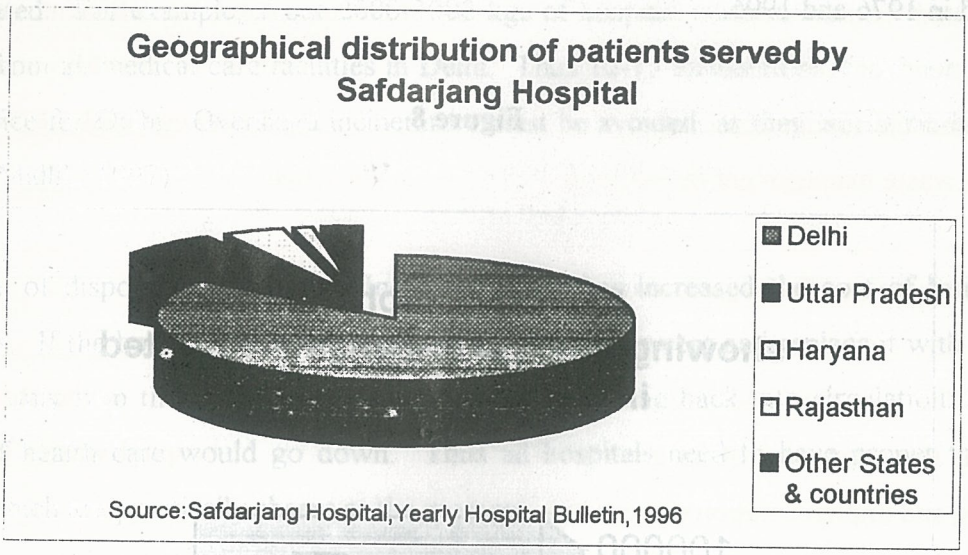


Source:Safdarjang Hospital,Yearly Hospital bulletin,1996

This hospital not only serves patients of the union territory of Delhi but also of the neighbouring states of Haryana, Rajasthan, Uttar Pradesh and other states and countries. Figure 9, illustrates a pie chart showing the geographical distribution of patients served by Safdarjang Hospital.

Nil Ratan Sarkar (NRS) Medical College Hospital is a State Government hospital located in Sealdah (North Calcutta) - one of the commercial centres of Calcutta. This hospital was established much before Safdarjang Hospital in 1949. The daily average number of in-patients in 1996 was 1270 which has witnessed an almost three fold increase since 1955 when it was merely 416 in -patients.

Figure 9



These two hospitals were chosen as samples to enable a comparative study of the existing hospital waste management in the two metropolitan cities of Delhi and Calcutta. As the administrative and management scenario in government hospitals have lacunae, it calls for immediate concern. It is primarily for this reason that the Safdarjang and NRS Medical College Hospital were chosen as case studies.

The Burns & Plastic OPD and Gynaecology OPD were selected to assess the entire hospital waste management procedure, as these wards generated large volumes of pathological and anatomical wastes. Moreover these categories of waste have not received desired attention from the hospital authorities. Further as both these hospitals were located in the vicinity of the commercial areas, they have profound impact on the surrounding environment. Thus this report is an effort to examine the inter-relationships between the hospital and the community at large.

6.1 Phases in Hospital Waste Management in the Study Area

Hospital waste management involves managing activities associated with the storage, transportation, treatment and finally the disposal of hospital waste in an environmentally

compatible manner with due considerations on the principles of economy, health, aesthetics, energy and conservation. (HSMI, 1990) In order to evolve an efficient and rational management of the hazardous hospital waste, it is essential to identify and explicitly understand the fundamental aspects and relationships involved between each of the phases of hospital waste management in Safdarjang Hospital in particular.

6.1.1 Storage and Segregation

The very first and integral stage of hospital waste management is the storage of the waste at the very point of its generation. The heterogeneity of hospital wastes calls for the planning and implementation of appropriate storage facilities.

In the selected out patient departments of Burns & Plastics (Ward No. 22, 23, 23a) and Gynaecology (Ward No. 1, 2, 3, 4, 5) the type, nature and the composition of the wastes varied greatly. In the Burns & Plastics OPD, blood and pus soaked bandages and dressings constituted almost 85% of the total waste generated followed by sharps (needles, syringes etc.) and plaster casts, which together make up for approximately10% of the waste output. Discarded medicines and blood stained beddings constituted the remaining 5% of the bio-medical waste. The proportion of this waste was comparatively higher in the ward nos. 1,2,3,4 and 5 of the Gynaecology OPD, constituting almost 25% of the hospital waste generated. Placenta from childbirth, needless and dressings were the other major bio-medical wastes, which comprised a substantial portion of the total quantum of hospital waste.

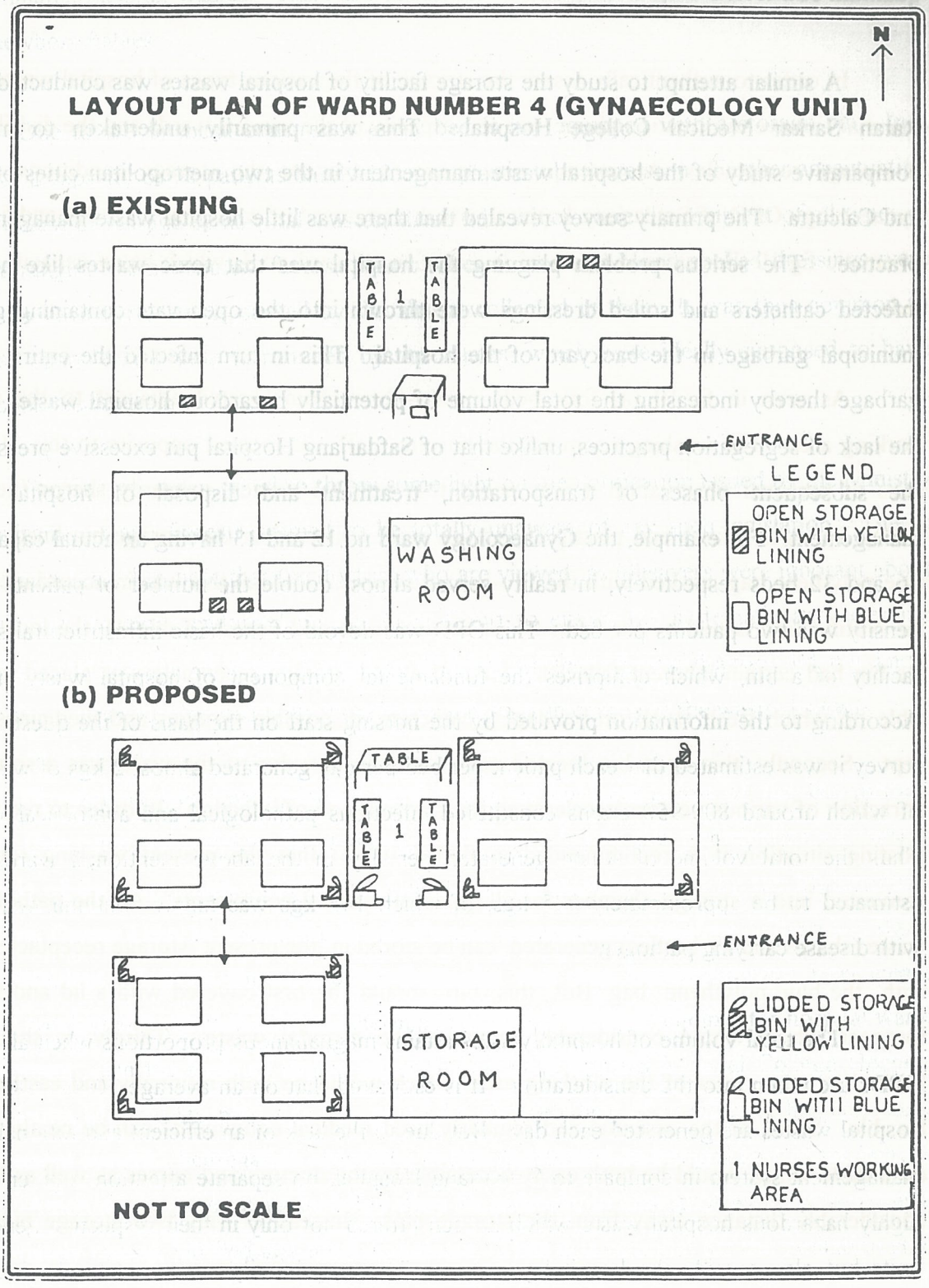
Contrary to the general callous hospital waste management practices all along the length and breadth of the country, it was indeed encouraging to note that the sanitation staff of Safdarjang hospital were if not in totality, trying to follow the guidelines laid down by the Ministry of Environment and Forests with respect to the type of the container and colour coding to be specified for the storage of different bio-medical wastes (Table 4). Lidded metal bins lined with yellow plastic bags, marked with the Bio-hazard symbol in red were located at strategic points in all the wards for collecting sharps and pathological wastes (amputated

body parts and blood stained dressings). These colour codes facilitated the immediate identification of the nature of hospital waste contained within the bins.

In order to authentically assess the storage of the various types of hospital wastes it is essential to have information about the total capacity of the various wards and the distribution of storage receptacles. An attempt was made to examine the storage conditions of the Gynaecology OPD of Safdarjang hospital, which comprised of ward nos. 1, 2, 3,4 and 5. The schematic fig.10 illustrates the general layout plan of ward no.4, which has a capacity of 18 beds.

As seen in fig.10 (a) four beds occupy one room located adjacent to the nurses working area. The washing room for the hospital staff was located opposite to this. On the basis of personal observation it was noted that hospital wastes, primarily sharps (needles, blades, syringes, glass) and plastic IV bottles were collected in the storage bin lined with a blue polythene bag marked with the Bio-hazard symbol. Though this was in accordance with the Notification issued by the Ministry of Environment and Forest (Table 4), the location of the bin had certain inherent fallacies. First of all the storage receptacle was placed under a table on which fresh stock on bandages, catheters, disposable syringes and medicines were kept. Secondly, this open bin located near the main corridor of the ward was a source of attraction of various vectors accelerating the transmission of infection. In order to rectify the existing situation it is recommended in figure 10 (b) that the present washing room be converted into a storage chamber for all types of medical equipments. All the pathological waste (sharps and IV bottles) generated can be stored in the present storage receptacle lined with the blue polythene bag. But this bin should be first covered with a lid and have a footgear which would considerably minimize the hospital waste. Thirdly, it should be located in one corner of the working area, which would be both rationally and aesthetically feasible. Some of the essential and regularly used medical equipments can be neatly placed on a table which would be both easily accessible by the doctors and nurses as well as be at a considerably distance away from the storage bins. Instead of only two storage bins with

FIGURE 10


N
LAYOUT PLAN OF WARD NUMBER 4 (GYNAECOLOGY UNIT)
(a) EXISTING
TABLE
1
TABLE
ENTRANCE
WASHING ROOM
LEGEND
OPEN STORAGE BIN WITH YELLOW LINING
OPEN STORAGE BIN WITH BLUE LINING
(b) PROPOSED
TABLE
TABLE
1
TABLE
ENTRANCE
STORAGE ROOM
LIDDED STORAGE BIN WITH YELLOW LINING
LIDDED STORAGE BIN WITH BLUE LINING
1 NURSES WORKING AREA
NOT TO SCALE

yellow lining, four bins one each for one bed is recommended to collect and store increase quantum of infected hospital wastes.

A similar attempt to study the storage facility of hospital wastes was conducted in Nil Ratan Sarkar Medical College Hospital. This was primarily undertaken to make a comparative study of the hospital waste management in the two metropolitan cities of Delhi and Calcutta. The primary survey revealed that there was little hospital waste management in practice. The serious problem plaguing the hospital was that toxic wastes like needles, infected catheters and soiled dressings were thrown into the open vats containing general municipal garbage in the backyard of the hospital. This in turn infected the entire pile of garbage thereby increasing the total volume of potentially hazardous hospital wastes. Thus the lack of segregation practices, unlike that of Safdarjang Hospital put excessive pressure on the subsequent phases of transportation, treatment and disposal of hospital waste management. For example, the Gynaecology ward no.12 and 13 having an actual capacity of 26 and 32 beds respectively, in reality served almost double the number of patients as the density was two patients per bed. This OPD was devoid of the basic infrastructural storage facility of a bin, which comprises the fundamental component of hospital waste storage. According to the information provided by the nursing staff on the basis of the questionnaire survey it was estimated that each patient per bed per day generated almost 2 kgs of waste out of which around 800-950 grams constituted infectious pathological and anatomical wastes. Thus the total volume of waste generated per day in the above mentioned wards were estimated to be approximately 205 kgs. of which 145 kgs was highly contaminated waste with disease carrying pathogens.

The total volume of hospital wastes attains magnanimous proportions when all the 14 OPDs are taken into the consideration. It is estimated that on an average 3000-3500 kgs of hospital wastes are generated each day. But due to the lack of an efficient and rational waste management system in compare to Safdarjang Hospital, no separate attention is given to this highly hazardous hospital waste which is seen littered not only in their respective generation units but also outside the hospital premises. This is primarily attributed to the increased

mobility of cats, dogs and cows which are instrumental in the widespread diffusion of contaminated hospital wastes. There are numerous instances where cats and dogs run away with newborn babies.

Due to the financial constraints every bed is not equipped with a storage bin. In a ward of a capacity of 32 patients barely 12 open plastic tubs were seen. Further accentuating the problem of storage of hospital wastes, these tubs which were the recipient of all types of wastes ranging from vomitus, faeces, plastic tubes to pus and blood soaked dressings were found to have perforations caused by the sharps collected in them. It was thus common to witness open leaking bins surrounded by the wastes, which were ideally supposed to have been contained therein.

The doctors when asked to throw some light on the notification issued by the Ministry of Environment and Forests seemed to be totally unaware of any such legislation. This is indeed paradoxical to note that the doctors who are viewed, as lifesavers were ignorant about the relevant standards endorsed by the Apex Court to ensure the systematic and scientific collection and storage of highly hazardous hospital wastes. A few doctors did not know where the dustbin was located in the hospital or who was in charge of the waste disposal.

Growing concern with respect to the lack of implementation of the Bio-medical wastes (Management and Handling) Rules, 1998, have led to the participation of various hospitals of the two cities of Delhi and Calcutta in an initiative taken by the Multinational Resource Center USA to access the hospital waste management practices. Glenn Mc Rae - Vice President of CGH Environmental Strategies and Ann Leonard-former Greenpeace worker conducted 'walk-throughs' to determine the kind of storage required for hospital waste management. On the basis of similar observations made in NRS Medical College Hospital and Calcutta Medical Hospital, Mc Rae noted the complete lack of an effective hospital waste management system. Segregation according to him constituted an integral part of the storage phase. Amongst the other steps included were an authority in charge of waste management, appropriately placed, labelled and lined containers. Thus it is essential for the sanitation staff

of both the Safdarjang Hospital and Nil Ratan Sarkar Medical College Hospital to function on the guidelines framed by the Ministry of Environment and Forest, giving special emphasis to segregation of hospital waste at its source, which would greatly reduce the total volume of hospital waste generated.

6.1.2 Transportation of Hospital Waste in Safdarjang Hospital

In Safdarjang Hospital the transportation of waste is carried out in two stages, viz. Primary and Secondary transportation. Primary transportation includes the transport of infected hospital waste collected from each of the 27 OPDs to the incinerator for treatment purposes. The class IV workers or the *Safai-Karamcharies* constituted the basic waste transporting work force, collecting the wastes from the various generating units (Wards and Operation Theatres) and then transferring it to the incinerator. Safdarjang Hospital has employed *Safai-Karamcharies* to facilitate the transportation of infected wastes, which has the potential of spreading many diseases.

In the Burns and Plastics OPD (Ward No. 22, 23,23a) and the Plaster/Dressing room *safai-karamcharies* were directly engaged in collecting and transporting waste. As the waste generated from these wards comprised of infectious pus and blood soaked bandages, plaster casts, needles and scissors, it was collected twice a day. On days when the patient inflow was high, the frequency of waste collection and transportation was increased to three times a day, divided into three shifts of 8 hours each. The sweepers collected primary, yellow, blue and black polythene bags from all the wards and the Intensive Care Unit, which contained anatomical, pathological (sharps) and general household garbage (paper, egg shell etc.) respectively. On an average 3 black bags and 2 bags each of blue and yellow colour coding were transported from the Burns and Plastic Unit in the first shift (7 am-2 pm) during which time the dressing of majority of the patients was carried out. But after the closure of the Dressing room at 1 pm, the quantum of waste generated substantially reduced to only 1 bag of blue and yellow each and 2 bags of black polythene bags. This was because of the fact that the generation of general waste like paper, fruit peeling and packaging material was high

and included not only wastes generated by patients but also the visitors. Though segregation of hospital waste was being carried out as per the guidelines issued by Ministry of Environment and Forests, all the wastes contained in the different colour polythene bags were first transformed into big black bags and ultimately carried to the incinerator, thus defeating the very purpose of incineration. As the greater proportion of hospital waste contains high putrescrible matter and the tropical climate accentuates the rapid decomposition of this waste, it is essential that the contaminated waste is collected and transported thrice a day.

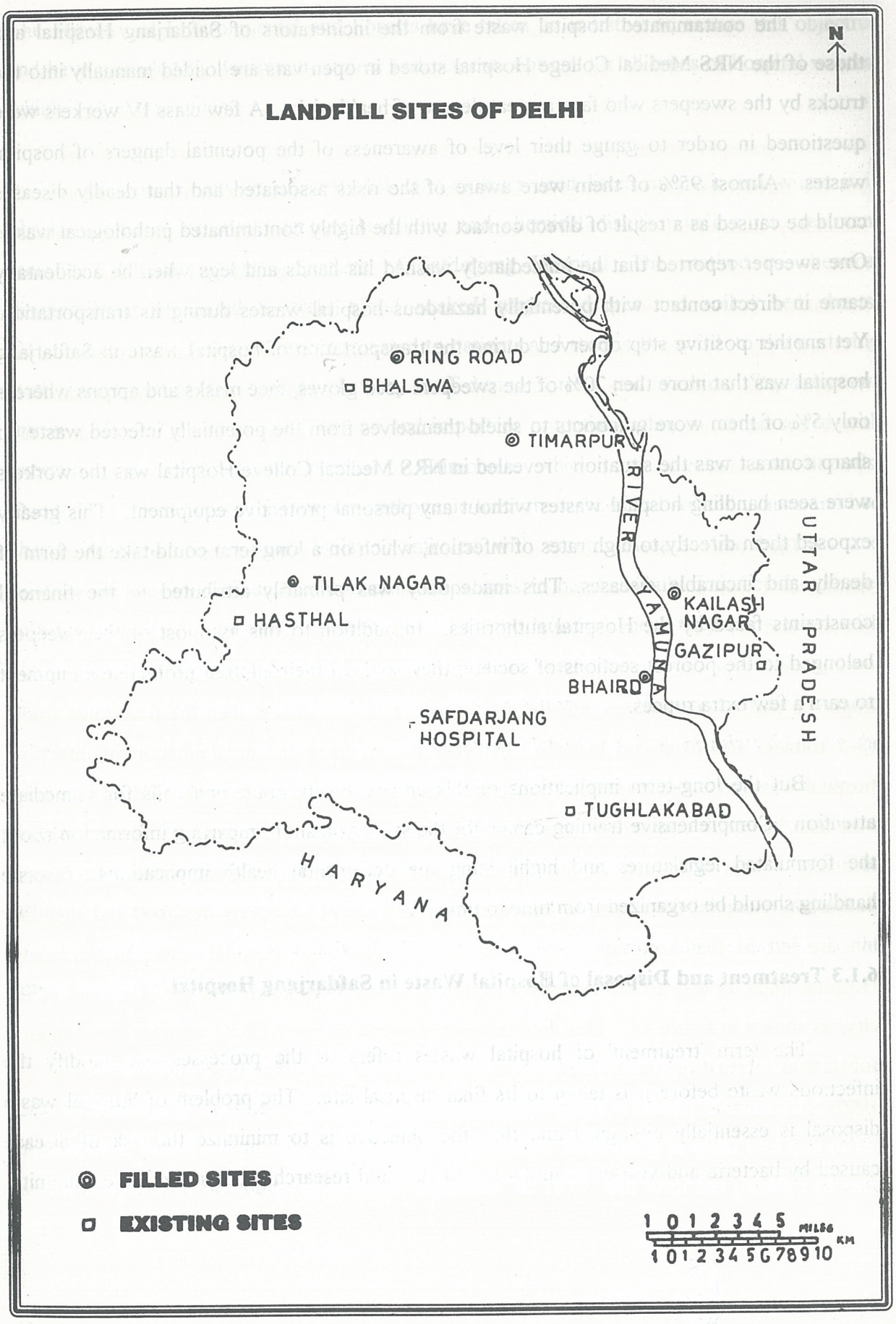
In order to facilitate the transportation of infected hospital wastes, the Central Government has provided funds to Safdarjang Hospital to use two and three wheeler trolleys and wheelbarrows. These manually operated equipments transferred the wastes properly tied in black polythene bags thus minimizing if not totally curbing the probability of release of hazardous constituents from the storage receptacle to the main garbage bin. The transportation of hospital wastes, accounted for about 60-80% of the total expenditure incurred.

The faulty design of the vehicles substantially limited the carrying capacity and compelled the sweepers to undertake a number of trips everyday, which increased the total time taken to transport a specified amount of waste considerably. On the basis of the questionnaire survey it was estimated that about an hour and a half is spent in the collection and transportation of hospital wastes from each of the wards. Thus it was calculated that it would require as much as 6 hours to transport all he wastes generated in the Burns and Plastics OPD. This reflects the wastage of valuable time as well as drain of human capital resource could have been utilized more efficiently and productively by organizing training camps for class IV workers and launching a Cleaning Brigade which would bring about a complete metamorphosis from a hospital littered with wastes to one of garbage and infection free environment. For the optimum performance of the transfer facilities, the proper selection of equipment and its utilization are essential. Very little has been done in terms of experiment in the field of primary transport of hospital waste. Innovations are limited and despite the increasing volumes of hazardous wastes, the obsolete infrastructure is yet to

witness a break through. Primary transport vehicles such as handcarts, trolleys and wheelbarrow, have a low loading height of about 1 mt., which has adverse health impact. Moreover, around 90% of these vehicles are open and result in seepage of water and littering the entire transport route. Not only are the design of the primary transport vehicles are faulty but the three New Delhi Municipal Corporation (NDMC) trucks which are engaged in the secondary transportation of incinerator waste (bottom ash and fly ash) also have inherent fallacies. These trucks are open flat bedded which not only spread foul smell but also drop substantial quantities of infected hospital waste along their route to the landfill site of Bhalsawa (fig 11). Therefore the thrust lies in the designing of primary transport vehicles like trolleys. The loading height should range between 1.5-2 mts. to facilitate transportation of waste by the sweepers and reduce the detrimental health impacts like a acute backaches, spondilities and arthritis.

The vehicles should be covered to minimize if not prevent the infected waste from getting air-borne and also to avoid water from entering which would increase the moisture content and provide fertile environs for the growth of pathogens. Tipping gears, preferably double shaft type are recommended to ensure quick unloading. Other additions to the fleet might be that of compactors which carry more wastes (7 tonnes) then the traditional trucks (3-5 tonnes) and front-end loaders. In order to terminate the dissemination of infectious hospital waste, it is recommended that tipper trucks with lined shutters be used. The storage bins also be made compatible with these trucks so that the bins may be unloaded without difficulty. This is termed as the 'containerized' transport of hospital waste. In case of Safdarjang Hospital the routes of the refuse vehicles are not properly designed and specified but are left to the discretion of the vehicle operator. The hospital waste of Safdarjang Hospital finds its way to the Bhalsawa landfill site, which us located in the other end of the city, as shown in figure 11. This long distance covered by the NDMC vehicles bring about a substantial increase in the transport cost, by increasing the direct costs by as much as 50-100%.

FIGURE 11


N
LANDFILL SITES OF DELHI
RING ROAD
BHALSWA
TIMARPUR
RIVER YAMUNA
UTTAR PRADESH
TILAK NAGAR
HASTHAL
KAILASH NAGAR
GAZIPUR
BHAIRO
SAFDARJANG HOSPITAL
TUGHLAKABAD
HARYANA
FILLED SITES
EXISTING SITES
1 0 1 2 3 4 5 MILES
1 0 1 2 3 4 5 6 7 8 9 10 KM

The contaminated hospital waste from the incinerators of Safdarjang Hospital and those of the NRS Medical College Hospital stored in open vats are loaded manually into the trucks by the sweepers who face a great degree of health risks. A few class IV workers were questioned in order to gauge their level of awareness of the potential dangers of hospital wastes. Almost 95% of them were aware of the risks associated and that deadly diseases could be caused as a result of direct contact with the highly contaminated pathological waste. One sweeper reported that he immediately washed his hands and legs when he accidentally came in direct contact with potentially hazardous hospital wastes during its transportation. Yet another positive step observed during the transportation of hospital waste in Safdarjang hospital was that more then 70% of the sweepers used gloves, face masks and aprons whereas only 5% of them wore gumboots to shield themselves from the potentially infected waste. In sharp contrast was the situation revealed in NRS Medical College Hospital was the workers were seen handling hospital wastes without any personal protective equipment. This greatly exposed them directly to high rates of infection, which on a long term could take the form of deadly and incurable diseases. This inadequacy was primarily attributed to the financial constraints faced by the Hospital authorities. In addition to this as, most of the sweepers belonged to the poorest sections of society; they sold off their allotted protective equipment to earn a few extra rupees.

But the long-term implications of this are extremely grave and calls for immediate attention. Comprehensive training camps for the sanitation staff, imparting information about the formulated legislatures and highlighting the detrimental health implications of waste handling should be organized from time to time.

6.1.3 Treatment and Disposal of Hospital Waste in Safdarjang Hospital

The term 'treatment' of hospital wastes refers to the processes that modify the infectious waste before it is taken to its final disposal site. The problem of hospital waste disposal is essentially biological and thus the objective is to minimize the risk of disease caused by bacteria and viruses from the health care and research centres into the community.

The Ministry of Environmental and Forests have taken an initiative to realize this objective and have provided the various treatment and disposal options for all types of hospital wastes, which is shown in Table 6.

Although a number of treatment options have been listed in black and white, it is observed that incineration, sanitary landfilling and chemical disinfection are the treatment methods adopted by the authorities of Safdarjang Hospital. The method of chemical disinfection is practiced to treat blood soaked surgical drapes and soiled bed sheets. Contaminated laundry is an infection hazard to patients and staff in the ward, to the portering staff during transport and to the laundry staff during sorting and washing. *Staphylococus aurens* is the one of the most common and important potential pathogen. Linen soiled with excretions and discharges are infected by Salmonella, which poses greater health hazards. Due to the lack of segregation of non-pathogenic linen from the blood soaked drapes and bed sheets from patients in strict isolation infected with enteric diseases like hepatitis and tuberculosis, the total volume of contaminated wastes to be chemically disinfected increases substantially. This contaminated linen is taken to the laundry where they are treated with disinfectants like chlorine, alcohol, phenotic compounds and formaldehyde. This treatment thus terminates any further probability of spreading infection. But the expenditure incurred to treat this type of hospital waste is high and is adding to the financial constraints faced by the authorities of Safdarjang Hospital. The cost factor can be reduced considerably if the laundry is divided into two major categories, viz. soiled pathogenic and non-pathogenic linen. The former can be treated with greater quantities of chemical disinfectants while the latter can be simply disinfected by heat during the process of washing. The procedure of separately treating contaminated linen greatly reduces the continuously increasing pressure on the limited budget of Safdarjang Hospital.

Incineration is another treatment alternative for hospital wastes adopted on a large scale by Safdarjang Hospital. This Central Government hospital is among the meager 20% of the hospitals, which has an incinerator within its premises. Safdarjang hospital was one of the earliest hospitals to be equipped with an incinerator in 1979. But with the passage of time

marking an increase in the volume of hospitals waste as well as the introduction of modernized incinerators, the earlier plant was rendered obsolete. In 1993, three new Destromat PY models of Thermax incinerators having a capacity of 175 kg/hr. were installed and commissioned by Nitasha Constructions and Nitasha Envirotech (P) Ltd. Since then the plant is treating nearly all the types of hospital wastes ranging from amputated body parts, plastic IV bottles, blood stained dressings, surgical gloves as well as general municipal garbage like fruit peelings, paper and packaging material. This is in total contradiction with the guidelines formulated by Ministry of Environment and Forests, which have recommended different treatment and disposal options for each waste category. Though significant quantities of hospital wastes were segregated in the very first phase of hospital waste management, the whole purpose of incineration was defeated when all the different wastes from the 27 OPDs was dumped in the garbage bin adjacent to the incinerators for treatment. As per the standard for treatment and disposal of bio-medical wastes, as specified in the earlier section, fixed by Central Pollution Control Board (CPCB), temperature of the primary chamber of incinerator at the Safdarjang Hospital is 8000° ± 50°C and the secondary chamber gas residence time is also one second at 105° ± 5°C, with the minimum 3% oxygen in the stack gas as confirmed by the senior engineer looking after the functioning and maintenance of the plant. But an inspection conducted by CPCB on June 6, 1997 revealed that the incinerator failed to confirm to the Combustion Efficiency (CE) norm of at least 99.99% at the as its CE was only 77.27%. This reduction of CE was primary attributed to the fact that even the non-incinerated hospital waste like plastics and kitchen waste dumped into the chambers for treatment. Plastics are known to contribute almost 30% of the chemical pollutants during incineration, which result in large-scale pollution of the ubiquitous air resources. Although the minimum stack height of 30 meters as specified by CPCB is confirmed by the incinerators, the basic rational of curbing air pollution and minimizing the detrimental effects of the spewing smoke on the surroundings has hardly been achieved. It is a common sight to see the column of the incinerator darkening the skyline with its lethal emission.

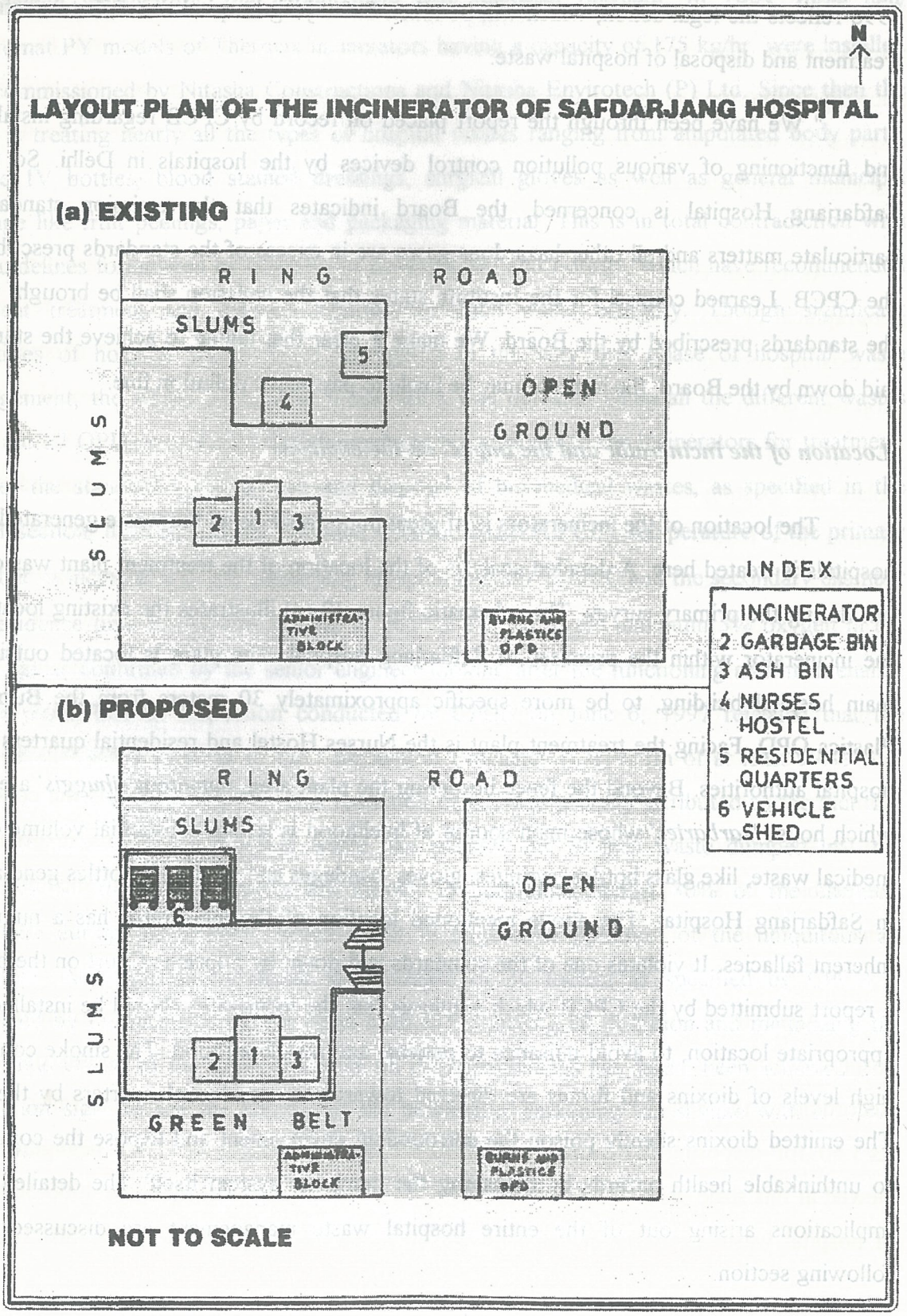
A section of the record of proceedings of the Supreme Court of India, dated April 7, 1996 reflects the legal action, which will be taken Safdarjang hospital that fails to confirm to treatment and disposal of hospital waste.

" We have been through the report placed on record by CPCB regarding installation and functioning of various pollution control devices by the hospitals in Delhi. So far as Safdarjang Hospital is concerned, the Board indicates that the emission standard of particulate matters and all other hazardous gases are in excess of the standards prescribed by the CPCB. Learned counsel for the Institute states that the emission shall be brought within the standards prescribed by the Board. We make it clear that failing to achieve the standards laid down by the Board, the institute may be liable to pay heavy pollution fine."

Location of the incinerator and the impact on the environs

The location of the incinerators is of great importance as all the waste generated in the hospitals is treated here. A detailed analysis of the location of the treatment plant was carried out during the primary survey. The schematic figure 12 (a) illustrates the existing location of the incinerator within the premises of Safdarjang hospital. The plant is located outside the main hospital building, to be more specific approximately 30 meters from the Burns and Plastics OPD. Facing the treatment plant is the Nurses Hostel and residential quarters of the hospital authorities. Beyond the fence bordering the plant area, numerous *'jhuggis'* are found which house *'karbaries'* whose main source of livelihood is selling substantial volume of bio-medical waste, like glass bottles, syringes, gloves, bandages and plastic IV bottles generated in Safdarjang Hospital. The above mentioned location of the incinerator has a number of inherent fallacies. It violates one of the standards laid down by Supreme Court on the basis of a report submitted by the CPCB which emphasis that the incinerator should be installed at an appropriate location, to avoid nuisance to patients and neighbourhood. The smoke containing high levels of dioxins and furans are directed towards the residential quarters by the wind. The emitted dioxins silently poison the surrounding environment and expose the community to unthinkable health hazards by damaging the immunity system itself. The detailed health implications arising out of the entire hospital waste management are discussed in the following section.

FIGURE 12


N
LAYOUT PLAN OF THE INCINERATOR OF SAFDARJANG HOSPITAL
(a) EXISTING
RING ROAD
SLUMS
SLUMS
OPEN GROUND
ADMINISTRATIVE BLOCK
BURNS AND PLASTICS OPD
INDEX
1 INCINERATOR
2 GARBAGE BIN
3 ASH BIN
4 NURSES HOSTEL
5 RESIDENTIAL QUARTERS
6 VEHICLE SHED
(b) PROPOSED
RING ROAD
SLUMS
SLUMS
OPEN GROUND
GREEN BELT
ADMINISTRATIVE BLOCK
BURNS AND PLASTICS OPD
NOT TO SCALE

The lane leading to the incinerators is strewed and littered with substantial quantities of waste dropped from the open wheelbarrows and trolleys during the process of transportation. The mobility of both animals like cats, dogs and cows as well as general public including the rag pickers in this areas has further accentuated not only the problem of disposal of waste but as also exposed the community as a whole to inherent health risks associated with potentially hazardous hospital wastes.

As human ecologists it is essential to deal with the etiology of disease within the geographical or environment perspective and thus certain recommendations with respect to the existing location of the incinerator has been suggested. The fig.12 (b) illustrates the proposed layout of the treatment area. As the relocation of the incinerator would run into crores of rupees it is not economically feasible. So the emphasis has been essentially to isolate the existing treatment area as far as possible from its surroundings. Instead of the existing low fence, the construction of a concrete compound wall of about 10 meters enclosing the entire area is recommended. This would be instrumental in checking the illegal entry of rag pickets from the adjoining *'jhuggies'*. The mobility of the animals and general public can be restricted by constructing high gates at the entrance of the lane leading to the incinerator site. It would be both environmentally and aesthetically feasible to have a green belt, which would provide a natural barrier from the main hospital premises, especially the administrative office of the Additional Medical Superintendent. As this area is the collection site for huge quantum of hospital wastes being transported from all the wards, it often faces the problem of shortage of transfer vehicles. Thus, as illustrated a small shed for these vehicles is recommended.

Apart from the location aspects of the incinerator, the costs incurred to treat the hospital wastes is also an integral component of the treatment and disposal of wastes. According to the Senior Engineer responsible for the functioning of the incinerator, it costs Rs.3.50 for disposing one kg.of hospital waste. This figure might seem negligible when viewed at this scale. But when the cost analysis is worked out for incinerating 4000-5000 kgs. of hospital waste everyday, it calculates to an unbelievable figure of Rs.15,750. This thus

exerts an immeasurable pressure on the hospital exchequer. The maintenance cost of the incinerator further adds to the financial constraints. As the waste are not segregated and entirely dumped into the incinerator the life of the plant is considerably shortened.

Different models of incinerators are designed to burn different composition of wastes, which vary in moisture content. For example, pathological wastes like amputated body parts, sputum etc. have maximum moisture content of about 85% followed left over food - 70% while the moisture content of blood bags, saline bottles, IV sets and syringes is as low as 20%. If wastes having high moisture content are burned for long periods of time, the incinerator might stop functioning. This is main reason for most of the hospitals having idle incinerators.

Recently the use of incinerators has engaged much debate. Analysing the various economical overheads and adverse health impacts of incinerators, there is an immediate need for a rational waste programme. A waste conservation programme is certainly going to cost money. It would invoice an initial investment on equipment as well as training the staff. No matter how a facility goes about, waste reduction costs, however, are not something a health care unit should she away from. Keeping a low cost hospital waste management in mind, organizations like the American Society for Health Care, Environmental Services, Healthcare Resource Conservation Coalition, National Plastics Control and The National Recycling Coalition of United State are now finding alternatives to incineration. The oldest and most popular option is Autoclaving which has been suggested to treat microbiological and biotechnological wastes like live or attenuated vaccines, human and animal cell culture used in research laboratories of Safdarjang Hospital as notified by Ministry of Environment and Forests (Table 6).

Microwave technology is yet another treatment option for handling disposables, plaster casts and soiled dressings. Landfilling is also a treatment alternative, which the Safdarjang Hospital has adopted. Large volumes of both bottom ash and fly ash generated during incineration containing large concentrations of heavy metals, dioxins and furans are

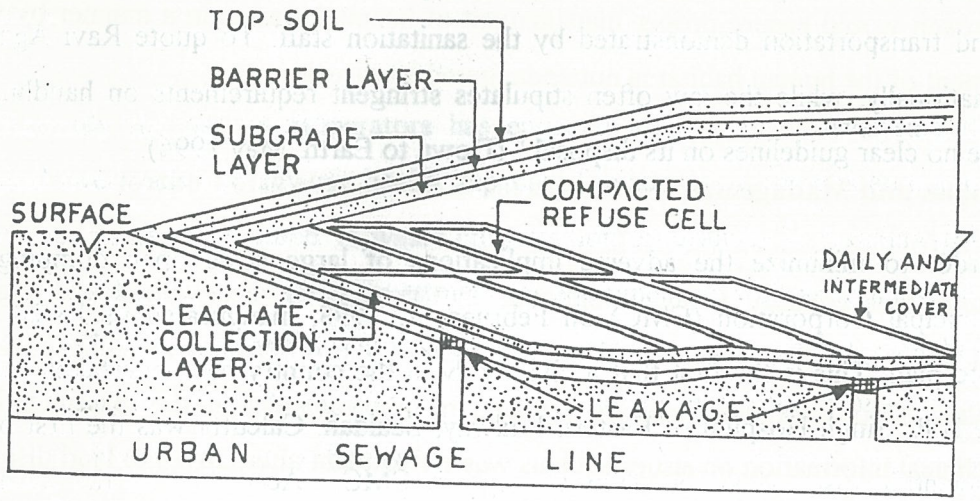
collected once a week by the NDMC trucks and disposed in the Bhalsawa grounds. The incinerator ash is irrationally dumped into the landfill, where it is rarely or insufficiently covered with inert material which results in ground water pollution through leaching, as illustrated in figure 13.According to WHO expert, leachate (highly saturated organic matter) can pollute sub-soil water flowing into the reservoirs, rainy wells and above all finds its way into the city's sewage and drainage that the average Delhite does not boil the water he consumes, it would directly afflict him by way of disease like Cholera, Jaundice and Gastroenteritis.

The disposal of hospital waste in the landfill depends upon the debatable efficiency of collection and transportation demonstrated by the sanitation staff. To quote Ravi Agarwal. "Even internationally, while the law often stipulates stringent requirements on handling the ash, there are no clear guidelines on its disposal." (Down to Earth, May 1996).

In order to minimize the adverse implications of large scale open dumping, the Calcutta Municipal Corporation (CMC) on February 1, 1998, inaugurated its Rs.20 lakhs medical waste plan, This is the first that a civic body in the country has undertaken such an exercise. the B.R. Singh Hospital of Eastern Railway, Sealdah. Calcutta was the first one to adopt this scientific disposal system launched by the CMC. According to the Municipal Commissioner. Mr. Asim Burman, three tones of anatomical and clinical wastes was collected on the very first day from 23 hospitals and missing homes in central and south Calcutta. The remaining hospitals and pathological clinics of the city will be covered by March, 1998.Today after three years the hospital waste of many of the city's well known hospitals like Calcutta Medical College Hospital and RG.Khar Medical College Hospital is not collected everyday by the CMC or Mass Education Waste Carrier. To facilitate the collection and transportation of about 25 tonnes of clinical and anatomical waste thrown everyday in open vats, two heavy-duty dumpers have been engaged. To overcome the time lost to due to the bottlenecks in traffic movements, these vehicles operate during the night. (The Statesman, January 19, 1998). The conservancy labourers, who are engaged in loading ,

FIGURE 13

CROSS-SECTION OF A LANDFILL SITE



SOURCE : MOELLER D.W., 1990. ENVIRONMENTAL HEALTH

the dumpers have been given special training to ensure the effective implementation of this medical waste plan, the CMC has set up an experts committee with Mr. K.J Nath as the chairman to monitor the scheme. Others members include Mr. Dhrubojyoti Ghosh and Mr. Pranabesh Sanyal of the State environment department and some senior civil officers. This kind of partnership between the municipality State pollution control Board, private agencies NGOs and technology provides is recommended to ensure and effective hospital wastes management plan. In this respect, the contribution being made by HUDCO - a premier techno-financial institution is commendable. Presently it is negotiating the extent of loan to be provided for the installation of the improved Destromat (standard) 1608-PCD Model of incinerator having a high capacity of treating 230 kgs. of hospital wastes per hour. Thus this holistic approach would ensure proper management of hospital wastes in a manner by which the environment of the human habitat is not endangered by diseases.

7. Technologies and Management Strategies for Hazardous Waste Control

Actions that enhance public confidence in the equity, effectiveness and vigorous enforcement of government programmes may reduce public opposition to siting hazardous waste facilities. Opposition also may be reduced by improvement in the dissemination of accurate technical information on issues such as waste treatment alternatives to land disposal.

7.1 Five Policy options can be examined:

1. Continue with the current programme
2. Extend controls to more hazardous waste and establish national regulatory standards based on specific technical criteria. Also restrict disposal of high-hazard waste on land and improve procedures for permitting facilities to disinfect clinical waste
3. Impose fees on generators of high-hazard waste that are land disposed, provide assistance for capital investments and research and development for waste reduction and treatment

4. Study the costs and advantages of classifying wastes and waste management facilities by degree of hazard to match hazard and risks with levels of regulatory control
5. Examine the need for greater integration of environmental programmes to remove gaps and inconsistencies in the regulation of hazardous clinical waste; and
6. To utilize technical data and personnel to its optimum capacity

Adverse health effects attributable to hazardous waste remain inadequately documented. Effects like-

- Contamination of ground water and reservoirs
- Contamination of drinking water wells
- Adverse incidents, including damage to human health, natural habitats, fish and livestock,crops,sewer systems and soil

7.2 The Trade-off between Near and Long Term Costs

The economic costs of Bio-medical waste are substantial. The cost of cleaning up uncontrolled sites and compensating for damage to human health and the environment calls for consideration of the full "life cycle" costs of managing Bio-medical waste. From an economic perspective, the overriding Bio-medical waste issue of today is: would it be more prudent and effective in the long term to increase the stringency of current land disposal regulations and encourage the use of alternatives of land disposal? The failure to improve waste management in the near term would surely lead to unacceptable health and environmental effects.

Several technological approaches can be used to reduce the amount of waste requiring treatment or disposal. An important way to reduce threats to public health and environment from hazardous hospital waste and to lessen the cost of waste management is to reduce the amount of waste generated.

7.3 A Hierarchy of Alternative Management Strategies

Alternative technological approaches provide means for the reduction of waste generation, destruction of waste and disposal of Bio-medical waste. Different alternatives are appropriate for different wastes and locations.

The following hierarchy (Fig.14) provides a useful framework for understanding the potential use of alternatives to disposal of clinical waste, consistent with good engineering practices and sound economics.

- **Infectious Bio-medical Waste Reduction** by process modification is usually a secondary benefit; the changes are motivated by other engineering and economic considerations, such as improving process efficiency and yield. The benefits are usually specific to individual plants and processes.

- **Source segregation or separation** is the most rational method of reducing waste before they require management as hazardous waste. The basic principle is to keep waste in concentrated and isolated forms rather than to produce large volume of indiscriminate mixtures that have to be separated later. This would facilitate medical waste identification and their subsequent treatment and disposal.

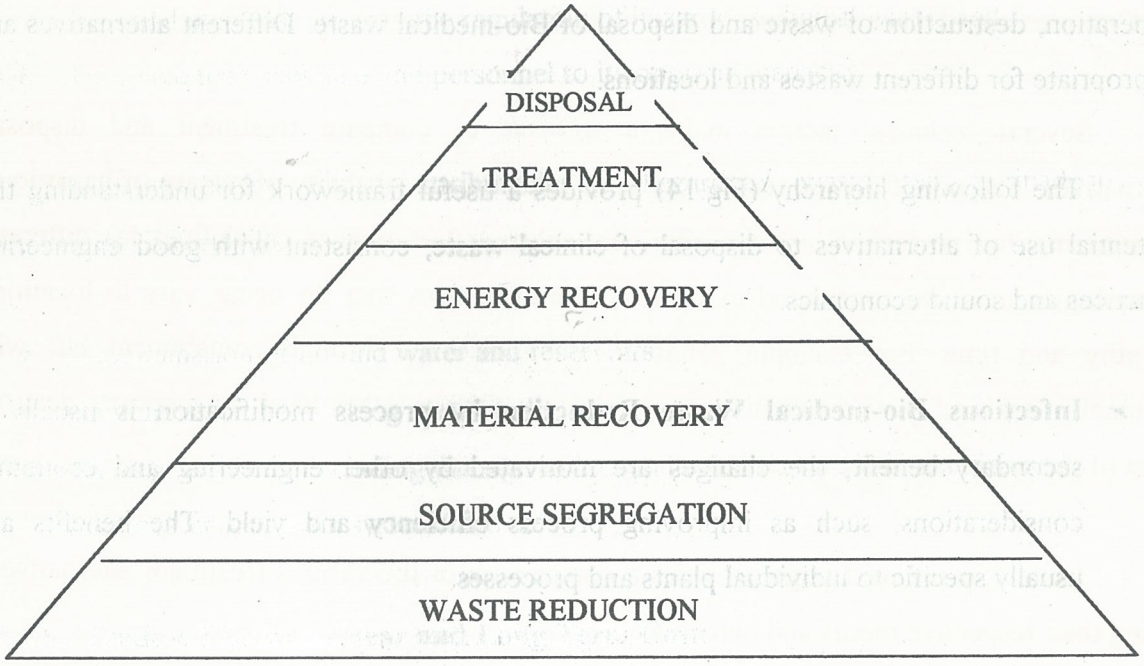
- **Material recovery**, either on site or off site, to make use of materials, including use of waste exchanges, so that a waste for one generator can be made available as a resource for another operation. This would bring about reduction in waste volume as recovery can be done before materials are discarded and managed as infectious waste.

- **Energy recovery** from (potential) waste or its components can perhaps be a useful supplement.

- **Waste treatment to** reduce the hazardous level and possibly the amount of waste requiring disposal.

Figure 14

Hierarchy For Judicious Biomedical Waste Management



➢ **Ultimate disposal** (preferably of residues from previous steps, of materials pre-treated to reduce mobility after land disposal and of untreatable wastes) in a manner that arrests the release of infectious constituents into the environment to acceptable levels.

Such a systematic ordering of bio-medical waste management options presents a number of advantages,viz;

1. Permanent solutions to infectious bio-medical waste problems are more likely to occur at some stage prior to disposal.
2. Fewer risks and costs are shifted to the future. An initial emphasis on medical waste reduction could significantly reduce costs of waste management.
3. If less infectious medical waste is produced and regulated by promoting the use of alternatives (as per the waste management hierarchy) and if there are reduced

administrative activities (inspection) for treatment and disposal facilities, then the cost of administering a regulatory programme and remediating uncontrolled sites could be reduced.

7.4 Comparison of Technologies

Several technical factors make it difficult to compare treatment and disposal alternatives. The goal for each technology is to reduce the probability of release of hazardous constituents, but no technology can offer zero release. Performance capabilities for different technologies must be considered in relative terms; releases that do occur vary in location, quantity and time. For example, landfills inhibit releases through containment but will eventually leak and may contaminate groundwater. On the other hand, incinerators destroy most of the waste but some air pollution may occur.

Table 7,in the next page provides a comparison of the various treatment alternatives, listing their respective merits and demerits.

An important issue in making comparisons and for regulatory purposes, is to describe the nature and impact of potential releases, not merely what the technology accompalishes.For example, technology may destroy or detoxify 99.99% of waste constituent input, but it is necessary to consider the total amount released and their toxic effects.

Newer treatment technologies such as Plasma Arc were developed by the military and are still in the experimental stage as far as medical waste is concerned. These could prove too expensive for their relatively smaller demand volume. Plasma is an ionized gas, which becomes an electrical conductor. Gas is passed through an electric arc, thus reaching very high temperatures of about 5,500 degrees Celsius. This is known as "thermal" or "hot" plasma. The plasma arc subjects the waste to a high temperature in the plasma or inert medium and then encases it in a glass like medium.

Table 7

Sl.No	Treatment Options	Merits	Demerits
1	LANDFILL	Semi-skilled personnel required	Ground water contamination Generation of toxic landfill gases Produces toxic leachates
2	INCINERATION	Reduction of waste volume up to 90% Makes waste unrecognisable Detoxifies organic waste Eliminates any long term liability for the waste Versatile process capable of accepting wide variety of waste Capable of handling large volume of waste Large land area not required Heat recovery potential	High investment and operational cost Technical expert required Emission of toxic gases like dioxin and furan Air pollution control equipment is required to control gaseous and particulate products of combustion Vulnerability to future restrictive emission laws
3	MECHANICAL\ CHEMICAL DISINFECTION	Significant reduction in waste volume Ability to make waste unrecognisable Rapid processing Waste deodorization Semi-skilled personnel required	Need for chemical storage and use Lack of suitability for some waste types High investment cost
4	STEAM AUTOCLAVE-DISINFECTION	Low investment and operating cost Ease of biological testing Less hazardous residues than incineration Semi-skilled personnel required	Inability to change waste appearance Inability to change waste volume Lack of suitability for some waste types
5	MICROWAVE DISINFECTION	Ability to make waste unrecognisable Reduction of waste volume Absence of liquid discharges	High investment costs. Increased waste weight. Lack of suitability for some waste types. Potential to expose workers to contaminated shredder. Production of uncharacterised air emissions.
6	PLASMA PYROLYSIS (Plasma Torch)	Mobile technology. Significant in waste volume. Residue like CO, CO_2, H_2, H_2O, are less hazardous than gases produced by incineration.	High investment at the initial stages. Requires skilled expertise.

Other technologies such as the Electro Thermal Deactivation (ETD) process, patented by Stericycle, a Fortune 100 company and a leader in waste management in the U.S. are more established. The process uses an oscillating energy field of low-frequency radio waves to heat regulated bio-medical waste to temperatures that destroy pathogens such as viruses, bacteria, fungi and yeast without melting the plastic content of the waste. (Agarwal, R., 2000)

"Capacity or infrastructure- building at each stage is what is needed more than education," says Dr. Girish of M S Ramaiah Hospital (Down to Earth, 2001). Experts believe that a Common Waste Treatment Facility (CWTF) could go a long way in safely disposing off Bio-medical waste, rather than having individual incinerator at every hospital. This would aim at both economic viability and environment quality. These could be set up at the outskirts of the city. Hyderabad has such facility and Chennai plans to come up with one such facility. Talks are underway to have such CWTF for Delhi, Mumbai and Calcutta too.

Advantages of CWTF:

I. As the small health care institutions like nursing homes (less than 50 beds), clinics, pathological centers, etc cannot bear the financial burden of setting up individual autoclave, microwave, incinerator, etc., it would be economically viable for these establishments to collectively treat their bio-medical waste in CWTF.

II. Due to lack of a CWTF, health care institutions will be compelled to install incinerators /autoclaves as per the Bio-medical Waste (Management and Handling) Rules, 1998. This would in turn make it difficult for the regulatory authority (Pollution Control Boards) to closely monitor their operation and maintenance, thereby leading to environmental degradation.

III. CWTF can be potentially be harnessed for energy recovery.

IV. The cost of treating per unit of bio-medical waste through the CWTF would be comparatively less than treating the wastes individually in the innumerable medical centres.

7.5 Role of Private Sector

A host of Indian companies including start-ups in industrial equipment are either manufacturing medical waste management devices or are marketing products of U.S. and other foreign companies. Leading U.S.companies like Sanitec International Holdings and Tuttnauer have been successful in creating a sizable installation base in some Indian cities through distributors. Some like Sanitec and American Exporters Inc., both based in New Jersey, are providing technical consultancy to Indian concerns and some others are still trying to make a dent in the Indian market. The future competition in this field will be guided by two factors- environment – friendliness and cost effectiveness.

Sanitec a world leader in the field has in its range of products a microwave disinfection unit, which shreds and treats segregated medical waste including pathological waste to render it unrecognisable and reducing its risk to public health and safety. The unit which has received approval from the New York State Department of Health, is the first non-burn technology in the world for treating pathological waste and has more than 80 installations all over the world.

Sanitec is also sharing its experience in setting up common waste treatment facilities in cities that include vehicle design, disinfection methods, safety while transporting and segregation of wastes and workers safety with Maridi, which manufactures plasma arc incinerators and autoclaves. The Sanitec microwave disinfection system reduces input waste material by 80% in volume without generating any liquid effluent and hazardous emissions. The first Sanitec installation in the country is coming up at a common medical waste disposal facility in Bangalore.

One company which has numerous installations in Delhi is New York based Tuttnauer Company Ltd.Delhi hospitals which have Tuttnauer autoclaves and sterilizers installed include the All India Institute of Medical Sciences, Guru Tegh Bahadur Hospital, Deen Dayal Upadhyaya Hospital,G.B.Pant Hospital ,Lok Nayak Jayaprakash Narayan

Hospital ,Escorts Heart Institute and Research Centre and Sanjay Gandhi Memorial Hospital. (Agarwal, R., 2000)

A relatively new low – cost alternative to current medical waste disposal methods has been developed by Portland based Clean Pro Industries Inc.The technology relies on cement – based solidification that incorporates a range of materials like gypsum, lime and Portland cement to form a slurry that fixates the wastes. By physical and chemical treatment of hazardous waste through solidification the waste is fixated and stabilized in a cement matrix that does not allow release of fluids under pressure.

A lot of Indian Companies are also getting into this field of collecting bio-medical waste, maintaining common waste disposal facilities and manufacturing non-incineration waste treatment apart from distributing equipment of foreign companies. These include Hyderabad – based G.J.Multiclave (India) Ltd. And Medicare Incin Pvt.Ltd., Millennium Technologies in Visakhapatnam, Safe Environ in Vijaywada , Aireff de Tox Incineration Ltd. In Mumbai and Rockwell Industrial Plants Ltd (RIPL), a non-resident Indian company based in New Delhi.

7.6 Comparison of Direct Costs

Costs are generally considered on some volume or weight basis for a particular management technique. Land disposal is still likely to be the low-cost option under the current regulations for most contaminated bio-medical waste. Generally different technologies compete at the low end and in the middle of the price spectrum, but in some cases the exact character of waste, not the cost determines the applicability of different technologies and therefore the management choice. There are greater price differences among the technologies for managing hospital wastes, with incineration more costly than land disposal.

It could be noted that transportation costs of bio-medical waste can be quite substantial, with long distances increasing direct costs by as much as 50-100% .In some locations, there may be no alternatives to land disposal and the added cost for transportation make land disposal even more attractive economically.

Environmentally sound medical waste management must go beyond the mere safe disposal and recovery of wastes that are generated and seek to address the root cause of the problem by attempting to change unsustainable patterns of production and consumption. This implies the application of the integrated life cycle management concept, which presents a unique opportunity to reconcile development with environmental protection.

8. Disease Ecology Related To Biomedical Waste Management

The mechanism which contains the growth and variation of diseases within a spatial unit has recently drawn the attention of Geographers. In fact, such variations are primarily governed by the socio-economic and behavioural factors - the aspects that are mostly neglected by medical scientists.

By the end of 1968, the geo-medical approach was recognized by the Indian Geographical Union, which gave emphasis on the environmental and ecological system - the base for the development of geographical pathology or more popularly called "Geomedicine" or "Geography of Health". This discipline provides a scientific basis for the understanding of the wholeness of life, which needs "medical care and insight wedded to a knowledge of environmental circumstances that make for health".

The prime concern of medical geography is the observations pertaining to the problems of health, defined by WHO as a "State of complete physical, mental and social well-being and not merely the absence of disease and infirmity". Most of the medical scientists first seek the vectors of health imbalances in "pathogens", but we the human ecologists are first concerned with the etiology of disease within the environmental

perspective, so called as 'geogens'. Accordingly to May, the founder of American School of Medical Geography, geogens are responsible for the pathogenesis of disease.

The long held convention that hospitals are institutions for cure of disease and epitome of cleanliness is proving to be nothing but a normative statement today. It is Ironical that the hospitals, which are supposed to cure patients, are the source of numerous diseases caused due to mishandling, incomplete and irrational treatment and disposal of infectious waste.

The health hazards and risks involved with the handling of hospital waste were examined with reference to difference segments of the societal structure.

Patients

The very source of generation of waste-the patients through undergo a systematic course of treatment are silently facing the adverse impacts of the improper and callous waste handling procedures of the hospital authorities.

As per the primary survey conducted in Nil Ratan Medical College Hospital, Calcutta, It was observed that there was lack of proper storage of waste. The high density of patients (three patients per bed) resulted in the excessive pressure on the already limited infrastructure, in the Gynaecology ward each bed was equipped with one open plastic tub placed under it. This was the recipient of all types of wastes ranging from fruit peelings, faces to catheter tubes. The Notification issued by the Ministry of Environment and Forest, 1998 which emphasized on colour coded polythene bags and single use sturdy container (Table 4) was merely a black and white statement, unheard of by the doctors themselves, Leaking and broken plastic containers surrounded by the waste meant to be contained in them was a common sight. Pathogens, which cause diseases like Hepatitis and TB, for instance thrive in the blood, sputum and pus soiled dressings. To further accentuate the problem, the excessive humidity provides a congenial environment for their multiplication.

In most of the hospitals the lavatories are always waterlogged and dirty. Patients refuse, blood and phlegm is not cleaned immediately. In such a germ infected atmosphere, both the patients and visitors the risk of getting infected with diseases. Half the room in almost all government hospitals in Calcutta has three inches of stagnant water. The washbasins in the wards reminded one of the scummy basins most of them have not been cleaned for ages. In the same basin doctors 'wash' their hands, patients spit and the sweeper squeezes the muck from the mopping cloth.

Yet another point of concern was the mobility of cats, dogs and even monkeys inside the hospital premises. There are numerous instances where cats and dogs run away with newborn babies. This is allegedly after getting addicted to human flesh whilst scavenging open disposal areas with easily accessible amputated body parts and surgical wastes.

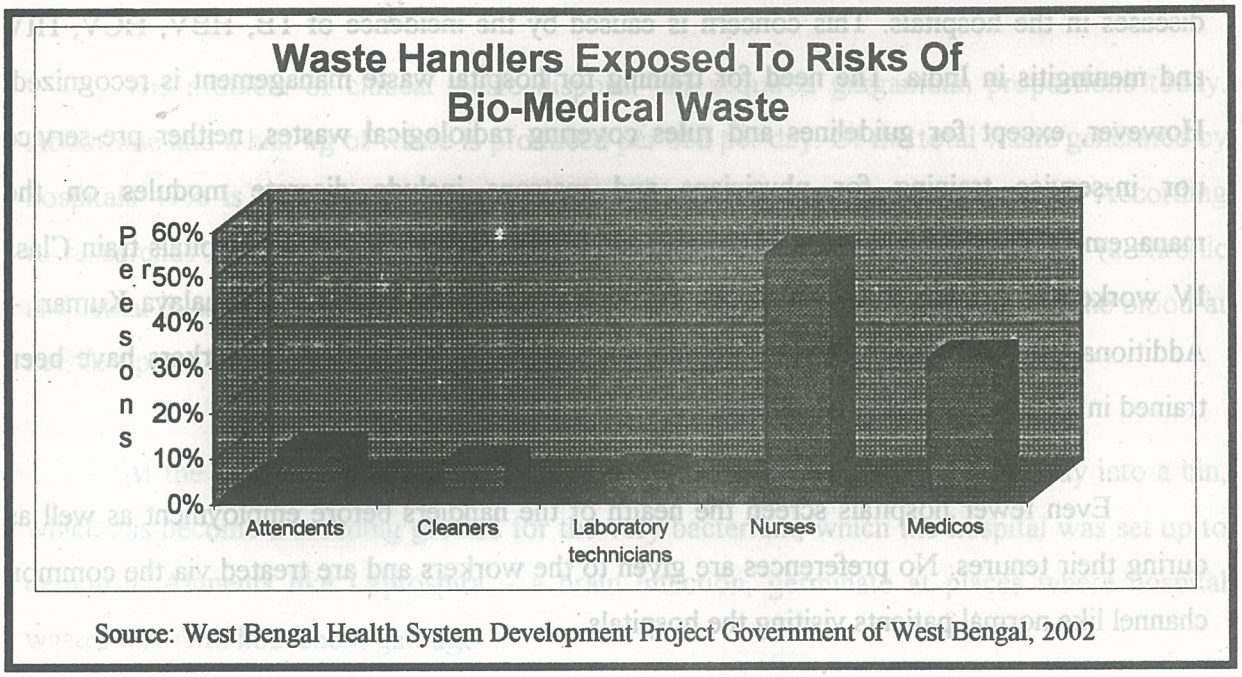
Class IV Workers

Safe practices are often limited to health professionals and the top tier of the sanitation team and essentially ignore the Class IV or Group D waste handlers. Budgets for personal protective equipment are inadequate. The *'safai-karamcharies'* in hospitals rarely wore masks, gloves and gumboots as the collect and transport reusable and disposables for decontamination, laundry and disposal bins. Of the 5800 metric tonnes of solid waste generated in Mumbai per day, an estimated 800 tonnes remain uncollected.

Thus of immediate concern is the health threat of Class IV workers who are exposed to infectious and contaminated hospital waste. For example, more than 5000 workers handle hospital waste in Mumbai. Chennai has about 9000 Class IV waste handlers and scavengers handling waste on 330 trucks, 8 transfer stations and two disposal sites. The workers who are especially at high risk of infection are those working on the two trucks dedicated to daily collection, transportation and disposal of human tissue, placentas and body parts from four of the co-operative hospitals that specialize in infectious disease. Despite separate collection,

transportation and disposal of these infectious pathogens, all materials are infected after being mixed in soaring high temperatures and excessive humidity typical of Chennai.

Figure 15



Source: West Bengal Health System Development Project Government of West Bengal, 2002

Compare to the overall dismal picture observed in majority of the hospitals of the country, positive signs of waste treatment and disposal are prevalent in Safdarjang Hospital. The Class IV workers are seen wearing aprons, gloves and masks while transporting waste from the Burns ward to the incinerator for final disposal.

On the basis of the questionnaire survey, it was found there was awareness of the fact that the handled waste is highly contaminated and potentially infectious. Many of the waste handlers complained of itching, rashes and lesions on their limbs as they seldom wore gloves and gumboots.

Due to the poor designing of waste vehicles, primarily trolleys and wheelbarrows the workers faced problems. The low height of the vehicles induced back pain. Joint pains and cramps were other common ailments due to low carrying capacity of the trolley and

subsequent innumerable shifts of transferring the waste either to temporary disposal sites or directly to the incinerator.

There is a concern among the medical staff about the risk of contracting infectious diseases in the hospitals. This concern is caused by the incidence of TB, HBV, HCV, HIV and meningitis in India. The need for training for hospital waste management is recognized. However, except for guidelines and rules covering radiological wastes, neither pre-service nor in-service training for physicians and matrons include discrete modules on the management of infectious and other hazardous hospital waste. Very few hospitals train Class IV workers in hospital waste handling procedures. According to Dr. Kaushalaya Kumari – Additional Medical Superintendent of Safdarjang Hospital the Group D workers have been trained in all aspects of waste handling.

Even fewer hospitals screen the health of the handlers before employment as well as during their tenures. No preferences are given to the workers and are treated via the common channel like normal patients visiting the hospitals.

After many years of sponsoring and providing technical assistance for Health Programmes, it is only in the most recent of Bank-assisted projects (Health system II Project in Karnataka, Punjab and West Bengal) that components for training in infectious waste management have been included.

Rag Pickers

Uncontrolled hospital waste management outside the hospital premises is yet another problem. It is common for contractors to pay the hospital for scavenging rights of medical waste that include sharps, plastic tubing and fabrics for resale. Almost 2/3rds of the total waste that leaves the hospitals daily are picked up by ragpickers. They come into close and continuous contact with hazardous refuse. The scavengers do not use personal protective equipment. On the basis of the survey, it was found that worm infestations, viral hepatitis, gastroenteritis, itching, skin lesions, allergies and boils were common aliments, which they

faced. The blood and pus stained dressings, which they scavenge to be scattered by shoes and other traffic.

Community

The problem of clinical waste disposal has acquired gargantuan proportions today. About one and a half kg of waste is produced per bed per day. Of the total waste generated by hospitals 47% is biomedical waste, contaminated by disease carrying pathogens. According to researches from Delhi's GB Pant Hospital, pathogens which cause Hepatitis-B (a chronic and lethal liver ailment carried by 43 million Indians), for instance, can remain in the blood at needle-tips or bandages and spread infection.

At the Delhi based TB Hospital, left overs from the kitchen find their way into a bin, which has become a breeding ground for the very bacterium, which the hospital was set up to demolish. Aliments like Laptospira – a brain infection, germinate at places where hospital wastes mix with household garbage.

Internationally, there have been alarming reports of anatomical wastes found at dump yards near settlements. The Lancet (Volume 343) has reported that poor slum dwellers in Olinda, Brazil, found human body parts in the city's garbage dump which sometimes even ended up as part of their food. In an inspection, a team set by Olinda's Health Secretary, found human fat, skin, foetuses, brains and breasts in the dump yard. In 1995, human foetuses were found near a nursing home in Hapur, Uttar Pradesh, according to local residents.

According to a study conducted by Danish National Environmental Research Institute, hospital wastes contributed 30% of the dioxins and furans produced, even though they made up only 1% of the waste generated.

In one of the comprehensive health risk assessments of medical waste incineration carried out by the California Department of health services along with the California Air

Resources Board in 1990, it was found that dioxins and metals like cadmium exercise the most significant carcinogenic effects.

In 1991, in the United Kingdom, a hospital incinerator was believed to be the main cause behind Leukaemia.

In Safdarjang Hospital, the incinerator adjacent to the doctors residential quarters, spewed smoke, generated from the burning of infectious hospital waste. The incinerator emits dioxins which cause cancer. Among the other ill effects of dioxins are birth defects, endemetrosis, reduced sperm count and decrease in the size of the testes.

The mishandling of incinerator ash, which consists of both fly ash, and bottom ash further contributes to health hazards. The as is highly toxic, containing large concentrations of heavy metals, dioxins and furans. The ash is dumped into landfills where it is rarely or in sufficiently covered with inert material. This results in ground water pollution through leaching.

According to a World Health Organisation expert, even leachate (highly saturated organic matters) can the average Delhite does not boil the water be drink, it could straight away afflict him by way of Cholera or Jaundice, Gastroenteritis and Typhoid.

The disposal of hospital waste, in a landfill depends upon the highly suspect and debatable efficiency of collection demonstrated by the local municipal ward. "Even internationally, while the law often stipulates stringent requirement on handling the ash, there is usually no clear guidance on its disposals," informed Ravi Agarwal. (Down to Earth, 1996)

9. Commercialisation And Unwanted Recycling Of Hospital Waste

At network operating in all the hospitals in the city as well as the country as a whole is recycling syringes and injections after doctors or nurses dispose them off.

The modus operandi is simple. Some men in the guise of sweepers visit the wards and pick up syringes or the cylinders in connirance with the *'safai-karamcharies'*. These are then taken away recycled and packed in clean jackets before being released again. They reappear in hospitals when doctors are forced to rely on medium grade syringes at rush hours. For instance, in Calcutta's most renowned Seth Sukhram Karnani Memorial Hospital staff who are supposed to have taken the Hippocratic Oath, that would be primarily responsible for millions of people suffering from AIDS.

"Injecting 70 patients per house with the accepted quality of disposable syringes is obviously not possible for us, given the present infrastructure. So we have to rely on a number of other varieties too," commented a first year PGT with the Calcutta Medical College on terms of anonymity. "We try to crush cylinders but these are not coffee cups. They are hard and it is not possible to break them down," he added. (The Asian Age, August 27, 1997).

A survey on the sterilisation of disposable syringes by the All India Institute of Health and Hygiene, he has revealed that 50% of those in use were non-sterile. Sweepers of the Calcutta Medical College Hospital salvage almost 108kg of this hospital waste daily and sell them in local market. This was revealed after an investigation by environment engineers of the West Bengal Pollution Control Board and the All India Institute of Hygiene and Public Health. The sweepers store the mixed waste in the hospital backyard and sell them after segregating them item wise.

As shown in table 8, each kilogram of blood bag fetches Rs.6, disposable syringes are sold at Rs.25 a kg. Each sweeper earns an estimated Rs. 16 to 17 daily by selling waste.

The rate of syrings varies in different parts of Delhi and also depends on their condition. Almost new looking syringes without scratches can be sold for us high as Rs. 50 a kg. On the other hand second grade syringes 90 for Rs. 18 a kg.

Table 8

COMMERCIALISATION OF HOSPITAL WASTES

Salvageable times	Quantity	Selling rate (Rs)	Total value (Rs)
Blood Bags	17.5kg	6/kg	105.00
Saline Bottles	421 pieces	2/piece	842.00
Aluminum Foils	2.62kg	30/kg	78.60
Syringes	1.4kg	25/kg	35.00
Miscellaneous items*	72.92kg	1/kg	72.92
Total	107.596kg	--	1,133.52
*Broken Glass, rubber tubes, surgical gloves, paper etc.			

(Source: The Statesman: 23.11.97)

One of the most alarming findings of my survey was that the hospital authorities launch a tender each year in order to extract the maximum price by disposing the waste generated within their premises. The contractor who bids the highest price for all the waste is allotted the contract. It has been found from various sources that this year the tender has been in favour of a contractor from Gautamnagar, about 2-3 kms from Safdarjang Hospital. All the glassware obtained as waste is melted in one of his establishment in Gautamnagar to produce glass bangles, which are in great demand and are marketed not only in Delhi but also in Faridabad.

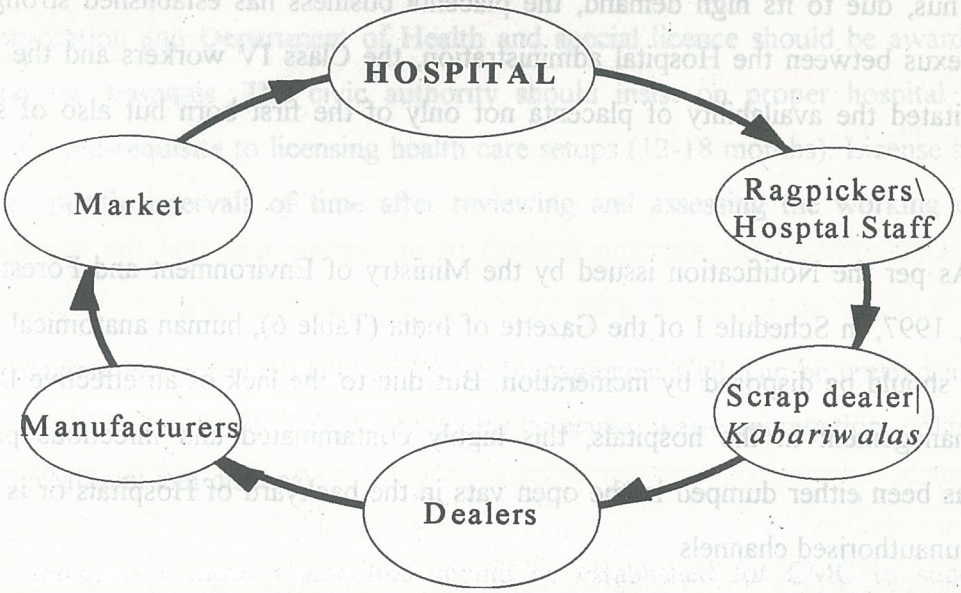
The syringes are washed and repacked in Azadpur or in areas around Delhi and Uttar Pradesh. It is from here that they proliferate into the different parts of the country.

Similar cases of untreated wastes were uncovered in a survey conducted in 2000,covering over 30 hospitals in Delhi. The study jointly carried out by the Delhi State Health Department, Delhi Pollution Control Committee and Srishti- a non-governmental organisation, indicated a high incidence of needle prick injuries from sharps such as syringes to medical personnel. Worldwide , according to a World Health Organisation (WHO) study,

8 to 16 million hepatitis – B, 2.3 to 4.7 million hepatitis – C and 80,000 to 160,000 HIV infections are estimated to occur from reuse of syringe needles without sterilization. A portion of these syringes comes from irrationally dumped bio- medical waste. (Agarwal,R., 2000)

Figure 16

Vicious Clinical Waste Cycle
Clinical Waste Reuse-Recycled



Bandages and blood and pus soiled cotton/dressings reach the main garbage bin. But before they are subjected to incineration, they are taken away by the ragpickers or by the safai-karamcharies themselves who in turn sell it to the *'kabaris'*. The bandages are washed and the soiled portion is removed by naked hands. This in turn used for making mattresses and *darries.*

Hospitals discard gloves after every operation. This is surely a positive sign for the patients, but it is leading to stealing of gloves, washing them and reselling them at Red Fort.

The trade of human organs has from time immemorial involved in numerous controversies. Kidney, liver and heart have always been the main organs of transplant. But the importance of the placenta has today reached magnified proportions. The inherent quality of the placenta obtained from the first-born is that it has would healing properties. It is due to this characteristic utility born is that it has wound healing properties. It is due to this characteristic utility that famous medical companies like Albert David use it to manufacture drugs. Thus, due to its high demand, the placenta business has established strong roots. A strong nexus between the Hospital administration, the Class IV workers and the companies has facilitated the availability of placenta not only of the first born but also of subsequent births.

As per the Notification issued by the Ministry of Environment and Forest, dated 27 October, 1997, in Schedule I of the Gazette of India (Table 6), human anatomical waste, like Placenta should be disposed by incineration. But due to the lack of an effective Bio-medical waste management in the hospitals, this highly contaminated and infectious pathological waste has been either dumped in the open vats in the backyard of Hospitals or is being sold through unauthorised channels.

The risk posed by hospital waste can never be totally eradicated. But by careful and rational planning as well as prompt execution they can be significantly reduced. Inadequate strategies and behind the scene nexus must be tackled before the risk escalates to gigantic proportions.

10. Recommendations

The volume of medical and non-segregated infectious waste has reached proportion that will cause public health crisis if not addressed immediately. Medical waste management

problem and potential solutions cross jurisdictions, sectors and disciplines. Both public and private actions are required to face the challenge posed in this field.

The current high level government and inter-jurisdictional attention to medical waste issues in an important step. Well known remedial steps, however, can be taken immediately. The following recommendations should be carefully considered by the government and by donors:

- It is suggested that all medical institutions should register their names with the Municipal Corporation and Department of Health and special licence should be awarded to doctors to run the hospitals. The civic authority should insist on proper hospital waste management as a pre-requisite to licensing health care setups (12-18 months). License should be renewed at specific intervals of time after reviewing and assessing the working of the system.

- A separate wing, called Hospital Waste Management Cell, can be created in each of the hospitals, which would maintain an inventory of waste, waste segregation, collection, transportation, treatment and disposal.

- An Infection Control Committee should be established for CMC to supervise hospital waste management in all health care institutions.

- The Bio-medical waste (Management and Handling) Rules, 1998 have delineated the medical institutions on the basis of total number of beds. It would be systematic to categorise them into two broad categories,viz,general and special hospitals. This would facilitate civic authorities to draw a clearer picture about the composition of waste, which plays a crucial part in hazardous waste management.

- Explore opportunities to harness power from medical waste dumped at Dhapa.

- Every hospital and medical set up should be held responsible for the waste, it generates for collection and disposal. It should ensure that the staff has the knowledge, skills, supplies and systems and needed to segregate, decontaminate and dispose the infectious waste.

- Waste comprising expired, contaminated and discarded medicines should be stored safely and be returned to the manufacturers for safe disposal.

- Segregation of infectious hospital waste is the most significant step required. Colour codes and Biohazard symbol should be used and infectious waste should be categorised.

- There should be a system of quantification and segregation of all waste in all hospitals, in order to check all malpractices, which occur during transit between the individual hospitals and sanitary landfill site (Dhapa).

- There are various technological options like Incineration, Autoclaving, Hydroclaving, Microwave treatment and Mechanically Chemical Technology. Incineration can lead to toxic emissions due to incomplete combustion. Incineration should therefore be done in three stages including advanced pollution control equipment.

- Alternate technologies like autoclaving, microwave treatment should therefore be done in three stages including advanced pollution control equipment.

- Alternate technologies like autoclaving, microwave treatment should be tried out for infectious waste excluding body parts. Combination of technologies should be used for treatment of infectious waste depending on the type of waste.

- Due to the small quantity of infectious waste generated and capital-intensive nature of treatment, common treatment facilities are recommended. Since small clinics cannot

afford their own independent treatment\ disposal facility, a Common Effluent Treatment Plant can be set up either by CMC or private operator. However, in this case safe transport facility should be provided.

- It is recommended to provide adequate protective gears against occupational health hazards (gloves, masks, gumboots, aprons, soaps etc.) to people engaged in handling and transporting bio-medical waste.

- Awareness campaign and training programme on hospital waste management should be organised.

- There is an urgent need to develop health education materials both print and electronic, like posters, books, booklets, films, videos, slides etc. A multipronged strategy needs to be developed and implemented regarding the optimum use of all education material. Audio-video screening sessions, group discussions, field visits, situation analysis, problem solving, informal interactions and module based training along with self study should be incorporated in training programme.

- Appropriate technologies for treatment of hospital waste should be field-tested by setting up demonstration projects.

- The private sector, consistent with the Environment Action Programme should forge a partnership with the government to collect and dispose infectious waste from medical facilities that are unable to decontaminate their waste.

- Hospital waste management requires a Holistic approach. There should be cooperation among all concerned agencies like ministries, doctors, financial institutions, technology providers, NGOs and the public.

- The Ministry of Environment and Forests and Central Pollution Control Board should remain responsible for environmental policy, status and regulations. The Ministry of Health and Family Welfare should remain responsible for the overall scientific and clinical medical policy and regulations. The new Occupational Health and Safety entities should be responsible for ensuring provisions for personal protective equipment, training and safe protection for workers, particularly the Class IV workers and scavengers.

- Medical Insurance for the workers involved in handling waste.

- Municipalities and the State Pollution Control Board should have the capacity of monitor compliance with medical waste transport and disposal guidelines, rules and policies.

- In case of liability for non-implementation of rules, a case under Environment Protection Act can be registered against the concerned institution.

- NGOs and Scientific organisation should be funded to study infectious waste threats to public health.

- Long term environmental policies, guidelines and status should be linked with immediate requirement to segregate and decontaminate medical waste at its source. This linkage should include appropriate technology for sustainable environmental and public health protection, rather than imported high-technology incineration, which are expensive to purchase and difficult to maintain.

- India multilateral and bilateral partners should support programme for medical waste management in current and future Health programmes.

Conclusion

The aim of this medico-geographical research is to provide an insight to the scientific understanding of human health problems, so that policies can be formulated for preventive measures and promote quality of life for the community as a whole. Environment and health development issues have become major target areas where research and developmental efforts are to be concentrated in the future. Planning of waste generation, evacuation, final treatment and disposal has to start at the earliest to find the best resolution, both environmentally and economically. Research and quality assurance efforts should continue and concentrate on ameliorating problems of medical care deficiencies.

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