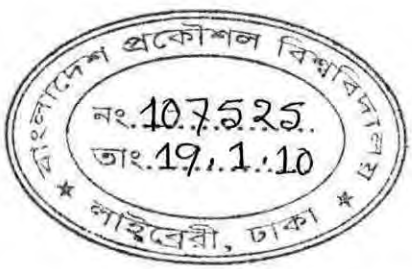
WASTE MANAGEMENT WITH SPECIAL EMPHASIS ON OCCUPATIONAL HEALTH AND SAFETY AT SELECTED HEALTHCARE ESTABLISHMENTS

MIRZA MD TAYABUR RAHMAN



DEPARTMENT OF CIVIL ENGINEERING
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WASTE MANAGEMENT WITH SPECIAL EMPHASIS ON OCCUPATIONAL HEALTH AND SAFETY AT SELECTED HEALTHCARE ESTABLISHMENTS

A Thesis Submitted

By

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A thesis titled "Waste Management With Special Emphasis on Occupational Health and Safety at Selected Healthcare Establishments" submitted by Mirza Md Tayabur Rahman, Roll No: 040304125 (P), Session: April 2003, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Civil Engineering (Environmental) on December 26, 2009.

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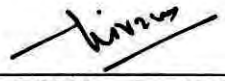

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ABBREVIATIONS

BLAST	Bangladesh Legal Aid Services Trust
BRAC	Bangladesh Rural Advancement Committee
BSMMU	Bangabandhu Sheikh Mujib Medical University
CC	City Corporation
CDC	Centers for Disease Control
CMH	Combined Military Hospital
CMCH	Chittagong Medical College Hospital
DMCH	Dhaka Medical College Hospital
ENT	Ear, Nose and Throat
EPA	Environmental Protection Agency's
ETD	Electro-Thermal-Deactivation
EU	European Union
GW	General Waste
HCC	Health Care Center
HCE	Health Care Establishment
MCH	Medical College Hospital
HCW	Healthcare Waste
HCWM	Healthcare Waste Management
MoH	Ministry of Health
MW	Medical Waste
HIV	Human Immunodeficiency Virus
HW	Hospital Waste

ICDDR'B	International Centre for Diarrheal Diseases and Research, Bangladesh
IPD	The Initiative for People's Development
LIFE	Local Initiative Facility for the Urban Environment
MOHFW	Ministry of Health and Family Welfare
NOC	No-Objection Certificate
PEP	Post Exposure Prophylaxis
PMU	Project Management Unit
PPE	Personal protective equipment
RMCH	Rangpur Medical College Hospital
SCC	Sylhet City Corporation
SOP	Standard Operating Procedure
SSMCH	Sir Salimullah Medical College Hospital
TOT	Training of Trainer
UNDP	United Nation Development Programme
USA	United States of America
VD	Venereal Disease
WHO	World Health Organization
WMO	Waste Management Officer

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ABSTRACT

Proper and safe management of HCW is recognized world wide. Similar study was carried out in different countries which have been compared with the findings of this study. Mean waste generation as per bed found 3.18 (±1.13) kg and 6.58 (±0.14) kg in CMHs and public hospitals respectively and the difference was statistically significant ($p<0.01$). Mean waste generation as per patient found 3.93(±0.42) and 4.53(±0.28) kg in CMHs and public hospitals respectively. The World Health Organization, European Communities and numerous Environmental Protection agencies have emphasized the need of proper handling and disposal of HCW from the HCEs.

The waste was collected from the different departments of the hospitals to compare the contribution of each department. Mean waste generation from Medicine, Surgery, Gynaecology, OT, Pathology, Emergency, OPD and Administration department of both CMHs and public hospitals was 332.71 kg vs. 3304.57 kg, 264.30 kg vs. 1703.00 kg, 363.06 kg vs. 1133.00 kg, 63.23 kg vs. 213.17 kg, 20.38 kg vs. 99.33 kg, 17.88 kg vs. 46.97 kg, 28.00 kg vs. 115.00 kg, and 4.00 kg vs. 8.00 kg respectively. In all departments of public hospitals significantly more waste generation was noted than the CMHs.

A disease survey was conducted in this study among the waste handlers on the basis of the information given by the individual. Disease survey revealed that out of 275 staffs of hospitals who were all time (198) waste handler 63.3% had skin infection, 26.3% had hepatitis, 55.8% had RTI, 48.0% had gastroenteritis, 48.0% had ocular infection, 76.3% had eczema, 74.7% had ring warm infection and 25.3% had fever. In case of some time waste handler (77) only 18.2% had skin infection, 5.2% had hepatitis, 17.6% had RTI, 7.8% had gastroenteritis, 15.6% had eczema, 9.1% had ring warm infection and 13.0% had fever. Among all respondents 55.3% had history of cut injury during handling of waste.

From the study, it is apparent that present system of HCW management is environmentally ineffective, inefficient and hazardous for health and the environment.

There are many public and private hospitals in our country. This study was conducted on 8 CMHs and 3 MCHs only. So, this study cannot reflect the true picture of the country. The seasonal variation of waste generation rate could not be considered due to lack of enough time. The application of this research will definitely contribute appropriate guidelines for the further future study and future planning and design of HCWM in our country.

Dedication

To Mothers,
Mine in particular

CHAPTER 1

INTRODUCTION

1.1. General

Health is an integral part of human development. But healthcare facilities which are intended to maintain this development by its improper actions are producing even more dangerous materials and thereby threatening life (Rahman et al. 2006). Healthcare sector in Bangladesh has been metamorphosed to service based business sectors recently. Foreign and local entrepreneurs are investing millions of dollars in this sector and the number of healthcare establishments (HCE) are growing very rapidly but healthcare waste (HCW) management is getting impromptu attention (Rahman et al, 2008). Environment and natural resources can be polluted, and consequently human beings, animals and plants can be impacted. HCW, because of its infectious nature, is one of the most dangerous causes of this pollution (Sabour et al. 2007). Improper management of HCW is now considered to be one of the most immediate and serious environmental problems (Alam et al. 2002). According to the World Health Organization (WHO), approximately 85% of HCW are non-hazardous, 10% are infectious, and around 5% are non-infectious but hazardous. The WHO has also estimated that injections with contaminated syringes caused hepatitis B virus infections (21 million), hepatitis C virus infections (2 million) and 260000 Human Immunodeficiency Virus (HIV) infections (WHO 2004). In India, infectious hospital waste could range from 15 to 35% depending on the total amount of waste generated (Alam et al 2008). In Pakistan, about 20% of hospital waste was found to be potentially infectious or hazardous (Ekhaise and Omavwoya 2008). HCW therefore, poses risks to individuals, communities and the environment if not carefully handled (Akter et al. 1998).

Bangladesh is a densely populated country, which lacks sufficient health care facilities for the general people of this country. The rapid growth of urbanization is irreparably degrading the urban environment and posing a serious threat to the natural resources and consequently holding back equitable sustainable development (Alam et al. 2008).

In Bangladesh generation of HCW (both hazardous and non-hazardous) is 0.78kg/day/bed. Generation of non-hazardious waste is 0.64kg/day/bed, which is 82.05%

of the total generated waste. Hazardous waste is generated 0.14 kg/day/bed, which is 17.95% of the total generated waste. The contribution of infectious waste is 0.11 kg/day/bed which is 78.57% of the hazardious waste volume and 14.10% of the total generated waste and sharp waste is 0.03kg/day/bed, which is 21.43% of the total hazardous waste and 3.85% of the total generated waste volume (Rahman et al. 2006).

There is no specific legislation in Bangladesh to regulate healthcare waste management (HCWM) issues. The Environment Conservation Act, 1995, as amended, speaks of waste only in general, and the Environment Conservation Rules, 1997, made under this Act do not describe any specific measures for the regulation of HCWM. The Environment Conservation Rules, 1997, state that to obtain environment clearance from the Department of Environment (DOE), an applicant has to procure a no-objection certificate (NOC) from their local authority, namely the City Corporation (metropolitan area), the Municipality (municipal area) and the Union Parishad (rural area). A major part of the private healthcare services do not have a NOC provided by the related authorities (Alam et al. 2008).

The typical scenario of HCWM in urban areas of Bangladesh is that hospitals are dependent on unreliable waste collection services from the city corporation/municipality, whereas in rural areas, the hospitals have to find their own disposal solutions (MOHFW 2004). A variety of methods including burning, burial, selling, dumping, reuse and removal in municipal bins are generally used by these medical facilities to dispose of their waste materials. There is no clear recommendation to segregate waste materials and ensure their proper disposal. Most hospitals collect all waste materials together and dump them in a common place such as the roadside, hospital surroundings or dustbins/drums for collection by the city corporation waste service. Waste is, in some instances, resold or poured down the drain into the main sewer (Akter 2000). In Bangladesh overall segregation of HCW at the source is, with only a few exceptions, very poor. In places where waste collection and categorization is practiced, there is no use of color coding and even no supply or use of plastic bags for packing materials. Furthermore, there is no use of secured intermediate storage facilities for waste. Trolleys are rarely used for internal transport, and cleaners do not use protective clothing (MOHFW 2004). Most doctors, nurses, matrons and staffs of the hospitals and clinics are not aware of the waste management procedures although knowing those are very necessary (Chowdhury 2006).

Occupational health practices in a medical center setting require the same skills as such practice elsewhere, including thoughtful administrative management; knowledge of interactions with safety, industrial hygiene, toxicology, preventive and clinical medicine, surveillance, assessment of history, physical findings, diagnosis, and treatment. Physicians must be aware of local licensing and skill requirements. Other evaluations, such as drug testing, commercial driver certification, baseline medical status before working with hazardous chemicals, immunization status, examinations for respirator clearance, or tuberculosis surveillance status may be required before starting work, but some may be delayed until specific job assignments have been clarified. Specific regulations apply to some functions, such as flight examinations or drug testing, requiring specific certification by designated agencies. The healthcare workplace represents a very hazardous environment compared to any other occupational workplace. Engineering and administrative controls should precede the use of personal protective equipments, but medical surveillance for adverse health effects from hazardous exposures often represents good medical practices and required by federal and even some state laws for specific hazards. Non-occupational injuries or illnesses should be treated similarly to work-related conditions if they affect work performance.

In developing countries, HCW materials have not received sufficient attention. In many countries, hazardous and HCW materials are still handled and disposed of together with domestic waste, thus creating a great health risk for municipal workers, the public and the environment (Silva et al. 2005). In addition, there has been no comprehensive effort to understand how waste materials generated in hospitals, clinics and other healthcare settings should be managed. Management of waste materials is usually delegated to the poorly educated labors who perform these activities without proper guidance and with insufficient protection (Diaz et al. 2005). A lot of research on HCW has already been carried out in different parts of the world (Appleton & Ali 2000, Rushbrook et al. 2000, Almuneef & Memish 2003, Mohee 2004, Diaz et al. 2005, Silva et al. 2005, Bdour et al. 2007, Shinee et al. 2007), but there has been very little research undertaken in Bangladesh (Rashid 1996, Rahman et al. 1999; Akter 2000; Rahman and Ali 2000). Thus, it is necessary to study the characteristics management of HCW in Bangladesh and so the present study was undertaken in selected Combined Military Hospitals (CMHs) and Medical College Hospitals (MCHs) of Bangladesh to quantify the amount of waste generated from there, its composition, and to compare the present waste generation

scenario between them and to assess the occupational hazards associated with the waste handlers in general.

1.2. Objectives

a. To identify the quantity of waste, those are generated in selected hospitals.
b. To analyze the physical composition of hospital waste and the relative proportion of hazardous and non-hazardous waste.
c. To compare the different types of waste generation between different MCHs and CMHs.
d. To assess the present status of hospital waste management in selected public hospitals of our country.
e. To find out the management practices; knowledge on medical waste reuse/recycle of waste, health and environmental consequences of respondents of different strata.
f. To assess the occupational hazards/ risks for the hospital staffs related to the handling of HCW.

1.3. Scope and Limitation of the Study

The study has mainly concentrated on HCW management with special emphasis on occupational health and safety of few selected HCE. In order to quantify the generated hazardous and non hazardous waste of the selected HCEs, a team physically visited and worked to measure the generated waste. The statistics about HCW (hazardous and non hazardous) have been collected from the selected HCE and an in depth analysis was carried out. Occupational health and safety of the persons associated with the handling of the HCW was very challenging. In most of the cases the respondents are very casual to give the facts and figures. The socio economic background, education and other social environment is the main cause for such casual attitude. It may be mentioned here the recorded diseases were not confirmed by medical examination rather recorded as reported by the respondent.

There are many public and private hospitals in our country. This study was conducted on 11 CMHs and 3 MCHs only. So, this study cannot reflect the true picture of the country. Selected HCEs were considered and visited to quantify the hazardous and non-hazardous portion of HCW. The seasonal variation of waste generation rate could not be considered due to lack of enough time. The radioactive wastes and radon gas emission from HCEs are not considered here, because no equipment was available to detect the presence and concentration of such gases.

1.4. Organization of the Thesis

The study has been presented in five chapters comprising different aspects of waste management with special emphasis on occupational health and safety at selected health care establishments.

Chapter 1: Presents a brief introduction to the study along with objectives, scope, limitation and finally organization of the project work.

Chapter 2: Comprises few relevant literature reviews, information about waste and medical waste, hospital waste management and appropriate technologies, occupational hazards: bio-safety, prevention and management, International and Bangladesh scenario related to the topic.

Chapter 3: Methodology has been included in this chapter. Study type, period, places and their selection, data collection and analysis methods are included here.

Chapter 4: Outlines the waste management with special emphasis on occupational health and safety at selected health care establishments analysis and the obtained results. Basing on the analysis and results a brief discussion has been incorporated.

Chapter 5: Summarize the whole study, the conclusion and the recommendation drawn thereof and provide some suggestions for further study in this area.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Solid, liquid, or gas wastes that can cause death, illness, or injury to people or destruction of the environment if improperly treated, stored, transported, or discarded. Substances are considered hazardous wastes if they are ignitable (capable of burning or causing a fire), corrosive (able to corrode steel or harm organisms because of extreme acidic or basic properties), reactive (able to explode or produce toxic cyanide or sulfide gas), or toxic (containing substances that are poisonous). Mixtures, residues, or materials containing hazardous wastes are also considered hazardous wastes.

Many dangerous substances can be used only with special precautions that decrease their risks. When discarded, these substances are no longer under the direct control of the user and may pose special hazards to people or other organisms that come in contact with them. Because of such potential risks, hazardous wastes are processed separately from ordinary wastes. Hospitals use special care in disposing of wastes contaminated with blood and tissue, separating these hazardous wastes from ordinary waste. Hospitals and doctors' offices must be especially careful with needles, scalpels, and glassware, called "sharps." Pharmacies discard outdated and unused drugs; testing laboratories dispose of chemical wastes. Medicine also makes use of significant amounts of radioactive isotopes for diagnosis and treatment, and these substances must be tracked and disposed of carefully. Worldwide, about 400 million metric tons of hazardous wastes are generated each year. In 1989 the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal was adopted at a meeting convened by the United Nations Environmental Program and attended by 116 countries.

In this chapter basic idea about solid waste, HCW generation and classification, HCW management, organizational responsibility of HCW management, HCW treatment and disposal, common practices in disposal, occupational hazards and related preventive measures has been presented. In addition to that brief scenario related to previous works in this field both international and national has been presented.

2.2. Waste

The European Union (EU) defines waste as an object the holder discards, intends to discard or is required to discard is waste under the Waste Framework Directive (European Directive 75/442/EC as amended).

Once a substance or object has become waste, it will remain waste until it has been fully recovered and no longer poses a potential threat to the environment or to human health".

The United Kingdom's (UK) Environmental Protection Act 1990 indicated waste includes any substance which constitutes a scrap material, an effluent or other unwanted surplus arising from the application of any process or any substance or article which requires to be disposed of which has been broken, worn out, contaminated or otherwise spoiled; this is supplemented with anything which is discarded otherwise dealt with as if it were waste shall be presumed to be waste unless the contrary is proved. This definition was amended by the Waste Management Licensing Regulations 1994 defining waste as: "havoc" for ever.

"Any substance or object which the producer or the person in possession of it, discards or intends or is required to discard but with exception of anything excluded from the scope of the Waste Directive".

In summary to define waste we can say:

a. Resources consumed by inefficient or non-essential activities.

b. Unwanted material left over from a production process, or output which has no marketable value.

c. Process or materials that do not (from the viewpoint of the customer) add value to any goods or services.

d. Material discharged to, deposited in, or emitted to an environment in such amount or manner that causes a harmful changes of environment.

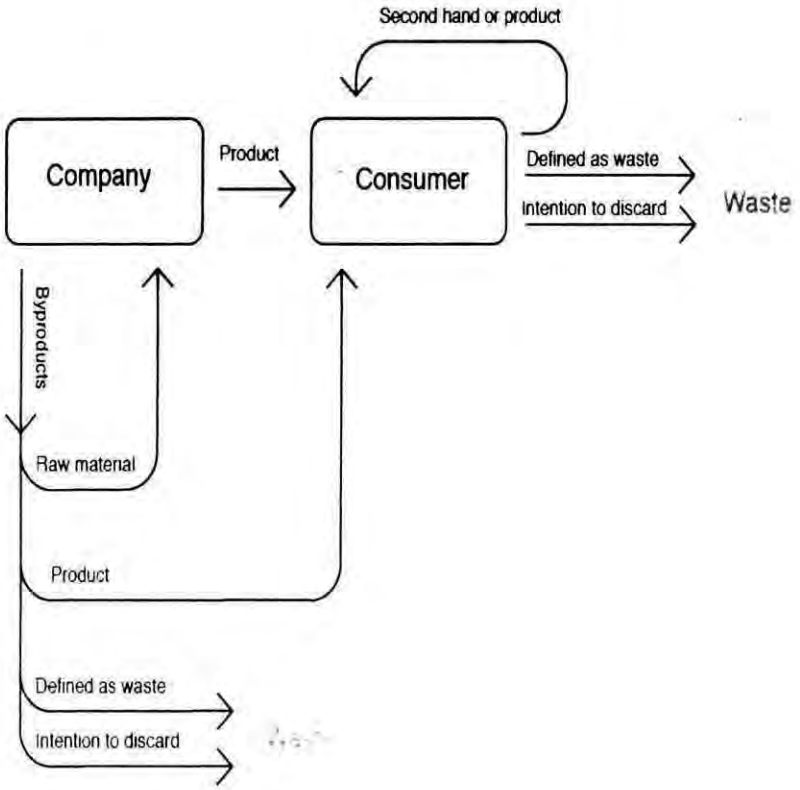


Fig-2.1 Flow chart of Waste

Municipal solid waste is produced as a result of economic productivity and consumption. Countries with higher incomes produce more waste per capita and per employee, and their wastes have higher portions of packaging materials and recyclable wastes. In low income countries, there is less commercial and industrial activity, as well as less institutional activity, thus resulting in lower waste generation rates. In countries where personal incomes are low, there is, of necessity, extensive recycling at the source. Table shows how solid waste collection, transport and sanitary landfill costs vary as a function of income. In developing countries, while the per capita quantities of wastes and labor costs are low, the costs of providing solid waste management are not proportionately low. Equipment capital costs and fuel costs in low income countries are comparable to those in high income countries, and sometimes are higher because of importation. Solid waste management cost is higher in low-income countries, when viewed as a percentage of personal income. Given the proportionately high cost of full service in developing countries and competing urban infrastructure needs, the prevailing low levels of solid waste service are likely to continue for at least another decade. Table assumes sanitary

landfill as the disposal method of choice, because it is usually the lowest cost of the environmentally acceptable solutions. Sanitary landfill costs roughly 3-8 times more than open dumping with some grading to maintain truck access to the working face.

Table-2.1 Generation of waste basing on income of the country

	LOW INCOME COUNTRY	MIDDLE INCOME COUNTRY	HIGH INCOME COUNTRY
Avg Waste Generation	0.2 m.t./cap/yr	0.3 m.t./cap/yr	0.6 m.t./cap/yr
Avg Income from GNP	370 $/cap/yr	2,400 $/cap/yr	22,000 $/cap/yr
Collection Cost	10-30 $/m.t.	30-70 $/m.t.	70-120 $/m.t.
Transfer Cost	3-8 $/m.t.	5-15 $/m.t.	15-20 $/m.t.
Sanitary Landfill Cost	3-10 $/m.t.	8-15 $/m.t.	20-50 $/m.t.
Total Cost Without Tfr	13-40 $/m.t.	38-85 $/m.t.	90-170 $/m.t.
Total Cost With Tfr	16-48 $/m.t.	43-100 $/m.t.	105-190 $/m.t.
Cost as % of Income	0.7-2.6%	0.5-1.3%	0.2-0.5%

Source: Sandra Cointreau-Levine (2006)

In 1993, hazardous waste survey conducted in 21 countries of Latin America showed, as expected, that the per person waste generation rate for industrial hazardous waste, sludge and solids is a function of the country's level of industrialization, with the highest rates (over 0.3 tonnage/person/year) in countries like Mexico and Brazil, and the lowest rates (under 0.1 tonnage/person/year) in countries like Bolivia and Ecuador. In most of these countries, more than 30% of the hazardous industrial wastes are inappropriately discharged to open dumps and controlled landfills. Similarly, hazardous medical waste is being co-disposed with general municipal solid waste in open dumps and controlled landfills, seldom in sanitary landfills with adequate protective measures (Koning et al. 2004).

2.3. Health Care Waste

2.3.1. Definition

Refers to any solid, liquid, gaseous and/or radioactive substance (WHO 2000) generate from patient's diagnosis, prevention, research, alleviation of disablement and treatment (both preventive and curative) purpose and as well as waste generated from all other department of health care establishment including waste from administrative section. Hospital waste is one of the varieties of major source of HCW. Hospitals produce a wide variety of waste ranging from simple discarded office paper to hazardous biological or radioactive waste.

On an average, in every country and in any type of HCE, it was found that HCW are generally comprises, 80% general or municipal waste, 15% pathological and infectious waste, 03% chemical waste, 01% sharp waste and less than 01% are radioactive, cytotoxic and pressurized waste (Pruss et al. 1999).

2.3.2. Factors Affecting the Generation of HCW

Several surveys have indication on typical HCW generation. Generation of HCW both quantitatively and qualitatively depends upon many factors, such as:

- Type of health care establishment.
- Categories (specialization) of the HCE.
- Load of patients/attendants in the HCE.
- Season of the year.
- Existing waste management system.
- Cultural value of service seeker.
- Education level of service seeker.
- Socio-economic status of the habitants.
- Attitude of the patient, attendants and services providers.
- Awareness among service providers and service seekers.
- Collection frequency of the generated waste.
- Government policy, guideline and Legislation etc (Rahman et al. 2006).

The generation of HCW varies from country to country. In middle and low-income countries generation of HCW is usually lower than High –Income countries.

Table-2.2 Hazardous hospital waste produced in selected countries

Country	Number of Beds	Quantity of Waste (tons/ year)
Argentina	15000	32850
Brazil	501660	109960
Cuba	50293	11010
Jamaica	5745	1260
Mexico	60100	13160
Venezuela	47200	10340

Source: Christen (1996)

The generation of waste also differs both in quantity and quality depending upon different departments within the same hospital.

Table-2.3 Waste generated in different departments in hospital (kg/day)

Department	Infectious	Sharp	General
Out patient department	1.52	1.90	2.84
Emergency/ casualty	3.18	1.78	5.22
Operation theatre	8.22	2.74	2.96
Lobar room	4.24	1.14	1.12
Pathology	2.81	2.36	2.32

Source: Estimation of hospital waste in Rawalpindi, 1996 (Rahman 2006)

2.3.3. Characteristics of HCW

HCW offers a wide variety of services and encompasses a variety if activities, each activity generating waste in various quantity and quality. Generally wastes that are generated in the HCEs are of two types.

❖ **Non-hazardous or General Waste**

The HCW is mainly non-hazardous, which means not potentially dangerous for human being and environment. Generally 80-82% of the total HCE's generated wastes are non-hazardous.

❖ **Hazardous Waste**

Hazardous HCW are the waste (solid, liquid, either bio-logical or non biological) that are generating as a by-product of heath care delivery system or research purpose, poses a substantial danger or potential to pose danger or negative changes to the plant, animal or human society or to the environment on its discharge, displaced or for dumping. All hazardous waste may be infectious or non-infectious, but all the infectious waste is (WHO 1998) hazardous and is the potential source of various microbiological diseases. It is crucial to categorize a waste hazardous because for effective waste management as labor, materials and other costs are related to handle this hazardous waste. Out of total generated (Pruss et al. 1999) HW, on an average 18-20% are hazardous. Out of this hazardous waste, 10-12% is infectious waste and rest 5-8% is non-infectious hazardous waste.

The mismanagement of HCW poses risks to people and the environment. Healthcare workers, patients, waste handlers, waste pickers, and the general public are exposed to health risks from infectious waste (particularly sharps), chemicals, and other special HCW. Improper disposal of special HCW, including open dumping and uncontrolled burning, increases the risk of spreading infections and of exposure to toxic emissions from incomplete combustion. For these reasons, occupational health and safety should be a component of HCWM plans.

Unfortunately management of hazardous waste that are generated from HCEs are improper and inadequate, which causes detrimental consequence to the occupational health, public health, environment and sustainability to the echo-system. Hazardous wastes are classified as under (Rahman 2006):

- Infectious
- Pathological

- Chemical
- Radioactive
- Pharmaceutical
- Cytotoxic
- Pressurized Sharp

Table-2.4 Composition of waste in a hospital (in %)

Types	Paper	Plastic	Pathological	Food	Glass	Metal	Others
Administrative	100	-	-	-	-	-	-
Cafeterias	20	20	-	60	-	-	-
Surgery	60	30	10	-	-	-	-
Emergency	60	35	05	-	-	-	-
Intensive care unit	60	35	05	-	-	-	-
Renal dialysis	10	85	05	-	-	-	-
Laboratory	35	30	25	-	10	-	-
Nursery	45	35	-	05	15	-	-
Pharmacy	50	30	-	-	20	-	-
Patient care	60	35	-	05	-	-	-
Research	50	-	30	-	-	-	-
Sharps	-	90	-	-	-	10	-

Source: (Rahman 2006)

2.3.4. Classification of HCW

HCWs are classified in number of ways in different institution and in different countries. Some common classifications were done:

- On the basis of contentment.
- As per EU classification.
- As per USA Classification.
- As per health Impact (WHO) etc.

But the suggested classification of hospital waste for Bangladesh (Rahman 2000) is shown in the figure 2.2.

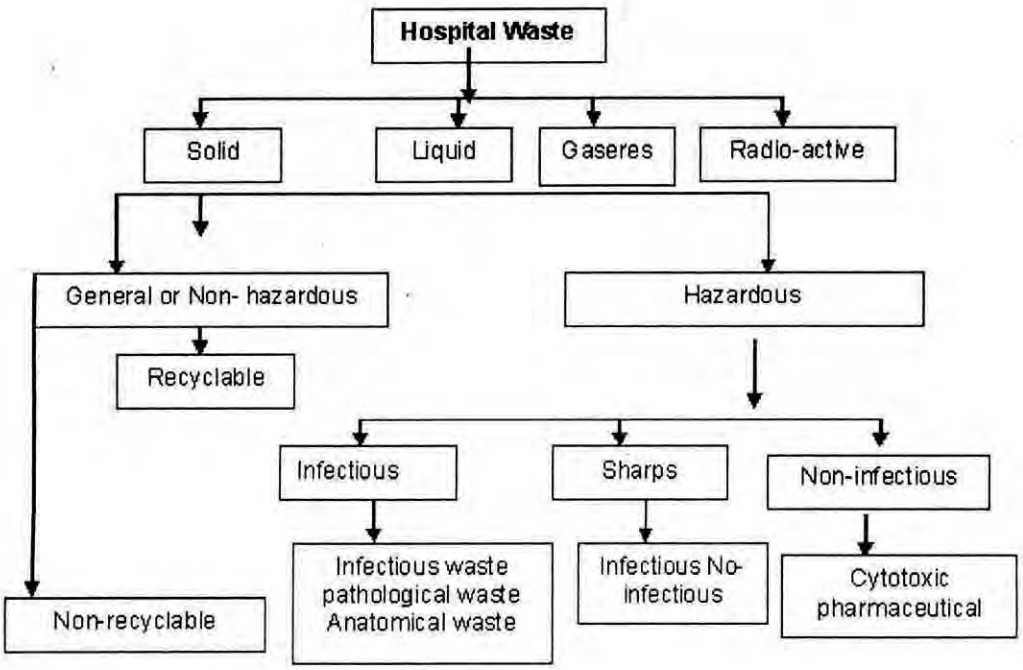


Fig-2.2 Classification of HCW

2.3.5. Characteristic of Waste at Source

HCEs are enriched with different department with lot of units. Different unit within the hospital mainly generate waste in following characteristics:

- **Medical ward:** mainly infectious wastes, say dressing, bandage, socked cotton, gloves, catheter, hypodermic needles, syringe, intravenous set, blood transfusion set etc.
- **Surgical ward:** mainly anatomical and then infectious waste, say tissue, organ, body parts, and sharps etc.
- **Labor and operation theater:** mainly anatomical than infectious waste, say, dead baby, placenta, amputated organ, operated body parts etc.
- **Laboratories:** mainly pathological including small anatomical, highly infectious, sharps, and radioactive and some chemical waste.

- **Stores:** mainly chemical and pharmaceuticals and also general wastes.
- **Support unit:** General waste.
- **Administration:** General waste.

2.3.6. HCW Management

Defined as practice (Pruss et al. 1999) of generation, handling, separation, collection, carrying, storage, treatment and finally disposing of generated HCW, to minimize occupational health hazard and for environmentally friendly HCEs. Management requires a strategy and appropriate allocation of resources according to the identified priorities. For effective and efficient waste management, HCEs should follow a pathway of some elements in terms of personnel, materials, costs, occupational health risk and safety. Every HCE should have a sound organization for proper waste management and should maintain records of the generated waste. Suggested elements for waste management are:

❖ **Waste Minimization**

A reduction in generation of waste is the reduction in handling, manpower and costs. Waste minimization can be done by source reduction, using recyclable wastes and by stock management.

❖ **Waste Segregation**

Waste should be segregated into different stream, soon after its generation at its point of generation. Segregation is the responsibility of waste generators/producers. Major share of waste management depends on this stage, say treatment and disposal option, policy planning and practice option, costs, manpower and risk etc. If segregation is not properly done, small quantity of hazardous waste has a chance to mix with large volume of non-

infectious waste, making the whole of waste into infectious waste and affects in the down stream of waste management. Waste should be segregated as per color code.

❖ Waste Identification

It is important to identify the categories of waste by sorting and placing them in "Color-coded" containers. Color coding containers are used for easy identification of waste, so for easy handling, treatment, identifying the source of generation and person responsible for generation and treatment.

Table-2.5 Suggested color code for Bangladesh

Contents	Type of waste	Color code
General waste	Type-1	Black
Clinical waste (Infectious, Anatomical and	Type-2	Yellow
Cytotoxic / Pharmaceutical waste	Type-3	Red
Radioactive waste	Type-4	Silver
Sharp waste	Type-5	Red box
Liquid waste	Type-6	No Code

Source: (Rahman 2000)

❖ Waste Handling

Under this heading a lot of activities are done, these are

- Collection of waste.
- Labeling of waste.
- Storage of waste.
- Transportation of waste.

Collection of Waste

Nursing and other clinical staffs should ensure that wastes are collected properly in a tightly closed or sealed bag when they are three quarters full. Bags are not to be stapled. Wastes should not be allowed to accumulate at the point of generation. A routine program for their collection should be established as part of the HCWM plan.

Labeling of Waste

All waste bags or containers should be labeled with basic information on their content and on the waste producer. This information may be written directly on the bag or container or preprinted labels may be securely attached. For HCW some additional information should be marked on the label: (i) Waste category; (ii) Date of collection; (iii) Place of generation and (iv) Waste destination. Labeling warns operating staffs and others about the hazardous nature of the waste. The hazards posed by container content can be quickly identified in case of any accident, enabling emergency services to take appropriate action.

Storage of Waste

The storage location for the HCW should be designed inside the HCEs. The waste in bags or containers should be stored in a separate room, or building of a size appropriate to the quantities of waste produced and the frequency of collection. Recommendations for the storage area and its equipments are:

- The storage area should have an impermeable, hard-standing floor with good drainage; it should be easy to clean and disinfect.
- There should be water supply for cleaning purposes.
- Should afford easy access for staff in charge of handling the waste.
- Facility to lock the store to prevent access by unauthorized persons.
- Easy access for the waste collection vehicles.
- There should be protection from sun light.

- Should be inaccessible for animals, insects and birds.
- Should have good lighting and at least passive ventilation.
- Should not be located in proximity of fresh food stores or food preparation areas.
- A supply of cleaning equipment, protective clothing, and waste bags or containers should be located conveniently close to the storage area.

Transportation of Waste

On- site Transportation

The movement and transportation of waste internally and externally should be considered as part of a comprehensive HCW management in all HCEs. Internally, wastes are usually transported from its initial storage point to an assembly area or on-site incinerator by means of trolleys or handcarts. Such equipments should be cleaned regularly and used exclusively for waste transportation and meet some specifications: (i) Easy to load and unload; (ii) No sharp edge that could damage waste bags or containers during loading and unloading; (iii) Easy to clean.

Off-site Transportation

Waste being transported externally should present no public health risk provided it has been suitably treated, but its physical appearance or the identifiable color coded containers may give rise to objects on aesthetic grounds. When hazardous wastes are transported, the contents of all containers and their potential hazards should be identified in documents carried in the vehicle. The transport vehicle should have an enclosed leak-proof body and be cleaned after each use and disinfected when necessary.

❖ **Waste Treatment and Disposal**

Security

Security of waste throughout its life cycle is important, because of its recycling from every point of generation, scavenging from storage, treatment and disposal.

Record Keeping

For effective waste treatment and disposal, accurate record keeping is essential. Record keeping is important because of compliance of the program.

- Assess the expenditure.
- Identifying the quality and quantity of waste.
- Assess direct cost for materials, equipments for collection, transportation, storage and disposal.
- Cost for prevention of waste related injury and illness.
- Assess annual, recurrent and special maintenance costs.
- To identify the cost in any in avoidable accidents.
- Future plan of investment, installation and sustainability.

❖ **Health and Safety**

Training

HCW management should be integrated into the daily activities of all health personnel of any HCE.. Three groups of peoples are related in the life cycle of waste management. They are:

- Waste generators: doctors, nurses, technicians etc
- Waste handlers: sweeper, ward boys, aya, cleaners, etc.
- Supervisors: directors, head of the departments, matrons etc.

Training is required for every group of people. Training should be provided whenever

- New policy is implemented.
- New employee began to work.
- When existing worker assigned for new work.
- When policy is changed.

❖ **Waste Management Options**

Waste management option (Becker et al 1989) may vary from institution to institution with different circumstances but should consider three main issues:

- The risk involved interms of finance, technical and legislation.

- Cost of each option.
- Managerial skill and time required.

Management should address some questions:

- Should the HCE act independently or co-operative with other HCE?
- How the HCE or groups of HCE dispose their generated wastes?
- Should the HCE or group of HCEs install enough capacity for its own project need or build in a margin share capacity for income generation?

❖ Waste Management Planning

Planning is required for improvement of waste management (WHO 2000) at all level of HCEs for appropriate, cost-effective and sustainable strategies to facilitate careful implementation of necessary measures and allocation of available resources for ensuring public and occupational safety and environmental regulatory compliance's at HCE level. We should remember that "Human elements related management issue of HCW is more important than that any modern sophisticated technological option of waste treatment."

National Level

National Hospital waste management plan (WHO 1998) can be developed through 7-step action plan, as per WHO, these are:

- Establishment policy commitment and responsibility for HCW management.
- Conduct a detailed national survey on HCW management practices.
- Develop national guidelines for waste management at the hospital level.
- Develop a policy on institutional, regional and or co-operative methods of HCW treatment.
- Legislation, regulation standard for HCW management.
- National training program.
- Review the national waste management program after implementation.

Local (Hospital) Level

Both for local and national level planning are required for effective waste management. It must have enough statistical data support for waste management plan of a hospital (Pruss et al. 1999). In waste management planning a system of accountability and reporting can easily be establish in a hospital by ensuring the following tasks listed below:

Define the categories of hazardous HCW.

Assess current HCW practice and responsibility.

The silent management of wastes depends upon good administrator; administration and organization supported by adequate legislation, finance and participation of trained and informed staffs.

Management/Organizational structure and responsibilities.

Assessment of current HCW management arrangement and costs.

Facility should be available from national level for determining the average daily quantity of each category waste generated from the HCEs, even by individual department. The hospital chief executive is responsible for economic aspect of the hospital. Detailed audits on purchasing practices cost of items that are regularly needed whether they are disposable, reusable or recyclable. Cost analysis must be enclosed with material and equipment cost e.g.

- Color coding bags/ containers
- Labeling
- Chemicals/ disinfectants
- Protective equipment
- Frequency of use
- Personnel time related to handling time
- Treatment cost etc.
- Personnel

Develop HCW management guideline.

Develop effective HCW management plan and policy.

Waste management plan should include:

- Detailed specification of waste container, whatever applicable.

- Timetable for waste collection from various areas of the HCE.
- Define the accountability and responsibility for personnel in terms of their generated waste minimization, segregation, pretreatment, handing and storage at their working place.
- Estimated cost of waste management equipments.
- Availability of waste treatment and disposal facility.
- Estimate the number and categories of personnel required for total waste management from its generation to ultimate disposal.
- Training and awareness programs.
- Emergency procedures meet-up facilities.
- Occupational safety.
- Policy for recycling.
- Policy for hospital income.

Legislation, regulation and standard for HCWM.

Interface with other agency:

- HCWM is interrelated with urban waste management.
- To make special arrangement with municipal authority or NGO's for waste treatment and disposal.
- Co-ordination with NGO's for producing public awareness and training for hospital personnel.
- An agency dealing with chemical and radioactive waste should be established to enable the hospital to dispose of these wastes.
- Make available centralized facility for waste treatment with non-government organization. The transport, treatment and disposal will be the responsibility of this agency.

Implement hospital waste management plan.

Evaluation and review of HCWM plan (Rahman 2006).

2.3.7. Organizational Responsibility of HCW Management

Hospital management must document the amount of waste generated and waste management practices. There must be comprehensive audit on current personnel duties,

responsibilities and reporting practices. Each departmental head or a nominated efficient officer should conduct audit in his department. The audit should be on waste separation, storage, collection, transportation and amount of waste produced, related materials and supplies used.

Designate one officer as waste management officer (WMO), who will do additional job with his own job. WMO should be responsible for operation and monitoring of waste management. He will maintain good communication with other members of the committee and will be responsible to the director for all activities. The WMO will be the key person in waste management.

For efficient waste management, responsibility can ensure by sharing duties among:

a. The ministry of health of the state/directorate of health services.
b. Hospital director / superintendent.
c. Waste management officer (WMO).
d. Departmental head.
e. Nursing superintendent/matron/senior staff nurse.
f. Ward master.
g. Waste handlers (Cleaner).
h. Waste generators (Nurse/Technologists).
i. Doctors.
j. All staffs of the hospital.

For effective waste management, there should be one "HCW management committee" chaired by hospital director/superintendent and he will delegate responsibilities to the sub-group. Members of the sub-group may include:

- Director / superintendent of the hospital.
- Head of the departments / consultants.
- Nursing superintendent / Matron.
- Ward master.
- Designated waste management officer (WHO).
- Engineer in charge of the hospital.
- Accountant.
- Store keeper.

2.3.8. HCW Treatment & Disposal

Waste treatment is a process that changes (WHO 1983) the character of hazardous waste into less or non-hazardous waste. Treatment made the waste non-recognizable but volume may or may not be reduced. There is no perfect or standard method of waste (Pruss et al. 1999) treatment technology, each technology has advantage and disadvantage. Treatment facility may on-site or off site. Selection method of treatment facility depends upon many factors, such as:

- Treatment effectiveness.
- Investment.
- Technical actuality.
- Sustainability.
- Service cost.
- Related manpower.
- Environmental pollution.
- Disposal site.
- Hazard of post treatment residue.
- Hazard for community people etc.

There are some commonly used technologies in our country, though various alternative treatments and other emerging techniques are being tried overseas. Certain treatment options are discussed here.

It has been found that, a variety of technologies have been developed for the storage, collection, treatment and disposal of medical wastes particularly for those wastes generated in industrialized countries. Several types of treatment and disposal processes have been applied (incineration, micro waving, chemical treatment, melting etc.), with varying degrees of safety, cost and impact on the environment. None of the available low-cost treatment devices are however safe and environmentally friendly. As WHO mentioned that, in developing countries, a trade-off has to be made between direct health risks from absence of HCW management leading to reuse of syringes, and indirect health risks created by environmental pollution *(e.g.* by production of dioxins from inadequate incineration). Progress could be made in waste minimization practices, in particular in the

development of materials and products leading to less waste, or less harmful waste when disposed of.

Overview of the various technologies used for the treatment and final disposal of different categories of HCW highlighted in the table below. Advantages and/or disadvantages with suitable condition and influencing parameters have been discussed along with the selected technology. Information on various technologies may help to select a specific technology for each type of waste and/or each country that is suitable considering the socio-economic and environmental condition of that country.

Table 2.6: Technologies for Treatment and Final Disposal

Technology	Description	Advantages	Disadvantages	Suitable condition
Incineration	A high temperature dry oxidation process that reduces organic and combustible waste to inorganic matter. Many different types of incinerator ranging from the sophisticated to the basic; however, basic incinerators often cause serious emissions problems.	Requires no pre- treatment. Good disinfection efficiency.	If not operated effectively may pollute atmosphere High capital and operational costs. Low cost incineration is possible by using a drum or brick incinerator, however, these present large emission problems and are not as effective in the destruction of hazards.	>60% combustible Moisture content < 30%. Not suitable for pressurized gas canisters, reactive chemical waste, PVC, wastes with high heavy metal content, photographic or radiography wastes.
Chemical disinfection	Chemicals added to the waste to kill/inactivate the pathogens. Shredding is usually necessary before disinfection, as only the surface of intact solid waste will be treated. The waste is then disposed of in a conventional way, e.g. landfill.	Efficient disinfection when operated well. Some chemical disinfectants are low cost. Shredding reduces volume of waste.	Disinfectants may themselves be hazardous to operators & pose risks in the case of leakage and subsequent disposal. Needs highly trained operators. Shredder liable to	Best for liquid or sewage Inadequate for pharmaceutical, chemical and some types of infectious waste.

Technology	Description	Advantages	Disadvantages	Suitable condition
			mechanical failure.	
Render inert	Mixing the waste with cement in order to prevent migration of toxic substances from waste into ground water etc.	Relatively low cost. Low-technology	Bulky and heavy final waste product to be disposed of.	Especially suitable for pharmaceuticals. Not suitable for infectious waste.
Wet thermal treatment (inc. autoclaving)	Exposure of shredded waste to high temperature, high-pressure steam. If temperature and contact time is sufficient, most micro-organisms are inactivated. Waste can subsequently be disposed of as municipal waste.	Relatively low capital and operating costs. Low environmental impact.	Shredder liable to mechanical failure. Efficiency of disinfection very sensitive to operational conditions.	Not suitable for anatomical, pharmaceutical or chemical wastes.
Microwave irradiation	Waste shredded, humidified and then irradiated by microwaves. The heat generated destroys micro-organisms.	Very efficient disinfection when operated well. Environmentally sound. Reduction in volume of waste.	Relatively high capital and operating costs. Potential operation and maintenance problems.	Not suitable for pharmaceutical or chemical wastes Not suitable for large metal objects.
Landfill (Sanitary)	Landfill isolates waste from the environment; it requires appropriate engineering preparation, staff to control operations, organized deposition and covering of waste. Waste may be pre-treated (see above). Ideally, healthcare waste is separated from municipal waste.	Simple, low cost & safe when operated properly.	If not operated properly scavengers may access the waste and it may cause pollution of environment etc.	Generally suitable

Technology	Description	Advantages	Disadvantages	Suitable condition
(Encapsulate)	Pre-treatment involving filling containers with waste, adding an immobilizing material and sealing the container e.g. bituminous sand, cement mortar.	Preventing access to HC waste by scavengers. Relatively simple, low cost & safe	Not recommended as sole method for non-sharp infectious waste. Bulky and heavy final waste product to be disposed of.	Appropriate for establishments using minimal programs for disposal of sharps, chemical or pharmaceutical residue.

Source: (WHO, 1999)

2.3.9. Common Practices in Low Income Countries

In high income countries, essentially all collected wastes go to safe sanitary landfill, composting, materials recovery or incineration facilities that are designed and operated to meet environmental protection standards. In these countries, hazardous wastes are handled separately from municipal solid waste, and subject to stringent environmental protection standards. In middle income countries, probably less than 10% of collected wastes are deposited in controlled landfills, and probably less than 5% are deposited in sanitary landfills. The rest is discharged to open dumps, most of which burn openly and have hazardously steep side slopes. In low-income countries, nearly all of collected wastes are deposited within open dumps. In most developing countries, hazardous waste facilities have not yet been implemented and hazardous wastes are co-mingled for disposal with municipal solid wastes, despite laws to the contrary. Common practices in the low income countries are:

- **Burial**

Although burial is suitable for minimal program, particularly in remote locations and in temporary health facilities still burial process have been used from many years in the poor country for disposal of hospital generated waste. In this process there is no reduction of weight but are reductions in volume of the waste. As the burial process does not sterilize the waste materials, so it is necessary to sterilize the waste materials prior to dispose by burial.

Considerations for design and specification of pits are:

a. Quality of waste.

b. Volume of clinical waste; The volume of hazardous waste is very important in designing pit, other properties of hazardous waste to be known are density, moisture. Several research and studies shows that the density of hazardous waste is 0.1 to 0.2 kg per liter. Dry infectious waste had a density as low as 1.5 kg / m^3 and wet infectious waste have a density as high as 1000 kg / m^3. Information on volume is very useful for estimating the required number of bins, number and size of the transport vehicles and designing the disposal pit, (iii) Decay factor: The degradation rate of clinical waste depend on type of waste, temperature, air supply and other environmental parameters, Reduction rate may changes from seasons to season.

c. Design and specification of pits and sharps,

d. Design and specification for disposal of waste.

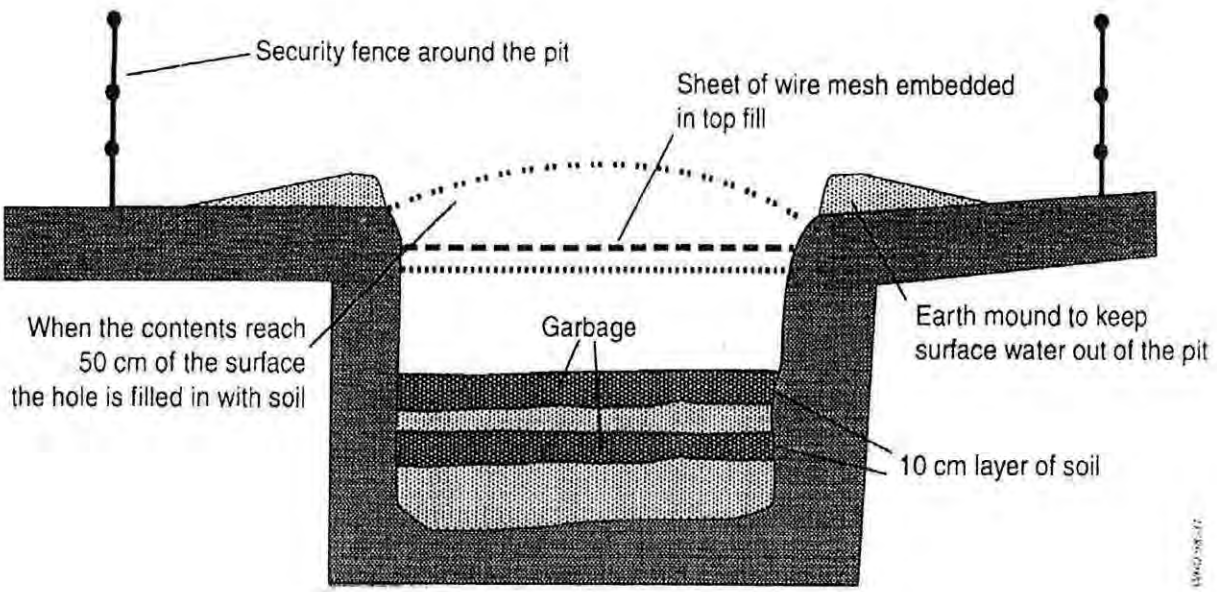


Figure-2.3: Example of a small burial pit for HCW

❖ Land disposal

If a municipality or medical authority genuinely lacks the means to treat wastes before disposal, the use of a landfill has to be regarded as an acceptable disposal route. Allowing health-care waste to accumulate at hospitals or elsewhere constitutes a far higher risk of the transmission of infection than careful disposal in a municipal landfill, even if the site is not designed to the standard used in higher-income countries. The primary objections to landfill disposal of hazardous health-care waste, especially untreated waste, may be cultural or religious or based on a perceived risk of the release of pathogens to air and water or on the risk of access by scavengers.

There are two distinct types of waste disposal to land—*open dumps* and *sanitary landfills*.

- **Open dumps** are characterized by the uncontrolled and scattered deposit of wastes at a site; this leads to acute pollution problems, fires, higher risks of disease transmission, and open access to scavengers and animals. Health-care waste should not be deposited on or around open dumps. The risk of either people or animals coming into contact with infectious pathogens is obvious, with the further risk of subsequent disease transmission, either directly through wounds, inhalation, or ingestion, or indirectly through the food chain or a pathogenic host species.

- **Sanitary landfills** are designed to have at least four advantages over open dumps: geological isolation of wastes from the environment, appropriate engineering preparations before the site is ready to accept wastes, staff present on site to control operations, and organized deposit and daily coverage of waste. Disposing of certain types of health-care waste (infectious waste and small quantities of pharmaceutical waste) in sanitary landfills is acceptable; sanitary landfill prevents contamination of soil and of surface water and groundwater, and limits air pollution, smells, and direct contact with the public. Upgrading from open dumping directly to sophisticated sanitary landfills may be technically and financially difficult for many municipalities. It has often been found impossible to sustain such efforts from the available local resources. However, this is no reason

for municipal authorities to abandon the move towards safer land disposal techniques, perhaps by a gradual approach.

In the absence of sanitary landfills, any site from a controlled dump upwards could accept HCW and avoid any measurable increase in infection risk. The minimal requirements would be the following:

- An established system for rational and organized deposit of wastes which could be used to dispose of health-care wastes;
- Some engineering work already completed to prepare the site to retain its wastes more effectively; rapid burial of the health-care waste, so that as much human or animal contact as possible is avoided.

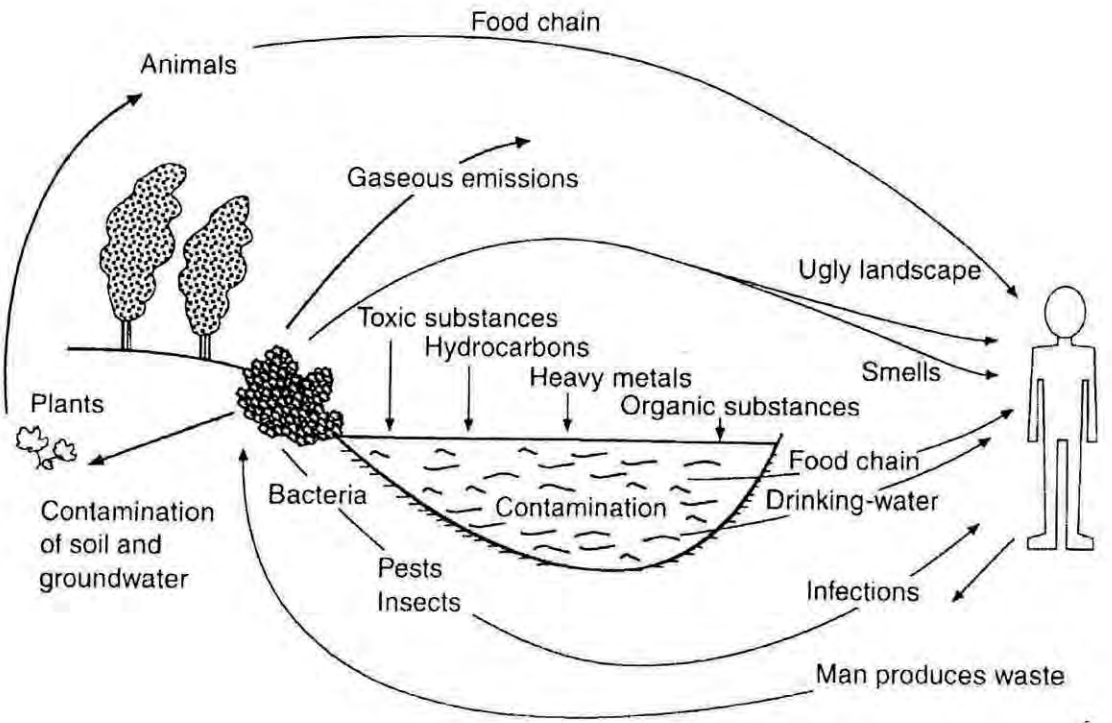


Fig-2.4: Routes of exposure to hazards caused by open dumping

Some essential elements for design and operation of sanitary landfills

- Access to site and working areas possible for waste delivery and site vehicles.
- Presence of site personnel capable of effective control of daily operations.
- Division of the site into manageable phases, appropriately prepared, before landfill starts.
- Adequate sealing of the base and sides of the site to minimize the movement of wastewater (leachate) off the site.
- Adequate mechanisms for leachate collection, and treatment systems if necessary.
- Organized deposit of wastes in a small area, allowing them to be spread, compacted, and covered daily.
- Surface water collection trenches around site boundaries.
- Construction of a final cover to minimize rainwater infiltration when each phase of the landfill is completed.

It is further recommended that HCW be deposited in one of the two following ways:

Proposed pathway for gradual upgrading of landfills

a. From open dumping to "controlled dumping: This involves reduction of the working area of the site to a more manageable size (2 ha for a medium-size town), covering unneeded areas of the site with soil, extinguishing fires, and agreeing rules of on-site working with scavengers if they cannot be excluded completely.
b. From controlled dumping to "engineered landfill: This involves the gradual adoption of engineering techniques to prevent surface water from entering the waste, extract and spread soils to cover wastes, gather wastewater (leachate) into lagoons, spread and compact waste into thinner layers, prepare new parts of the landfill with excavation equipment, and isolate the waste from the surrounding geology (e.g. with plastic sheeting under the waste).
c. From engineered landfill to "sanitary landfill: This involves the continuing refinement, with increasing design and construction complexity, of the engineering techniques begun for engineered landfill. In addition, there should be landfill gas control measures, environmental monitoring points and bore holes (for monitoring air and groundwater quality), a highly organized and well trained work force, detailed record-keeping by the site office, and, in some circumstances, on-site treatment of leachate.

d. In a shallow hollow excavated in mature municipal waste in the layer below the base of the working face, and immediately covered by a 2- metre layer of fresh municipal waste. Scavenging in this part of the site must be prevented. The same method is often used for hazardous solid industrial wastes; it is specifically intended to prevent animals and scavengers from re-excavating the deposited healthcare waste.
e. In a deeper (1–2m) pit excavated in mature municipal waste (i.e. waste covered at least 3 months previously). The pit is then backfilled with the mature municipal waste that was removed. Scavenging in this part of the site must be prevented.

Alternatively, a special *small burial pit* could be prepared to receive HCW only. The pit should be 2m deep and filled to a depth of 1–1.5m. After each waste load, the waste should be covered with a soil layer 10–15cm deep. If coverage with soil is not possible, lime may be deposited over the waste. In case of outbreak of an especially virulent infection (such as Ebola virus), both lime and soil cover may be added. Access to this dedicated disposal area should be restricted, and the use of a pit would make supervision by landfill staff easier and thus prevent scavenging.

Before HCWs are sent for disposal, it is prudent to inspect landfill sites to ensure that there is sensible control of waste deposition (Pruss et al. 1999).

❖ **Chemical Disinfection**

The techniques were used for killing microorganisms of medical equipment's, floors, toilets and also for treatment of waste. The treatment procedure is used for disinfecting rather than sterilization. Chemical disinfection is suitable for treating semi-liquid waste and also pathological waste.

Commonly used chemicals are:

- Formaldehyde.
- Alcohol.
- Chlorohezidine.
- Ethylin oxide.
- Sodium hypochloride.
- Iodine.

2.3.10. Disposal of HCW

The purpose of proper disposal of waste to:

- Prevent spread of infection to the health care providers and community.
- Protect the health care providers from accidental injury.
- Provide an aesthetically pleasing atmosphere.

The disposal of HCW can be done by:

a. Waste water has a multidimensional hazard on health and environment, there are strict limitations on the discharge of hazardous liquid to sewer. Common managements are:

- Connection with municipal treatment plant.
- On-site treatment of waste water and then discharge into sewer system.
- Discharge into general sewer after chemical neutralization.

b. Non-hazardous solid waste does not contain infectious material and usually does not cause public health hazard. 80-85% of the total volumes of HCW are municipal waste. Maximum portion of the waste can be recycled or reused. Remaining portion of the waste can mixed with municipal house hold waste and can find their way to municipal dustbin. If there is still remaining can burned periodically within hospital premises under every precaution giving emphasis on health hazard and environmental pollution.

c. Disposal of sharp waste in a puncture resistant container generally made of easily available object, such as cardboard, tin can or non-PVC plastic with a central hole at the top. When the container is 3/4th full, plug the top tightly. Finally dispose the sharp waste by burial or any technique such as Incineration.

d. Solid hazardous wastes are handled with wearing protective equipment and collect in non-corrosive washable containers with tightly fitting covers. Collect the waste containers as per schedule and transport to the final disposal site.

e. Pharmaceutical and Radioactive materials should be disposed by returning to the manufacturer, return to the suppliers or as per law of Atomic energy commission, Bangladesh (Radioactive waste). Pharmaceuticals can be disposed by high temperature incinerators.

f. Residue of incinerators, burning method can be disposed by land filling or can be transferred to the public dustbin under the agreement with City Corporation (Rahman 2006).

2.3.11. Accountability of Waste Treatment/Disposal

Operational management of HCW can be done by

- Government sector
- Private sector
- Joint sector

There may be installation of "Central treatment /disposal plant" beyond city and residential area. Whatever may be the treatment technology, waste from all health care establishments could be carried by transport agency, could be government, semi government or non-government agency. There might be provision for treatment of health care waste on payment basis, for money generation (Rahman 2006).

2.4. Occupational Hazards: Bio-Safety, Prevention and Management

2.4.1 General

HCW includes materials sufficiently contaminated with blood or body fluid that is capable of transmitting mainly infectious diseases. Bio-hazardous waste is produced from a wide array of clinical settings: hospitals and laboratories, physician offices, dental offices, clinics, research facilities, surgery centers, nursing homes, and settings where health care is delivered. All theses settings are socially obligated to maintain a clean environment and to dispose of medical waste, in order to prevent pollution and infection among themselves and also among the general public. Doctors, nurses, pharmacists, radiologists, laboratory technician, dentists, physical therapist, ward boys, ayas, cleaners, sweepers, porters, ambulance drivers and other personnel working in this field, all run the risk of direct contact with potentially infectious or other harmful waste that are generated from patient care activities. Therefore, administrators of HCEs will realize the need and importance of

careful handling of hazardous HCWs for the safety of their staffs and the environment at large. They shall be particular to take necessary actions to correct the poor waste handling practices in their respective HCEs. Thus, clinical waste management and infection control measures are inter related and both are important for prevention of bio-hazards because health care providers are at constant risk of exposure to blood borne pathogens such as HIV – the virus that causes AIDS, the hepatitis B virus (HBV), and the hepatitis C virus (HCV) and many other bacteria.

2.4.2. Hazards Related to HCW

The exposure to hazardous HCW may lead to disease or injury. The significant characteristics of hazardous HCW are as follows:

- It contains infectious agents.
- It involves sharp items.
- It contains toxic and hazardous chemical or pharmaceutical products.
- It is genotoxic.
- It is radioactive.

2.4.3. Universal Precautions Against Infectious Materials Causing Bio-hazards

These are a set of precautions designed to prevent transmission of HIV, HBV, HCV, and other blood borne pathogens when providing first aid or health care. Under universal precautions, blood and certain body fluids of all patients are considered potentially infectious. In the workplace, universal precautions should be followed where workers are exposed to blood and certain other body fluids including semen, vaginal secrétions, synovial fluid, serebrospinal fluid, pleural fluid, peritoneal fluid, pericardial fluid, amniotic fluid etc. Universal precautions do not apply to nasal secretions, sputum, sweat, tears, feces, urine, vomits, saliva etc (except in the dental setting, where saliva is likely to be contaminated with blood). Universal precautions should be applied to all body fluids when it is difficult to identify the specific body fluid or when body fluids are visibly contaminated with blood. Any unfixed tissue or organ from a human (living or dead);

and HIV-containing cell or tissue cultures, organ cultures, and HIV-or HBV/HCV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV/HCV are also considered infectious.

❖ Hazards from Infectious Waste and Sharps

Infectious waste usually contains pathogenic microorganisms. Pathogens in infectious waste may enter to the human body mainly through the following routes:

- Puncture, abrasion or cut in the skin;
- Splashing of blood or other body fluids on the mucous membranes particularly on the mouth. eyes or nose;
- Inhalation; and
- Ingestion.

It is important to know that almost all cases of hepatitis B and C viruses and HIV transmission to health care personnel occurred through preventable accidental puncture injury and handling of HCW.

❖ Hazards from Chemical and Pharmaceutical Waste

Many of the chemicals and pharmaceuticals used in HCEs are hazardous such as toxic, genotoxic, corrosive, flammable, reactive, explosive, and shock-sensitive. This problem gives rise to serious consequences when large quantities of unwanted or outdated chemicals and pharmaceuticals are disposed off. They may cause intoxication and injury including burns. Intoxication can result from absorption of chemical and pharmaceutical through skin or the mucous membranes, or from inhalation or ingestion. Injuries to the skin, the eyes, or the mucous membranes of the airways can be caused by contact with flammable, corrosive or reactive chemicals such as formaldehyde and other volatile substances. Poorly stored and disposed of these substances can directly or indirectly affect the health of anyone who comes into contact with them. This also creates a gross environmental pollution through contaminating groundwater, air or other products

including foods. Chemical residues discharged into the sewage treatment plants exert toxic effects on the natural ecosystems of wastewater. Similar problems may be caused by pharmaceutical residues such as antibiotics and other drugs, heavy metals such as mercury, phenols and other disinfectants and antiseptics.

❖ **Hazards from Genotoxic Waste**

The severity of the hazards for health care workers who are responsible for the handling or disposal of genotoxic waste is mainly depend on the substance toxicity itself, and the extend and duration of exposure. It may also occur during the preparation of or treatment with particular drugs or chemicals. The exposure usually occur through inhalation of dust or aerosols, absorption through skin, ingestion of food accidentally contaminated with cytotoxic drugs, chemicals, or other waste, and ingestion due to improper practice such as mouth pipe ting. This also can happen through contact with body fluids and secretions of patients undergoing chemotherapy. The cytotoxicity of many antineoplastic drugs including alkylating agents is carcinogenic and mutagenic. In addition they are extremely irritant and have harmful local effects after direct contact with skin or eyes. They may also cause dizziness, nausea, headache or dermatitis. Therefore, genotoxic waste should be specially handled with extreme care.

❖ **Hazards from Radioactive Waste**

Hazards due to radioactive waste range from headache and vomiting to more serious problems such as destruction of tissues. The hazards may arise from contamination of external surfaces of containers or improper mode or duration of waste storage. Health care workers and waste handling or cleaning personnel exposed to this radioactivity are most at risk.

2.4.4. Safety Against Biohazards

How can workers prevent exposure to blood and body fluids?
Barriers are used for protection against occupational exposure to blood and certain body fluids. These barriers consist of:

- Personal protective equipment (PPE).

- Engineering controls.
- Work practice controls.

❖ Personal Protective Equipment (PPE)

PPE includes gloves, lab coats, gowns, shoe covers, goggles, glasses with side shields, masks, etc. The purpose of PPE is to prevent blood, body fluids from reaching the workers' skin, mucous membranes, or personal clothing. It must create an effective barrier between the exposed worker and any blood or other body fluids.

The type of protective clothing use should be depending upon the extent of the risk associated with the HCE. The following should be made available to all personnel who collect or handle HCW:

- Helmets with to without visors - depending on the operation.
- Face masks – depending on operation.
- Eye protectors (safety goggles) - depending on operation.
- Disposable gloves for medical staff and heavy-duty gloves for waste handlers– obligatory.
- Leg protectors or industrial boots – obligatory.
- Industrial aprons – obligatory.
- Overalls (coveralls) – obligatory.

PPE is also recommended for health care waste transportation in small hospital.

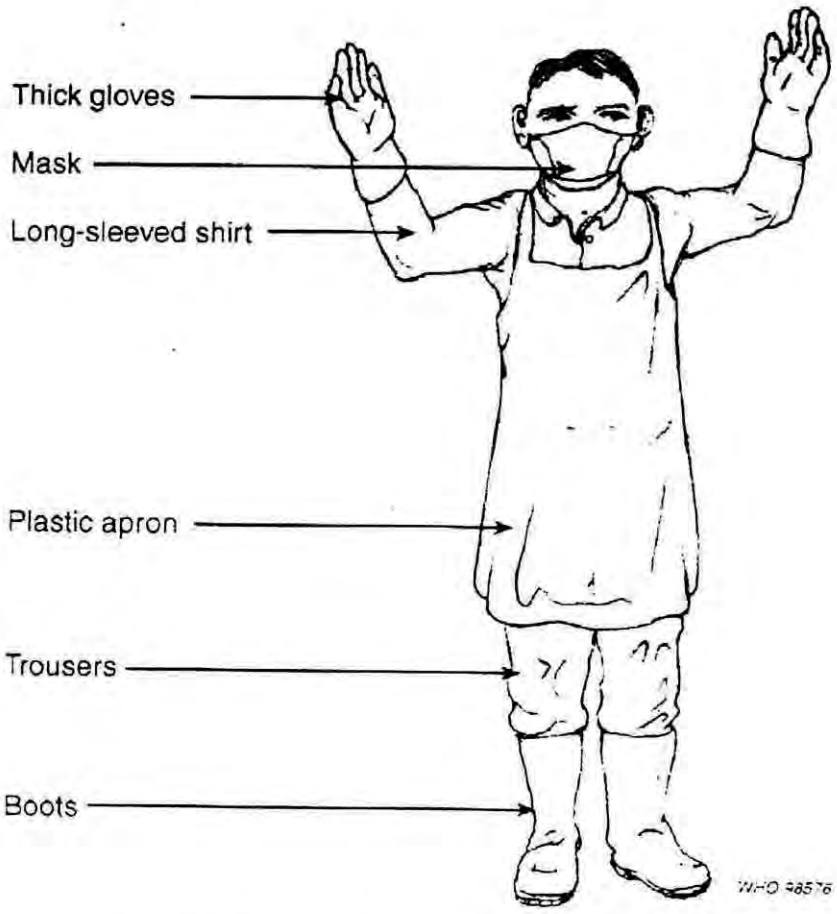


Fig-2.5: Personal Protection Equipments

❖ **Engineering Control**

Engineering controls refer to methods of isolating or removing hazards from the workplace. Examples of engineering controls include: sharps disposal containers, safe carrying, incineration etc.

❖ **Work Practice Controls**

It refers to practical techniques that reduce the likelihood of exposure by changing the way a task is performed. Examples of activities requiring specific attention to work practice controls include: hand washing, handling of used needles and other sharps and contaminated reusable sharps, collecting and transporting of fluids and tissues according to approved safe practices.

❖ Personal Hygiene

Basic personal hygiene is important for reducing the risks from handling HCW and convenient washing facilities with water and soap should be available for personnel involved in the tasks.

❖ Staff Immunization

Immunization against hepatitis B infection is recommended. Tetanus immunization is also recommended for all personnel handling waste.

❖ Golden Rules of Universal Precautions

a. Wash hands before and after every patient contact, and immediately if in direct contact with blood or body fluids.

b. Wear gloves when contact with blood or body fluids, mucous membranes or non-intact skin is anticipated and wash hands after their removal.

c. Take precautions to prevent puncture wounds, cuts and abrasions in the presence of blood

d. Protect skin lesions and existing wounds by means of waterproof dressings and/or gloves

e. Avoid invasive procedures if suffering from chronic skin lesions on hands.

f. Avoid use of or exposure to sharps and sharp objects, but when unavoidable, take particular care in their handling and ensure approved procedures are followed for their disposal.

g. Never re-sheath/recap needles. Always dispose of needles directly into sharps bins

h. Protect the eyes and mouth by means of a visor, goggles or safety spectacles and a mask whenever splashing is a possibility.

i. Wear rubber boots or plastic disposable overshoes when the floor or ground is likely to be contaminated.

j. Control surface contamination by blood and body fluids through appropriate decontamination procedures.

k. Use approved procedures for sterilization and disinfection of instruments and equipment

l. Use approved procedures for sterilization and disinfection of instruments and equipment.

m. Dispose of all contaminated waste and linen safely.

n. Use the agreed procedure for the safe procedure of contaminated wastes.

Application of these precautions, particularly with regard to necessary protective clothing, will vary accordingly to the degree of anticipated contact with blood, body fluids or tissues. The risk of exposure must be assessed for each procedure and the appropriate action taken.

2.4.5. Sharps Management and Incidence Procedure

❖ **Procedures in the Event of a Contamination Incident**

A "sharps" or "needle stick" injury is one in which blood or body fluid from one person is inoculated into another on the point of a needle, scalpel or other sharp object. However, the following advice also applies to spillage of blood or body fluids on to skin, especially broken or eczematous skin, mucous membranes or the eye. If you are in any doubt seek advice. The major health risks to someone exposed to such event are Hepatitis B, Hepatitis C, and HIV infection.

❖ Needle Stick Injuries Causing Biohazards

A needle stick injury is the result of an accident with a needle. Several studies show that needles cause injuries at every stage of their use, disassembly, or disposal. Nursing and laboratory staff usually experiences such 30 to 50 percent of all injuries during clinical procedures.

Chances of exposure

Critical situations during clinical procedures include:

- Withdrawing a needle from a patient, especially if staff attends to bleeding patients while disposing of the needle.
- Having the device jarred by a patient.
- Pulling a needle out of the rubber stopper of a vacuum tube which can jab the hand in a rebound reflex.

Work conditions that might contribute to an increase in the number of needle stick injuries include:

- Difficult patient care situations.
- Working with reduced lighting.
- Staff Experience: New staff tends to have more needle stick injuries than experienced staff.
- Recapping:
  - Recapping can account for 25 to 30 percent of all needle stick injuries of nursing and laboratory staff. Often, it is the single most common cause.
- Injuries commonly occur when workers try to do several things at the same time, especially while disassembling or disposing of needles
- In crowded conditions on the way to the disposal box.
- To protect themselves when disassembling a non-disposable needle device with an exposed contaminated needle.

- From exposed needles when several items were carried to a disposal box in a single trip.
- To store a syringe safely between uses if its contents were to be administered in two or more doses at different times in crowded conditions on the way to the disposal box.
- Guidelines from the Centre for Disease Control (USA) recommend that workers should not recap (or bend or cut) needles but dispose of them directly into approved, puncture-proof containers.

Recapping: Injuries occur in three different ways:

- The needle misses the cap and accidentally enters the hand holding it.
- The needle pierces the cap and enters the hand holding it.
- The poorly fitting cap slips off of a recapped needle and the needle stabs the hand.

Disposal

- Needle stick injuries commonly occur when workers dispose of needles. They also occur when needles are disposed of improperly in regular garbage or lost in the workplace.
- *Special Containers*: Up to 30 percent of needle stick injuries of nursing and laboratory staff occur when workers attempt to dispose of needles into sharps containers. *Accidents occur at every step:*
- While carrying the needle to the disposal container, especially when the needle is uncapped and mixed with other trash.
- While placing the needle into the disposal container, especially if the container is overfilled.
- While emptying disposal containers instead of sealing them for disposal.
- *Improper Disposal*: Virtually all needle stick injuries of domestic and portering staff are from needles that have either been lost in the workplace or thrown into

regular garbage. Janitors and garbage handlers can also experience needle stick injuries or cuts from "sharps" when handling trash that contains needles or scalpels. Some attribute the problem to forgetfulness or lack of motivation or training on the part of people who work with and dispose of needles. Others feel that inconvenient disposal systems contribute to these incidents.

- Maintenance staffs have also experienced needle stick injuries when they have been cleaning ducts or other areas with their hands and have found hidden needles and syringes. These injuries have usually happened when they are reaching into areas where they cannot see and were not wearing leather gloves.

❖ Response to Accidental Injury and Exposure Incidence

All staff members who are responsible for handing HCW should be educated to deal with the management of injuries and exposures. These include:

- Initiation of immediate first aid measures;
- Reporting of the accident to the designated authority;
- Identification of items involved in the accident and take appropriate protective measures;
- Sought medical attention for the accident management;
- Establishment of medical surveillance;
- Participation of periodic blood and other examinations as indicated;
- Maintaining record keeping.

❖ Response to Other Exposures or Emergencies

All health staff members should be educated for emergency response to the following situations:

- Accidental spillage of waste
- Equipment failure

- Accidental tear or breakage of containers;
- Interruption or delay in collection, treatment and disposal;
- Explosion and fire;
- Any other accident that needs immediate action or decision.

Necessary equipment should be made readily available at hand in all times for dealing with any emergency situation. In case of emergency situation or accidents immediately report the incident to the designated authority.

❖ **Reporting of Incidence**

When any accident occurs at any institution, facility or any other site where hazardous health care waste is handled or during treatment of such waste, the authorized person should report the incidence using the accidence form to the designated authority for record keeping and taking appropriate preventive measures. Incidence reporting form is given in Appendix III.

First Aid and Immediate Help

- Encourage bleeding where skin is punctured
- Wash thoroughly with copious amounts of soap and warm water.
- DO NOT USE A SCRUBBING BRUSH.
- If eyes are involved, wash immediately with water (use tap water or sterile water if tap water not available).
- If the mouth is contaminated rinse with plenty of water
- Where massive contamination of unbroken skin has occurred, remove contaminated clothing and wash all affected areas with copious amounts of water.
- Ensure that your manager or immediate senior is informed promptly of the incident.
- The injured person should complete an incident reporting form and report to designated person

❖ **Post Exposure Prophylaxis (PEP)**

After exposure, if the source patient is known to be infected with HIV or is considered to be "at risk" but there is no facility for testing, then approved guidelines on PEP (HIV) for health care workers need to follow.

The following points to be considered for PEP (HIV)

- The choice of anti-retroviral drugs.
- To ensure that all health care workers after exposure should have immediate access to PEP.
- Supply availability of drugs and appropriate laboratory investigations.
- Appropriate counseling.
- Setting up of local PEP policies and protocols.

2.5. Preventive Measures

2.5.1. Prevention of Needle Stick Injuries

Preventing needle stick injuries is the most effective way to protect workers from the infectious diseases that needle stick accidents transmit. A comprehensive needle stick injury prevention program would include:

- Employee training.
- To follow recommended guidelines.
- Safe recapping procedures if essential.
- Effective disposal systems.
- Surveillance programs.
- Improved equipment design

❖ Employee Training

To reduce needle stick injuries, an effective program must include employee training. Workers need to know how to properly use, assemble, disassemble, and dispose of needles. Workers need to understand the risks associated with needle stick injuries and know the proper means to prevent them. Specifically, the training programs should address.

- Risk of injury.
- Potential hazards.
- Recommended precautions for use and disposal of needles.
- Procedures for reporting injuries.
- The importance of hepatitis B vaccination where appropriate.

❖ Recommended Guidelines to Follow

Workers should consider these as potentially infectious and handle them with care to prevent accidental injuries.

- Disposable needles and syringes, scalpel blades, and other sharp items--workers should place these in puncture-resistant containers located near the area of use. They should avoid overfilling the containers because accidental needle stick injuries may occur.
- Workers should not recap needles by hand or purposely bend, break, or remove them from disposable syringes or otherwise manipulate them by hand

❖ Safe Recapping Procedures

- In situations where recapping is considered necessary, develop safe approaches which workers can follow. Workers should never move an exposed needle tip towards an unprotected hand.

- Single-Handed Scooping: Recapping can be safe when people lay the cap on a flat surface and scoop it onto the tip of a syringe held in one hand. They must keep the free hand away from the sheath and well behind the exposed needle.

❖ **Effective Disposal System**

- Effective system: Having disposal containers readily available can greatly prevent needle stick injuries and eliminate the need for recapping needles.
- Containers should be puncture-proof.
- Replace the containers before they are completely filled.
- Make sure they are sealed, collected, and disposed of in accordance with local regulations for biomedical waste.
- All staff should report every incident in which they find needles left at the bedside or thrown into the regular garbage.

❖ **Surveillance Programs**

There is still a serious lack of information about the various factors that cause accidents with needles. Surveillance programs that provide in-depth analysis of needle stick accidents are an important tool for obtaining this information. The goals of these programs should include:

- Determining the rate of needle stick injuries.
- Investigating the factors that cause the injuries.
- Ensuring that injured workers receive proper treatment.
- Identifying areas in which the prevention program needs improvement.
- Eventually providing practical strategies for dealing with the problem.

2.5.2. Other Preventive Measures

❖ **Cytotoxic Safety: Chemical and Pharmaceutical Waste Safety**

Less hazardous chemicals should be substituted whenever possible and appropriate personal protective equipment should be used to minimize the occupational risks due to exposure to chemical and pharmaceutical waste. Premises where chemical hazardous chemicals are used should be properly ventilated.

The senior pharmacist of the health care facility should be designated to ensure safe use of cytotoxic drugs. The following key measures are essential in minimizing exposure:

- Written procedure with specifying safe working methods for each process;
- Information of supplier's specifications on potential hazards;
- Established procedure for emergency response in case of spillage or other occupational accident;
- Appropriate education and training for all personnel involved in the handling of cytotoxic drugs.

In hospitals where cytotoxic drugs are used, established specific guidelines for safe handling of cytotoxic products. The guidelines should include rules on the following waste handling procedures for the protection of personnel who are responsible for handling cytotoxic products:

- separate collection of waste in leak-proof bags or containers and put labeling for identification;
- return of outdated drugs to suppliers;
- separately keep them in safe storage from other health care waste;
- provision for the disposal of contaminated material, for the decontamination of reusable equipment, and for the treatment of spillages;

- provision of the treatment of infectious waste contaminated with Cytotoxic products.

❖ **Radioactive Safety**

- Users of radiation materials must keep records of surveys, inventories, order and packing slips for the safety of the workers as well as inspections and investigations by nuclear safety and radiation control division of the Atomic Energy Commission.
- Individuals must keep themselves away from sources of radiation and use remote handling tools to prevent high dose.
- Appropriate radiation shield, protective clothing and dosimeter must be worn where indicated.
- Radioactive waste should be stored by encapsulation for decay of action.
- Radioactive containers such as bottles glass wear should be destroyed before disposal for avoidance of public access.

❖ **Important Considerations to Avoid Biohazards While Dealing with HCW**

- The waste should be separated at the source of its generation and high-risk waste should be labeled properly.
- For smooth functioning of hospital waste management, a color-coding policy should be adopted.
- The different colored waste containers should be provided throughout the hospital so that waste can be segregated at its source.
- Place waste containers close to where the waste is generated and where convenient for users. Carrying waste from place to place increases the risk of infection for handlers.

- Use plastic or galvanized metal containers with cover lids for contaminated waste collection and use separate containers for collection of sharps materials which should ideally be puncture-proof.
- Use personal protective equipment when handling waste for example, heavy- duty utility gloves, and protective shoes.
- Reusable waste containers should be emptied at least once daily or when three-quarters full and wash properly with vim or 0.5% chlorine solution and rinse with water before replacing them to its place.
- The used container should be closed on the top firmly and tightly, and the container should be taken to a pre-designated area for collection and transportation for at least once daily or as frequently as needed.
- The waste collection staff should ensure that the waste is segregated properly according to the color-coding policy procedure and then carry it to the appropriate disposal area.
- The waste containers should be carried by holding on the top and avoiding touching to the body as well as avoiding jar king, throwing or dragging waste over floor.
- The waste collection staff may have reserved the right to refuse to remove the waste if sharps or items liable to cause injury are found in the wrong containers.
- The waste containers should be stored in a safe area until the transportation to the designated disposal destination. However, the storage time should not exceed 24 hours during summer and 48 hours in the winter season.
- If general waste or hazardous waste is mixed together, the mixed waste should be considered as hazardous waste and dispose of as clinical waste.
- Under any circumstances no staff members should put their bare hands into any waste containers.
- Special care should be taken when handling and transporting damaged and leaked waste container. During the collection of such a container, it should be replaced with a new one. No container should be collected if damaged or leaked.

- In case, if there is a leakage of the waste container, or there is a spillage of infectious waste, gently collect the spillage into a new container, soak the area with hypochlorite solution and leave the area for 15-30 minutes. Then wash and wipe the area with soap and water.
- No waste containers should be collected without proper labeling from the source site.
- The waste container should contain maximum 100kg for solid waste and 50 liters for liquid waste.
- Equipments that are used to hold and transport waste must not be used for any other purpose in the hospital.
- Wash hands or use alcohol based hand-rub after removing gloves when handling waste.
- Hospital staff members including doctors, nurses should be trained and made aware about the segregation of waste and the use of colour-coding waste disposal system. Housekeeping staff and waste collection staff should also be adequately trained about safe way of handling and transporting of waste as well as the accident and spillage management procedures.
- Hepatitis B immunization should be offered to all concerned hospital staff members and proper recording of such immunization should be maintained by the authority.

2.6. Related Previous Work

2.6.1. International Scenario

Suwannee et al (2002) surveyed the waste from hospital and clinics in Phitsanulok, town in north central Thiland and found the average daily waste generated as general, medical and hazardous waste from all hospitals in Phitsanulok at 1.751, 0.284 and 0.013 kg/bed/day respectively and at 0.323, 0.041 and 0.002 kg/bed/day respectively from all clinics in Phitsanulok Province. Medical waste from all hospitals consisted of needles,

gloves, drain tubes, cottons and gauze, napkins, plastic syringes, swap and body parts with total daily generation at 0.452, 0.480, 0.390, 0.404, 0.018, 0.355, 0.004 and 0.382 kg/bed/day respectively. Information about proper waste management process is needed to improve HCW management. HCWM is an important and necessary component of environmental health protection.

Klangsin and Harding (1998) investigated HCW practices used by hospitals in Oregon, Washington, and Idaho states of United States of America (USA), which includes the majority of hospitals in the USA. Environmental Protection Agency's (EPA) Region 10. During the fall of 1993, 225 hospitals were surveyed with a response rate of 72.5%. The results reported here focus on infectious waste segregation practices, medical waste treatment and disposal practices, and the operating status of hospital incinerators in these three states. Hospitals were provided a definition of HCW in the survey, but were queried about how they define infectious waste. The results implied that there was no consensus about which agency or organization's definition of infectious waste should be used in their waste management programs. Confusion around the definition of infectious waste may also have contributed to the finding that almost half of the hospitals are not segregating infectious waste from other HCW. The most frequently used practice of treating and disposing of HCW was the use of private haulers that transport HCW to treatment facilities (61.5%). The next most frequently reported techniques were pouring into municipal sewage (46.6%), depositing in landfills (41.6%), and autoclaving (32.3%). Other methods adopted by hospitals included Electro-Thermal-Deactivation (ETD), hydro-pulping, microwaving, and grinding before pouring into the municipal sewer. Hospitals were asked to identify all methods they used in the treatment and disposal of HCW. Percentages, therefore, add up to greater than 100% because the majority chose more than one method. Hospitals in Oregon and Washington used microwaving and ETD methods to treat medical waste, while those in Idaho did not. No hospitals in any of the states reported using irradiation as a treatment technique. Most hospitals in Oregon and Washington no longer operate their incinerators due to more stringent regulations regarding air pollution emissions. Hospitals in Idaho, however, were still operating incinerators in the absence of state regulations specific to these types of facilities.

A survey conducted by Askarian et al (2004) in 15 private hospitals of Fars province of Iran to determine the amount of different kinds of waste produced and the present

situation of waste management. The results indicated that the waste generation rate is 4.45 kg/bed/day, which includes 1830 kg (71.44%) of domestic waste, 712 kg (27.8%) of infectious waste, and 19.6 kg (0.76%) of sharps. Segregation of the different types of waste are not carried out perfectly. Two (13.3%) hospitals use containers without lids for on-site transport of wastes. Nine (60%) hospitals are equipped with an incinerator and six of them (40%) have operational problems with the incinerators. In all hospitals municipal workers transport waste outside the hospital premises daily or at the most on alternative days. In the hospitals under study, there aren't any training courses about hospital waste management and the hazards associated with them. The training courses that are provided are either ineffective or unsuitable. Performing extensive studies all over the country, compiling and enacting rules, establishing standards and providing effective personnel training are the main challenges for the concerned authorities and specialists in this field.

Bdour et al (2007) conducted a survey of the procedures available, techniques, and methods of handling and disposing of HCW at medium (between 100 and 200 beds) to large (over 200 beds) size healthcare facilities located in Irbid city (a major city in the North-Western part of Jordan). A total of 14 healthcare facilities, including four hospitals and 10 clinical laboratories, serving a total population of about 1.5 million, were surveyed during the course of this research. Their study took into consideration both the quantity and quality of the generated wastes to determine generation rates and physical properties. Results of the survey showed that healthcare facilities in Irbid city have less appropriate practices when it comes to the handling, storage, and disposal of wastes generated in comparison to the developed world. There are no defined methods for handling and disposal of these wastes, starting from the personnel responsible for collection through those who transport the wastes to the disposal site. Moreover, there are no specific regulations or guidelines for segregation or classification of these wastes. This means that wastes are mixed, for example, wastes coming from the kitchen with those generated by different departments. Also, more importantly, none of the sites surveyed could provide estimated quantities of waste generated by each department, based upon the known variables within the departments. Average generation rates of total HCW in the hospitals were estimated to be 6.10 kg/patient/day (3.49 kg/bed/day), 5.62 kg/patient/day (3.14 kg/bed/day), and 4.02 kg/patient/day (1.88 kg/bed/day) for public, maternity, and private hospitals, respectively. For medical laboratories, rates were found to be in the range of 0.053-0.065 kg/test-day for governmental laboratories, and 0.034-0.102 kg/test-day for

private laboratories. Although, based on the type of waste, domestic or general waste makes up a large proportion of the waste volume, so that if such waste is not mixed with patient derived waste, it can be easily handled. However, based on infections, it is important for healthcare staff to take precautions in handling sharps and pathological wastes, which comprises only about 26% of the total infectious wastes. Statistical analysis was conducted to develop mathematical models to aid in the prediction of waste quantities generated by the hospitals studied, or similar sites in the city that are not included in this study. In these models, the number of patients, number of beds, and hospital type were determined to be significant factors on waste generation. Such models provide decision makers with tools to better manage their medical waste, given the dynamic conditions of their healthcare facilities.

A survey for HCW disposal was performed by Hosny and El-Zarka (2005) in order to examine the current status of HCW disposal in some hospitals in Alexandria city of Northern Egypt and to properly assess management of this type of hazardous waste. A questionnaire was designed for hospitals to assess the quantity of medical waste, collection, sorting, storage, transportation and way of final disposal. From the total waste generated by healthcare activities, almost 80% are waste similar to domestic waste. The remaining approximate of 20% is considered as hazardous waste. As Alexandria has about 3911 healthcare facilities providing medical services for people, a huge amount of medical waste are generated daily with about 208 tons generated per month. The results revealed that the most common problems associated with healthcare wastes are the absence of waste management, lack of awareness about their health hazards, insufficient financial and human resources for proper management, and poor control of waste disposal. The current situation of HCW disposal in Alexandria is depending on incinerators. Some of these incinerators are not working anymore. Incinerations as a system is not accepted at the time being in most developed countries due to the risks associated with it and suitable substitution management system for medical waste disposal is now taking its place.

HCW management was evaluated by Stanković et al (2008) in three hospitals of Serbia in Nisava and Toplica district. All the stages of existing waste management (segregation, collection, storage, transportation and disposal of waste) were examined by interviewing the personnel involved in the management of waste. The generated waste was a mixture

of hazardous and non-hazardous waste. The study found that waste management performance there was poor and that there were problems in every stages of management. The results indicate that the waste generation rate was 1.92 kg/bed/day and consisted of 98.7% general waste and 1.3% sharps. Inappropriate segregation practices were the biggest problem and led to increased quantities of general waste. There were no specific regulations for the segregation of the medical waste. None of the surveyed hospitals have a system to refine wastewater and there were no training courses about hospital waste management.

The objectives of the study conducted by Patil and Pokhrel (2005) were: (i) to assess the waste handling and treatment system of hospital bio-medical solid waste and (ii) to quantitatively estimate the amount of non-infectious and infectious waste generated in different wards/sections. During the study, it was observed that: (i) the personnel working under the occupier (who has control over the institution to take all steps to ensure biomedical waste is handled without any adverse effects to human health and the environment) were trained to take adequate precautionary measures in handling these bio-hazardous waste materials, (ii) the process of segregation, collection, transport, storage and final disposal of infectious waste was done in compliance with the Standard Operating Procedures (SOP), (iii) the final disposal was by incineration in accordance to EPA Rules 1998, (iv) the non-infectious waste was collected separately in different containers and treated as general waste, and (v) on an average about 520 kg of non-infectious and 101 kg of infectious waste is generated per day (about 2.31 kg/day/bed, gross weight comprising both infectious and non-infectious waste). This hospital also extends its facility to the neighboring clinics and hospitals by treating their produced waste for incineration.

The waste generation rate ranges between 0.5 and 2.0 kg/bed/ day. It is estimated that annually about 0.33 million tones of waste are generated in India. The solid waste from the hospitals consists of bandages, linen and other infectious waste (30.0-35.0%), plastics (7.0-10.0%), disposable syringes (0.3-0.5%), glass (3-5%) and other general wastes including food (40.0-45.0%). In general, the wastes are collected in a mixed form, transported and disposed of along with municipal solid wastes. At many places, authorities are failing to install appropriate systems for a variety of reasons, such as non-availability of appropriate technologies, inadequate financial resources and absence of

professional training on waste management. Hazards associated with health-care waste management and shortcomings in the existing system are known and identified. The rules for management and handling of biomedical wastes are summarized, giving the categories of different wastes, suggested storage containers including color-coding and treatment options. Existing and proposed systems of health-care waste management are described. A waste-management plan for health-care establishments is also proposed, which includes institutional arrangements, appropriate technologies, operational plans, financial management and the drawing up of appropriate staff training programs (Patil and Shekdar 2001).

Abdulla et al (2008) investigated the HCWM practices used by hospitals in Northern Jordan. A comprehensive inspection survey was conducted for all 21 hospitals located in the study area. Field visits were conducted to provide information on the different HCWM aspects. The results reported here focus on the level of HCW segregation, treatment and disposal options practiced in the study area hospitals. The total number of beds in the hospitals was 2296, and the anticipated quantity of medical waste generated by these hospitals was about 1400 kg/day. The most frequently used treatment practice for solid medical waste was incineration. Of these hospitals, only 48% had incinerators, and none of these incinerators met the Ministry of Health (MoH) regulations. As for the liquid medical waste, the survey results indicated that 57.0% of surveyed hospitals were discharging it into the municipal sewer system, while the remaining hospitals were collecting their liquid waste in septic tanks. The results indicated that the medical waste generation rate ranges from approximately 0.5 to 2.2 kg/bed/day, which is comprised of 90.0% of infectious waste and 10.0% sharps. The results also showed that segregation of various medical waste types in the hospitals has not been conducted properly. The study revealed the need for training and capacity building programs of all employees involved in the medical waste management.

A total of 91 healthcare facilities, including hospitals (21), health centers (48) and clinical laboratories (22) were surveyed by Da Silva et al (2005) to provide information about the management, segregation, generation, storage and disposal of HCW. The results about management aspects indicate that practices in most healthcare facilities do not comply with the principles stated in Brazilian legislation. All facilities demonstrated a priority on segregation of infectious-biological wastes. Average generation rates of total and

infectious-biological wastes in the hospitals were estimated to be 3.245 and 0.570 kg/bed-day, respectively.

A number of health studies have been conducted in India, with the following results reported by Nath KJ et al (2005).

- Tuberculosis, bronchitis, asthma, pneumonia, dysentery, parasites, and malnutrition are the most commonly experienced diseases among waste pickers based on health studies of waste pickers conducted in Bangalore, Manohar, and New Delhi.
- About 180 waste pickers at the Calcutta's open dumps were studied in 1995. During the course of one year, 40% had chronic cough, and 37% had jaundice. The average quarterly incidence of diarrhea was 85%, of fever was 72%, of cough and cold was 63%. Eye soreness or redness occurred quarterly in 15% and skin ulcers in 29%., with nearly all rates higher at the largest dump site than these averages
- A comparative study of waste pickers working at Calcutta's Dhapa dump in the 1980's and nearby farmers who use organic solid waste as fertilizer, showed that pickers reported higher prevalence of respiratory diseases (pickers: 71% vs. farmers: 34%), diarrhea (pickers: 55% vs. farmers: 28%) and protozoal and helminthic infestation (32% vs. 12%).
- At Bombay's open dump sites, 95 solid waste workers were surveyed and examined. Of all landfill workers surveyed, 80% had eye problems, 73% had respiratory ailments, 51% had gastrointestinal ailments, 40% had skin infections or allergies, and 22% had orthopedic ailments. Based on clinical examination, 90% had decreased visual acuity. Most workers complained of eye burning, diminished vision, redness, itching, watering. Clinical examination showed 27% had skin lesions, of which 30% were determined to be directly occupation related.

2.6.2 Bangladesh Scenario

In developing countries there is no proper management or treatment of HCW. Bangladesh, one of the densely populated developing countries where there is no HCW management system. Dhaka the capital of Bangladesh, situation is becoming more critical in regards of HCW management. Gradually it is becoming a serious threat for city dwellers. A number of projects have been working on HCW issues in Bangladesh. Most of the financial support on this purpose provided through development agencies and stakeholders. Non governmental organization such as PRISM Bangladesh, The Initiative for People's Development (IPD), Prodipan, BRAC, BCAS, Local Initiative Facility for the Urban Environment (LIFE) are working on HCW issues.

The aims of the study conducted by Akter et al (2005) was to i) conduct a feasibility study to establish the viability of HCWM rules implementation, ii) identify the appropriate technology and management model, iii) establish viable final disposal technological options in which the both parties and other actors can participate as partners, and iv) establish a coordination and partnership model in HCWM in Bangladesh. The pilot period of the study was from July 2005 to February 2006. A baseline survey was done to assess the existing hospital waste management practices in city corporation (CC) areas, as well as to ascertain the training needs for relevant institutes' establishment. The findings showed that the lack of awareness, training and management planning is the basic constraints of hospital waste management at CC area. Based on training need assessment BRAC prepared a training of trainer (TOT) module (according to the draft HCWM manual) and provided TOT for a 15-member core trainer group. BRAC also provided training for healthcare workers e.g. doctors, nurses, cleaners, technicians, administration officers, and City Corporation's staff. A total 850 healthcare personnel and healthcare workers have been provided with in-house HCWM training covering almost all hospitals, clinics and diagnostic centers in Rajshahi city and 257 healthcare workers at Joypurhat hospital. Several orientation seminars and workshops were organized for CC officials, clinic owners and hospital management personnel. In 1999, The Bangladesh Legal Aid Services Trust (BLAST) carried out a study particularly in Sir Salimullah Medical College Hospital (SSMCH), Holy Family Hospital and Bangabandhu Sheikh Mujib Medical University (BSMMU). The survey assessed the existing medical waste management system. It has been found in the assessment that there

was no national policy or legislation on safe management of medical waste. There was no particular monitoring authority to look after the medical waste management in local or national level (Dana 1999).

Rahman et al (2003) reported that 288 tons of solid waste generated every day within the Sylhet City Corporation (SCC) area of which 6 tons were health waste. Again among them 24.35% of health waste were hazardous.

Rashid (1996) conducted a study in different hospitals of Dhaka city in 1996 to assess the existing waste management and also to assess different technological options for improvement of the present situation. It has been found that the rate of waste generation was about 1.16 kg/bed/day, and the hazardous waste was 0.169 kg/bed/day. The contribution of infectious, sharps, and pathological wastes were about 10.5%. 3.5% and 1.5% respectively compared to solid waste of 3000 tons/day in Dhaka city.

The Initiative for People's Development (IPD) carried out a project on the 'Medical waste management action plan in Dhaka city' which has been started on 2000. The project was funded by United Nation Development Programme (UNDP) through the Project Management Unit (PMU). They surveyed 24 clinics through a structured method. They provided training for awareness build-up and developed some materials on medical waste management for health worker. The project has been lasted for eight months and finished in 2001.

Sarkar et al (2006) stated that Hospital waste has not been got proper attention in Sylhet City Corporation (SCC) which is also very common for other cities of Bangladesh. Even the solid waste management system of SCC is not effective and adequate. Their study encompasses on an in-depth analysis of the present condition of waste management system of selected Health Care Centers (HCCs) in SCC and an assessment has been performed for the improvement of hospital sanitation situation. It was observed that the average waste generation rate for hospitals and clinics (HCC-A) is 0.934 kg/bed/day, which is much higher than that (0.0414 kg/capita/day) for diagnostic center and out door clinics (HCC-B). The percentage of hazardous waste produced in the 'HCC-A' is 22.92% where as that for 'HCC-B' is 36.03%. These portions of hazardous wastes require special

attention. The remaining portions of waste can be easily disposed off into the municipal dustbin if they are carefully segregated.

Alam et al (2008) determined the generation rates and physical properties of HCW in Chittagong Medical College Hospital (CMCH) and also to estimate the amount of infectious and non-infectious waste generated in different wards. CMCH, the second largest hospital in Bangladesh, comprises 34 wards, 12 of which were selected randomly. Waste materials were collected from these wards and then segregated and weighed. Waste generation was found to be 73.22 kg/ward/day, 1.28 kg/bed and 0.57 kg/patient/day. A total of 2490 kg of HCW was produced each day in CMCH (37% being infectious and the rest being noninfectious waste). Infectious waste was 27.07 kg/ward/day, 0.47 kg/bed/day and 0.21 kg/patient/day and the non-infectious waste was 46.15 kg/ward/day, 0.81 kg/bed/day and 0.36 kg/patient/day. HCW comprised eight categories of waste materials with vegetable/food waste being the largest component (50.21%) and varied significantly ($P < 0.05$) among the 12 different wards studied. The greatest amount of HCW was recorded 154 kg in Orthopaedics followed by 96.66 kg in the Medicine Unit-3 and the smallest amount was recorded in Casualty 8.79 kg. The amount of HCW was positively correlated with the number of occupied beds ($r_{xy} = 0.79$, $P < 0.01$). There was no structured form of medical waste treatment in CMCH and most waste materials were dumped in open areas for natural degradation or re-sold by scavengers. It is essential to develop a national policy and implement a comprehensive action plan for HCWM that will provide environmentally sound technological measures to improve HCWM in Bangladesh.

The quantities of different categories of HCW in Dhaka city are estimated by Rahman et al (1999) on the basis of the data collected from selected hospitals/clinics from an intensive survey extending over 7 to 10 days during the March to May 1998. These wastes were collected 3 times a day. The average generation rate of total HCW was about 1.2 kg/bed/day.

A survey paper presented by Hassan et al (2008) documented that HCE in Dhaka city generated a total of 5,562 kg/day of wastes, of which about 77.4% were non-hazardous and about 22.6% were hazardous. The average waste generation rate for the surveyed HCE was 1.9 kg/bed/day or 0.5 kg/patient/day. The study reveals that there was no

proper, systematic management of medical waste except in a few private HCE that segregate their infectious wastes. Some cleaners were found to salvage used sharps, saline bags, blood bags and test tubes for resale or reuse.

International centre for diarrheal diseases and research, Bangladesh (ICDDR'B) conducted a study on medical waste with the aim of present hospital waste management practice. In their study on Waste Management in Healthcare Facilities: A review' shown that medical waste is growing serious threat for public health and as well as environment. They reviewed the suggestion of health care providers and other support staff for establishing and implementing a programme for the effective management of medical waste. They also suggested developing the scenario of healthcare service in regards to proper patient care and save environment through waste management both in house and outside (Nessa et al 2001).

2.6.3. Concluding Remarks

Both nationally and internationally lot many studies carried out to evaluate the amount of HCW generation in the HCEs and appropriate treatment or managements of the HCWs. The hazards of the HCWs are much more compared to the general solid waste. In most of the hospitals the HCWs are normally treated in the same way that of the general solid waste. In our country there are different categories of HCEs. In general the military institutions are restricted places for carrying out for such study for the general student. Being a member of the armed forces it was an unique opportunity for me to carry out a study to evaluate the generated HCWs in some selected military hospitals and MCHs and compare those to make some recommendations in this regard. Many study related to HCWs carried out in past in different institutions but not involving any military institution in our country. In study may be a reference in future for further study in the related field.

CHAPTER 3

METHODOLOGY

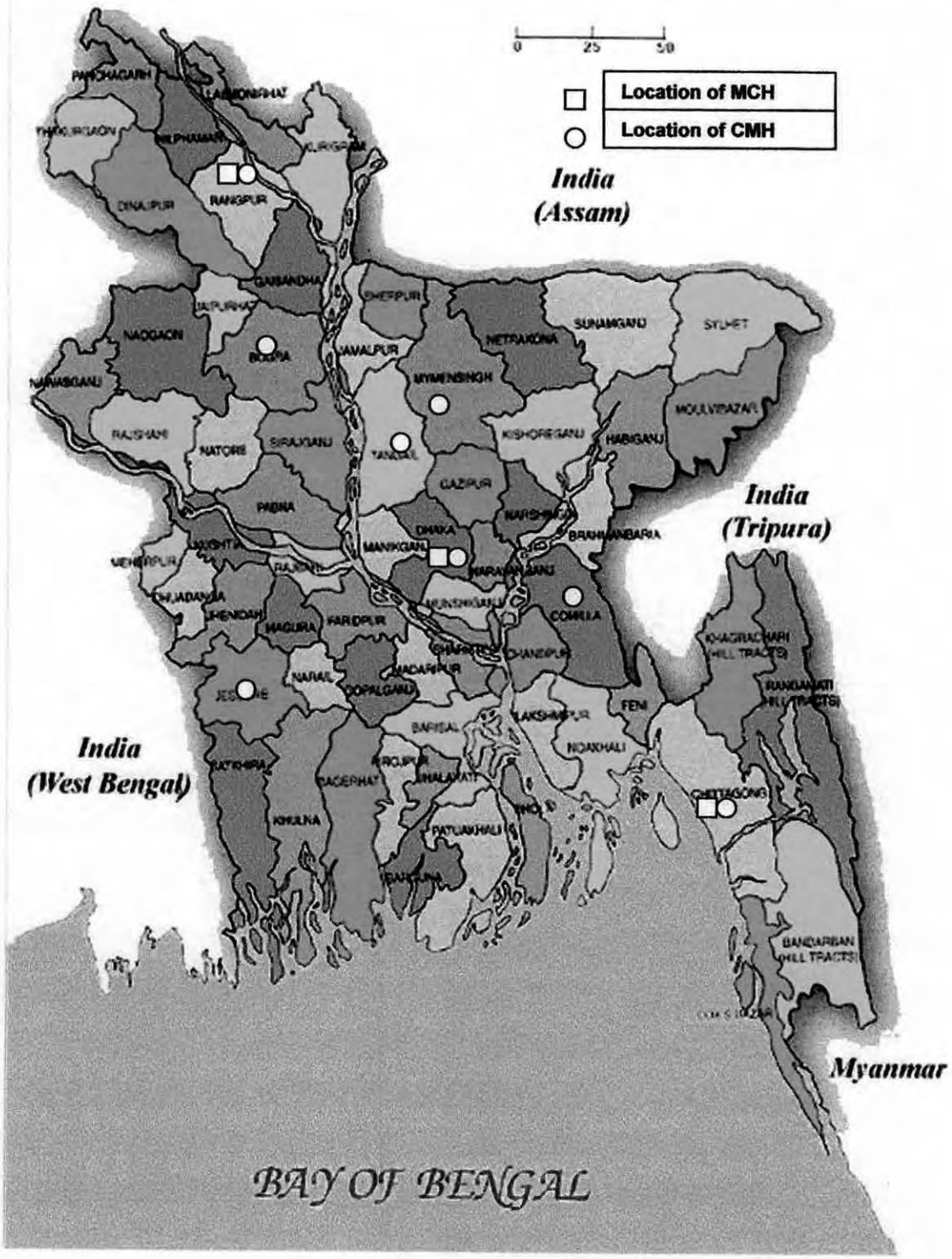
3.1. Introduction

A total of 11 HCEs were selected of which 8 were CMHs and 3 were MCHs with widely varying capacity of bed and facilities. CMHs with less capacity and MCHs with high capacity in regards bed and other facilities. Respondents for survey were same from all HCEs for ease of calculation. All departments were classified in some groups and waste was collected under three main classes and weighed. Officials and other staffs were interviewed and reports and records were consulted during the survey. Limitations were reported to the appropriate authority.

3.2. Selection of HCEs for Study

The study was conducted from December 2007 to June 2009. HCEs were selected purpose for the smooth conduct of the thesis work. In Bangladesh previous many study has been carried out in different hospitals both in government and public sector. In fact no such study carried out in any military institutions. In general people have less access to such organizations. Being a member of defence force I took the advantage to conduct such study to compare the standard of CMHs with the public hospitals. Under mentioned hospitals were enrolled as study places:

- CMH Mymensingh.
- CMH Jessore.
- CMH Comilla.
- CMH CTG.
- CMH Dhaka.
- CMH Bogra.
- CMH, Rangpur.
- CMH Gatail.
- Dhaka MCH.
- Chittagong MCH.
- Rangpur MCH.



Map Showing Location of MCHs and CMHs

Fig 3.1: Map showing location of the selected HCEs

The distributions of beds in study hospitals were different. There were differences in distribution of departments within same bed strength. In some of the secondary level hospitals, whole beds were categorized in male and female unit, whatever may the disease, females are gathered in female and male are in male unit. In secondary level hospital, another department included in the study named "Others", which included Diarrhea and infectious disease cases, whatever may be male and female patients.

So, the included departments under the headline in the study were:

- Surgery (includes General Surgery, Neuro-surgery, Eye, ENT, and Orthopedic departments, Nephrology, Casualty, Burn unit both male and female).
- Medicine (includes Medicine, Pediatrics, Psychiatrics and Skin VD departments-both male and female).
- Gynaecology.
- Operation Theater (All operation including Obstratical and Infectious case).
- Pathology & Blood Bank.
- Labor room and Labor ward.
- Emergency.
- Out patient department & Kitchen.
- Administration.
- Others (Diarrhea and infectious cases, both male and female).

3.3. Data Collection

- Questionnaire: A set of question given as appendix I was given to the respondents to know their personal information like name, age, gender, education, occupation, monthly income etc. Certain questions were specific for the hospital staffs and some for the patients to know the aspects regarding HCW collection system of the HCE, use of safety equipments by the staffs, feelings of the staffs regarding HCW managements, requirement of training of the staffs etc.
- Checklist: While collecting the data from different HCEs care was taken to collect waste from different departments like medicine, surgery, gynaecology, OT, pathology, emergency, OPD and administration etc. Bed and patients distribution was done under gynaecology, medicine and others and surgery.

- Interpersonal interviews: Officials of different levels of the administration was interviewed. Directors of the MCHs and Commanding officers of the CHMs, doctors, nurses, technicians and different lower level staffs were interviewed to know different aspects of in house and out house aspects of waste disposal chain.
- Consultation on up-to-date reports and records of the institute: Administrative officials were consulted to know up to date information on different aspects of the hospital staffs and fixed and variable costs involved in HCWM. In many cases up to date data could not be found or was not provided.
- Hospital records: Hospital records were consulted to get required data.
- Observation: Observation regarding collection, segregation, storage, transportation, use of safety equipments by the staffs, record keeping etc was informed to the concerned officials of the HCEs.
- Orientation program: The waste was collected by a selected team in each hospital and the team was oriented about the method of collection, segregation and record keeping of the collected waste during the survey.
- Weighed the waste: After collection and segregation different types of waste was weighed with a balance and was recorded.
- Hospital Stakeholders Contacted: Stakeholders from a range of official and social strata were contacted/open dialoged with an aim to identify the drawbacks, issues, opportunities and correlates in developing occupation health hazards and hospital waste management system.

Service providers were:

- Director / Superintendent.
- Doctors.
- Medical technologists.
- Nurses.
- Accountant.
- Ward-master.
- Head Cook.
- Waste handlers.

Target beneficiaries:

- Patients.

- Visitors.
- Attendants.

3.4. Classification of Waste

Though there are different types of HCW but for the ease of collection and segregation inn this study HCW were classified into three categories on the basis of their source of potential hazardous instead of eight categories according to WHO (1983). The categories are:

- General or Non-hazardous.
- Infectious (Anatomical & pathological) and
- Sharp waste.

Infectious and sharp waste can be grouped under hazardous waste. In the selected HCEs with varying capacity and facilities above three categories were appropriate for smooth conduct of the study.

3.5. Data Analysis

Data processing followed a pathway of some stages, were:

- Questionnaire coding, registration and editing.
- Edit verification.
- Listing the open ended responses.
- Development of data entry structure.
- Data entry.
- Analysis of data with dummy table.
- Program developing, running and
- Report generation.

Data was processed and analyzed by using SPSS software. Consultants enriched the report comprehensive and complete by providing data, diagram, charts, analysis direction etc. Related variables were analyzed in different way statistically.

CHAPTER 4
RESULTS DISCUSSION

4.1. General

A total of 11 public HCEs were selected of which 8 were CMHs and 3 were MCHs. From each institution 6 types of respondents were selected, total 374 respondents, 34 from each hospital. Of them 9 patients, 1 administrator, 6 physicians, 6 nurses, 6 cleaner, 6 technicians were surveyed. The HCEs were of varying size in regards their capacity and facilities but the number of respondents were kept same for the ease of calculation and presenting the data. There were different departments which were classified under eight categories and wastes were classified into three groups for ease of collection and record keeping. Waste for 7days were collected from different wards and departments and analyzed for the research work. A team with some orientation program was trained to collect, segregate and weigh the collected waste. A preset questionnaire was used to get the intended information. Questionnaire was designed to get some personal information of the respondent and information related to the occupational hazards of the waste handlers. It also contained some question to evaluate the standard of knowledge of the staffs about the existing waste collection system, use of safety equipments, feelings and satisfaction level of different groups regarding HCWM, level and need for the HCWM training etc. Information related to the diseases of the hospital staffs were collected as reported by the respondents and was correlated with different groups of waste handlers. In many cases the respondents and the hospital staffs were reluctant to provide with the information as asked for. Annual investments of each hospital related to HCWM were asked but could not be provided by the authority since they have some restriction on such information as reported by the concern officials. Collected data was analyzed to quantify the waste, composition of waste, compare the variation of generated waste between CMHs and MCHs, assess occupational hazards/risks of the waste handlers etc.

4.2. Details of Analysis and Results

Details of the analysis and results are presented as below.

4.2.1. Distribution of Respondents on Questionnaire Survey

Total 374 respondents, 34 from each hospital, of them 9 patients, 1 administrator, 6 physicians, 6 nurses, 6 cleaner, 6 technicians, were surveyed. Though the capacity of the HCEs were of varying size in regards their bed capacity and their different departments but same numbers of the respondents were taken for the ease of calculation and presentation of the data. Out of total 374 respondents 99 were patients and 275 were hospital staffs who were directly or indirectly related with the HCW management. The physicians and the administrators (77 persons) classified as part time waste handlers and nurse, cleaners and technicians (198 persons) classified as all time waste handlers. Table 4.1 shows the distribution of respondents of questionnaire survey.

Table-4.1: Distribution of the respondents on Questionnaire Survey

Name of Hospital	Respondent						Total
	Patients	Adminis-trator	Physi-cians	Nurse	Cleaner	Techni-cians	
CMH Mymensingh	9	1	6	6	6	6	34
CMH Jessore	9	1	6	6	6	6	34
CMH Comilla	9	1	6	6	6	6	34
CMH CTG	9	1	6	6	6	6	34
CMH Dhaka	9	1	6	6	6	6	34
CMH Bogra	9	1	6	6	6	6	34
CMH, Rangpur	9	1	6	6	6	6	34
CMH Ghatail	9	1	6	6	6	6	34
DMCH	9	1	6	6	6	6	34
CMCH	9	1	6	6	6	6	34
RMCH	9	1	6	6	6	6	34
Total	**99**	**11**	**66**	**66**	**66**	**66**	**374**

4.2.2 Distribution of Respondents by Age

Table 4.2 shows that 44.6% respondents were within 26 to 35 years age range followed by 24.1% within 36 to 45 years, 18.2% within 46 to 55 years, 10.4% up to 25 years and 2.7% 56 and above years age group. Mean (±SD) age of all respondents was 36.86 (±9.89) years.

Table-4.2: Distribution of respondents by age (years)

Age	Frequency	Percent
Up to 25	39	10.4%
26-35	167	44.7%
36-45	90	24.1%
46-55	68	18.2%
56 and above	10	2.7%
Total	**374**	**100%**

Mean±SD (range) = 36.86±9.89 (19-62)

4.2.3. Distribution of Respondents by Gender

Table 4.3 shows the gender distribution of the respondents. Out of all respondents 54.5% were male and 45.5% were female.

Table-4.3: Gender distribution of the respondents

Gender	Frequency	Percent
Male	204	54.5%
Female	170	45.5%
Total	**374**	**100%**

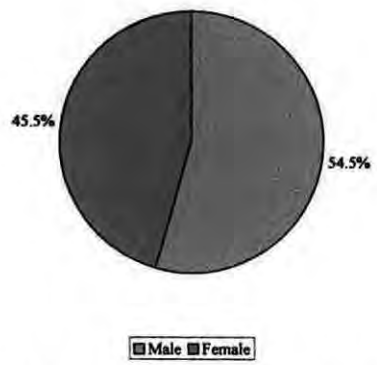


Fig 4.1: Gender distribution of respondents

4.2.4. Distribution of Respondents by Education

Table 4.4 shows that out of all respondents maximum 42.0% were educated up to graduate and above level, followed by 31.6% up to higher secondary level, 14.4% up to SSC level, 10.7% up to primary level and 1.3% were illiterate.

Table-4.4: Distribution of the respondents by education

Education	Frequency	Percent
Illiterate	5	1.3%
Primary	40	10.7%
Secondary	54	14.4%
Higher secondary	118	31.6%
Graduate and above	157	42%
Total	**374**	**100%**

4.2.5. Distribution of Respondents by Occupation

Table 4.5 shows that out of all respondent 97.1% were service holder, 1.3% were businessman, 1.1% were housewife, student and day labor was 0.3% of each.

Table-4.5: Distribution of the respondents by occupation (n=374)

Occupation	Frequency	Percent
Service	363	97.1%
Housewife	4	1.1%
Student	1	0.3%
Business	5	1.3%
Day labor	1	0.3%
Total	**374**	**100%**

4.2.6. Distribution of Respondent by Type

Out of all respondents 275 (73.5%) were hospital staffs and 99 (26.5%) were patients.

Table-4.6: Distribution of the respondents by type

Respondents type	Frequency	Percent
Hospital staffs	275	73.5%
Patients	99	26.5%
Total	374	100%

4.2.7. Distribution of Respondent as Waste Handler

Among all enrolled respondents 275 (73.5%) were hospital staffs and 99 (26.5%) were patients. Among all staffs 72% (nurse, cleaner, technician) were direct waste handler and 28% were occasional (administrator, physicians) waste handler.

Table-4.7: Distribution of the respondents as waste handler

Waste handler	Frequency	Percent
All time	198	72%
Some time	77	28%
Total	275	100%

4.2.8. Educational Status of the Hospital Staffs

Table 4.8 shows that out of all nurses 1.5% was educated up to secondary level, 57.6% up to higher secondary level and 40.9% graduate and above level. In cleaner group 3.0% were illiterate, 40.9% were educated up to primary level, 25.8% up to secondary level, and 30.3% higher secondary level. Out of all technicians 13.6% up to primary level, 25.8% secondary level, 42.4% higher secondary level and 18.2% graduate and above level. Statistically significant difference was observed in term of education level among all time waste handler ($p<0.001$).

Table 4.8: Educational status of the hospital staffs (all time waste handler)

Education	All time waste handler			p value
	Nurse	Cleaner	Technicians	
Illiterate	0 (.0)	2 (3.0)	0 (.0)	
Primary	0 (.0)	27 (40.9)	9 (13.6)	
Secondary	1 (1.5)	17 (25.8)	17 (25.8)	<0.001
Higher secondary	38 (57.6)	20 (30.3)	28 (42.4)	
Graduate and above	27 (40.9)	0 (.0)	12 (18.2)	
Total	66 (100.0)	66 (100.0)	66 (100.0)	

(Figures in parenthesis shows the corresponding percentage)

4.2.9. Monthly Family Income of Hospital Staffs

From the study it was found mean family income of Nurses were 10774.36, Cleaners were 6428.26 and technicians were 7387.50. The average family income of the all time waste handlers was found 8196.71.

Table 4.9: Monthly family income of the hospital staffs (all time waste handler)

Respondent	Mean (Tk)	Std. Deviation
Nurse (n=66)	10774	6131
Cleaner (n=66)	6428	2901
Technicians (n=66)	7388	2943
Total (n=198)	8197	3992

4.2.10. Distribution of Bed and Patients in Different Hospitals

Table 4.10 gives the distribution of the beds and the patients of different hospitals. It is observed that among the CMHs Dhaka CMH is the largest with bed capacity of 850 and the smallest is Ghatail CMH with 100 bed capacity. DMCH is having highest bed capacity of 1400. Total bed capacity of 3 MCHs are 3006 where of 8 CMHs are 2691. It is observed that average patients in the CMHs are less than the bed capacity with an exception with Dhaka CMH. On the other hand all the MCHs have more average patients than its bed capacity and it is highest in case of DMCH with a ratio of 7:10. Bed are distributed under three departments, those are gynaecology, medicine and others and surgery. This is done for ease of calculation and presenting the data. Ward wise bed distribution is shown in figure 4.2. It is seen that Dhaka CMH is having highest bed in medicine group and it is 675. DMCH having highest gynaecology and surgery bed, 450 and 500 respectively.

Table-4.10: Bed and patients distribution of different hospitals

			Bed distribution		
Hospitals	**Total Bed**	**Average patients**	**Gynae**	**Medicine and others**	**Surgery**
CMH Mymensingh	145	85	50	80	15
CMH Jessore	399	252	60	259	80
CMH Comilla	299	195	15	244	40
CMH CTG	449	300	20	299	130
CMH Dhaka	850	1190	55	675	120
CMH Bogra	299	165	30	229	40
CMH, Rangpur	150	110	20	106	24
CMH Ghatail	100	120	30	40	30
DMCH	1400	2000	450	450	500
CMCH	956	1500	400	350	250
RMCH	650	890	250	200	200

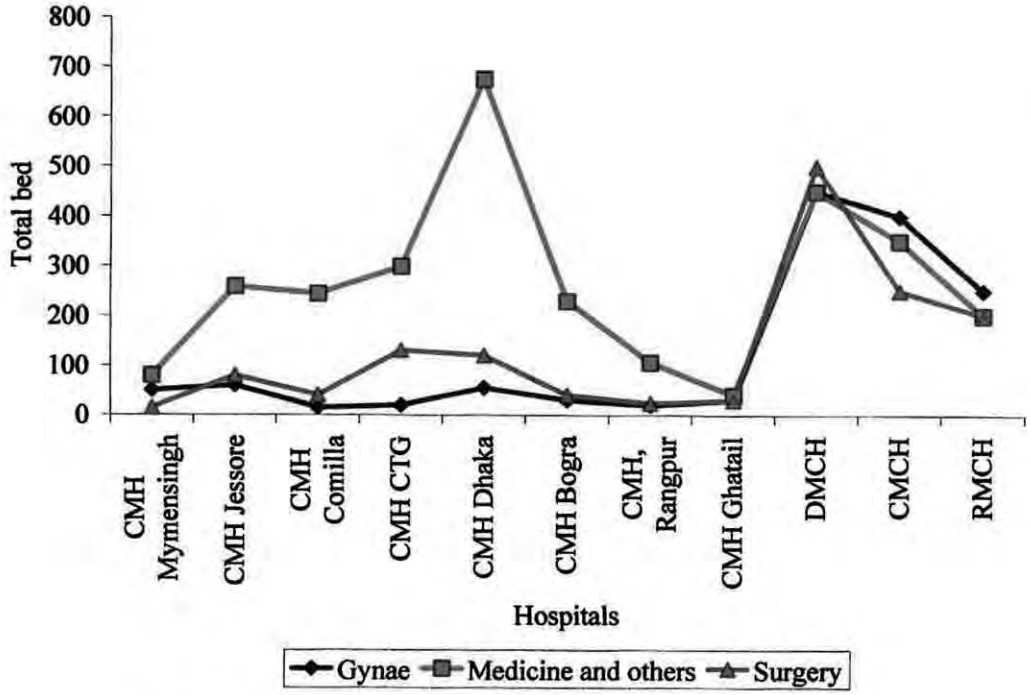


Figure-4.2: Bed & Ward distribution of different hospitals

4.2.11. Distribution of Attendants per Patient

Table 4.11 shows that the CMHs have less attendants than that of MCHs..

Table-4.11: Distribution of patient's by attendants

Name of Hospital	Mean ±SD
CMH Mymensingh	1.56±0.53
CMH Jessore	1.22±0.44
CMH Comilla	1.44±0.53
CMH CTG	1.56±0.53
CMH Dhaka	1.56±0.53
CMH Bogra	1.22±0.44
CMH, Rangpur	1.56±0.53
CMH Gatail	1.67±0.71
Dhaka Medical College Hospital	4.44±1.24
Chattagong Medical College Hospital	4.78±1.20
Rangpur Medical College Hospital	5.67±2.23

It reflects the strict compliance of rules in the CMHs. In fact most of the patients in the CMHs are the soldiers and care is taken by the hospital staffs as such requirement of attendant is less. In table 4.12 CMHs are classified as one type (Group A) and the MCHs are classified as second type (Group B). It was observed that the average attendants of patients in CMHs are less compared to the MCHs.

Table-4.12: Mean distribution of the patient's attendant

Type of hospital	Mean	p value
CMHs (n=72)	1.47±0.53	0.001
Public Hospital (n=27)	4.96±1.65	

4.2.12. Distribution of Waste in Different Hospitals

Table 4.13 shows that total waste generation of CMH Mymensingh, Jessore, Comilla, CTG, Dhaka, Bogra, Rangpur, Ghatail, DMCH, CMCH and RMCH was 350.00, 1058.40, 791.70, 1221.00, 3800.00, 552.00, 454.30, 521.00, 9380.00, 6315.00, and 4174.10 kg respectively with an average of 4088.2 kg/day. The percentage of the generated waste is given in the paren. Corresponding values for general, infectious and sharp waste is also given in the table.

Table-4.13: Different types of waste distribution at different hospitals

	Generation of hospital waste in kg/week (% of total waste)			
	Total waste	Non hazardous	Hazardous	
		General waste	Infectious waste	Sharp waste
CMH Mymensingh	350	290.5 (83%)	56 (16%)	3.5 (%)
CMH Jessore	1058.4	836.14 (79%)	201.1 (19%)	21.17 (2%)
CMH Comilla	791.7	633.36 (80%)	150.42 (19%)	7.92 (1%)
CMH CTG	1221	1019.54 (83%)	195.36 (16%)	6.11 (1%)
CMH Dhaka	3800	3230 (85%)	494 (13%)	76 (2%)
CMH Bogra	552	458.16 (82%)	91.08 (17%)	2.76 (1%)
CMH, Rangpur	454.3	340.73 (75%)	109.03 (24%	4.54 (1%)
CMH Ghatail	521	395.96 (76%)	119.83 (23%)	5.21 (1%)
DMCH	9380	7879.2 (84%)	1313.2 (14%)	187.6 (2%)
CMCH	6315	5052 (80%)	1136.7 (18%)	126.3 (2%)
RMCH	4174.1	3381.02 (81%)	459.15 (11%)	333.93 (8%)

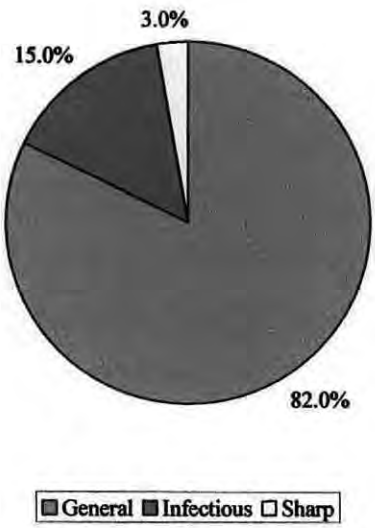


Figure 4.3: Different types of generated waste

Pie diagram shows that different types of generated waste from different surveyed hospitals. 82.0% generated waste was general, 15.0% were infectious and 3.0% were sharp.

❖ Distribution of Waste/Bed/Day in Different Hospitals

Table 4.14 shows that non hazardous waste generation rate was more in DMCH (0.80 kg/bed/day) and hazardous waste in CMCH (0.19kg/bed/day).

Table-4.14: Distribution of different types of waste as per bed per day

	Generation of hospital waste (kg/bed/day)			
	Non hazardous	Hazardous	Non hazardous	Hazardous
CMH Mymensingh	290.5	59.5	0.29	0.06
CMH Jessore	836	222	0.30	0.08
CMH Comilla	633	158	0.30	0.08
CMH CTG	1020	201	0.32	0.06
CMH Dhaka	3230	570	0.54	0.10
CMH Bogra	458	94	0.22	0.04
CMH, Rangpur	341	114	0.32	0.11
CMH Ghatail	396	125	0.57	0.18
DMCH	7879	1501	0.80	0.15
CMCH	5052	1263	0.75	0.19
RMCH	3381	793	0.74	0.17

❖ Distribution of Waste/Patient/Day in Different Hospitals

Table 4.15 show the distribution of different types of waste per patient per day. As per patient non hazardous waste generation rate was more in DMCH (0.56 kg/day) and hazardous waste in CMH Rangpur and CMH Ghatail (0.15kg/day of each). It is observed that though the bed capacity of the hospitals vary widely but the waste per patient per day is having a nearby values. The average value of the non hazardous waste found .45 kg per patient per day in the CMHs and .53 kg per patient per day in the MCHs. The average value for the hazardous waste found .113 kg per patient per day in CMHs and .12 kg per patient per day in the MCHs.

Table-4.15: Distribution of different types of waste as per patient per day

Hospitals	Generation of hospital waste (kg/patient/day)			
	Non hazardous	Hazardous	Non hazardous	Hazardous
CMH Mymensingh	290.5	59.5	0.49	0.10
CMH Jessore	836	222	0.47	0.13
CMH Comilla	633	158	0.46	0.12
CMH CTG	1020	201	0.49	0.10
CMH Dhaka	3230	570	0.39	0.07
CMH Bogra	458	94	0.40	0.08
CMH, Rangpur	341	114	0.44	0.15
CMH Ghatail	396	125	0.47	0.15
DMCH	7879	1501	0.56	0.11
CMCH	5052	1263	0.48	0.12
RMCH	3381	793	0.54	0.13

❖ Distribution of Waste/Bed & Patient/Day in Different Hospitals

Waste generation rate as per bed in CMH Mymensingh, Jessore, Comilla, CTG, Dhaka, Bogra, Rangpur, Ghatail, DMCH, CMCH and RMCH was 0.34, 0.38, 0.38, 0.39, 0.64, 0.26, 0.5, 0.74, 0.96, 0.94 and 0.92 kg/day respectively and as per patients 0.59, 0.60, 0.58, 0.58, 0.46, 0.48, 0.59, 0.62, 0.67, 0.60 and 0.67 kg/day respectively.

Table-4.16: Waste generation of different hospitals on the basis of bed and patients

Hospitals	Waste(kg per bed)	Waste(kg per bed per day)	Waste (kg per patient)	Waste (kg per patients per day)
CMH Mymensingh	2.41	0.34	4.12	0.59
CMH Jessore	2.65	0.38	4.2	0.60
CMH Comilla	2.65	0.38	4.06	0.58
CMH CTG	2.72	0.39	4.07	0.58
CMH Dhaka	4.47	0.64	3.19	0.46
CMH Bogra	1.85	0.26	3.35	0.48
CMH, Rangpur	3.49	0.5	4.13	0.59
CMH Ghatail	5.21	0.74	4.34	0.62
DMCH	6.7	0.96	4.69	0.67
CMCH	6.61	0.94	4.21	0.60
RMCH	6.42	0.92	4.69	0.67

4.2.13. Amount of Waste Collected per Departments in Different Hospitals

Table 4.17 shows the amount of waste collected from Medicine, Surgery, Gynaecology, Operation theatre, Pathology, Emergency, out patient department and Administration departments. Rate of waste generation in medicine, surgery and gynaecology department found higher than other departments, and minimum found in administration department. The amount of collected waste is more in the MCHs than that of CMHs and correspond to the number of bed/patients in the HCEs.

Table-4.17: Department wise distribution of waste from different hospitals (kg/wk)

Hospitals	Medicine	Surgery	Gynae	OT	Pathology	Emergency	OPD	Administration
CMH Mymensingh	105	50	147	20	5	10	10	3
CMH Jessore	178.2	255	425.2	130	25	20	20	5
CMH Comilla	222.7	200	236	40	40	10	40	3
CMH CTG	442	197.7	368	88.3	20	30	70	5
CMH Dhaka	1122	1038	1422	174	20	10	10	4
CMH Bogra	198	145.3	108.7	16	15	28	35	6
CMH, Rangpur	205	103.5	64.3	20.5	18	20	20	3
CMH Ghatail	188.8	124.9	133.3	17	20	15	19	3
DMCH	4525	2633	1678	265	110	40	120	9
CMCH	2996.5	1780	1105.5	175	85	45	120	8
RMCH	2392.2	696	615.5	199.5	103	55.9	105	7

4.2.14. Distribution of Waste in CMH Mymensingh

The survey showed the total waste generation from Medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration department of CMH Mymensingh was 105.0 kg, 50.0 kg, 147 kg, 20 kg, 5 kg, 10.0 kg, 10.0kg and 3.0kg respectively. Hazardous waste was generated more from surgery, gynaecology, OT, and emergency department and general waste from OPD and administration department.

Table-4.18: Distribution of different types of waste in CMH Mymensingh

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	52.50	31.50	21.00	105.00
Surgery	5.00	33.00	12.00	50.00
Gynaecology	35.00	70.00	42.00	147.00
OT	4.00	11.00	5.00	20.00
Pathology	0.25	4.50	0.25	5.00
Emergency	3.00	5.00	2.00	10.00
OPD	8.00	2.00	.00	10.00
Administration	3.00	.00	.00	3.00

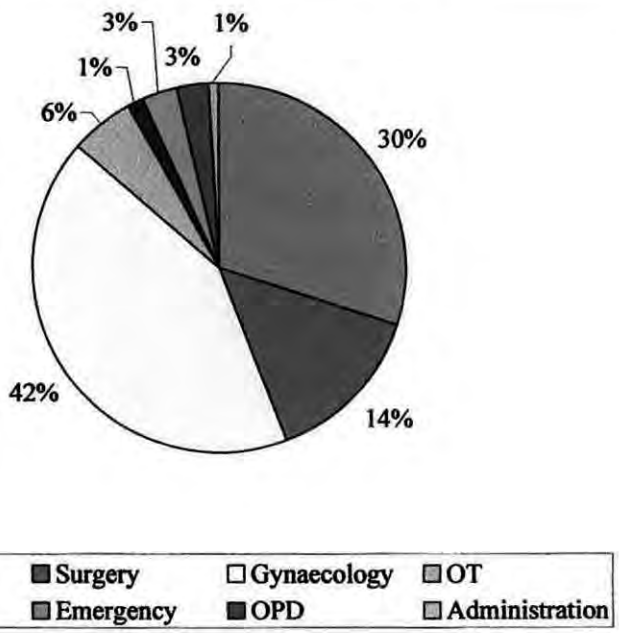


Figure-4.4: Total waste from different departments of CMH Mymensingh

4.2.15. Distribution of Waste in CMH Jessore

The survey showed the total waste generation from Medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration department of CMH Jessore was 127.01 kg, 31.75 kg, 105.84 kg, 15.00 kg, 2.00 kg, 18.00 kg, 14.00kg and 4.50kg respectively. Hazardous waste was generated more from surgery, gynaecology, OT, and emergency department and general waste from OPD and administration department.

Table-4.19: Distribution of different types of waste in CMH Jessore

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	127.01	42.34	8.85	178.20
Surgery	31.75	118.25	105.00	255.00
Gynaecology	105.84	154.76	264.60	425.20
OT	15.00	100.00	15.00	130.00
Pathology	2.00	20.00	3.00	25.00
Emergency	18.00	2.00	0.50	20.00
OPD	14.00	4.00	2.00	20.00
Administration	4.50	.0	0.50	5.00

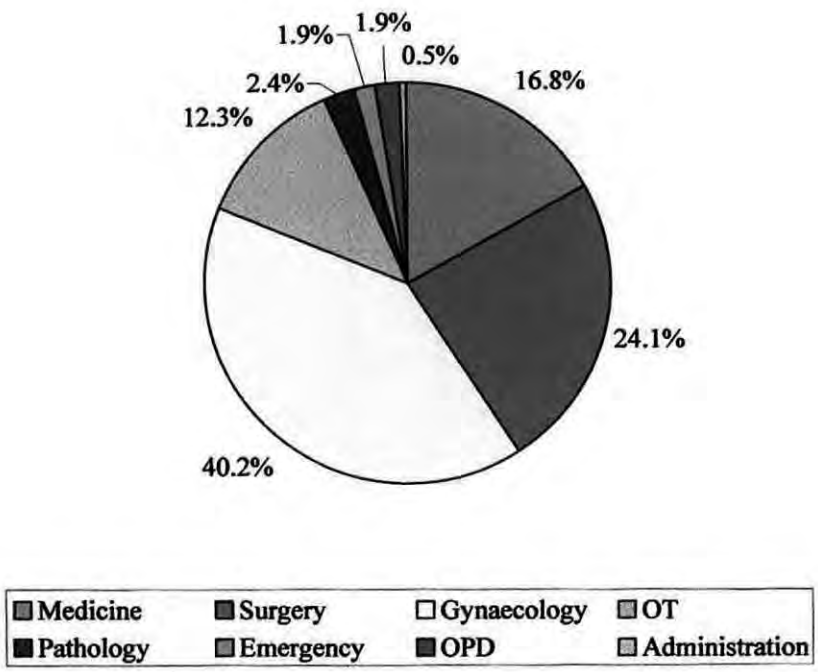


Figure-4.5: Total waste from different departments of CMH Jessore

4.2.16. Distribution of Waste in CMH Comilla

The survey showed the total waste generation from Medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration department of CMH Comilla was 222.70 kg, 200.00 kg, 236.00 kg, 40.00 kg, 40.00 kg, 10.00 kg,40.0 kg and 3.0 kg respectively. Infectious waste was generated more from surgery and gynaecology department, sharp from medicine, surgery and gynaecology department and general waste from medicine and gynaecology.

Table-4.20: Distribution of different types of waste in CMH Comilla

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	118.76	47.50	56.44	222.70
Surgery	27.00	125.50	47.50	200.00
Gynaecology	60.00	131.00	45.00	236.00
OT	5.00	30.00	5.00	40.00
Pathology	5.00	33.00	2.00	40.00
Emergency	5.00	3.00	2.00	10.00
OPD	15.00	15.00	10.00	40.00
Administration	3.00	.0	.0	3.00

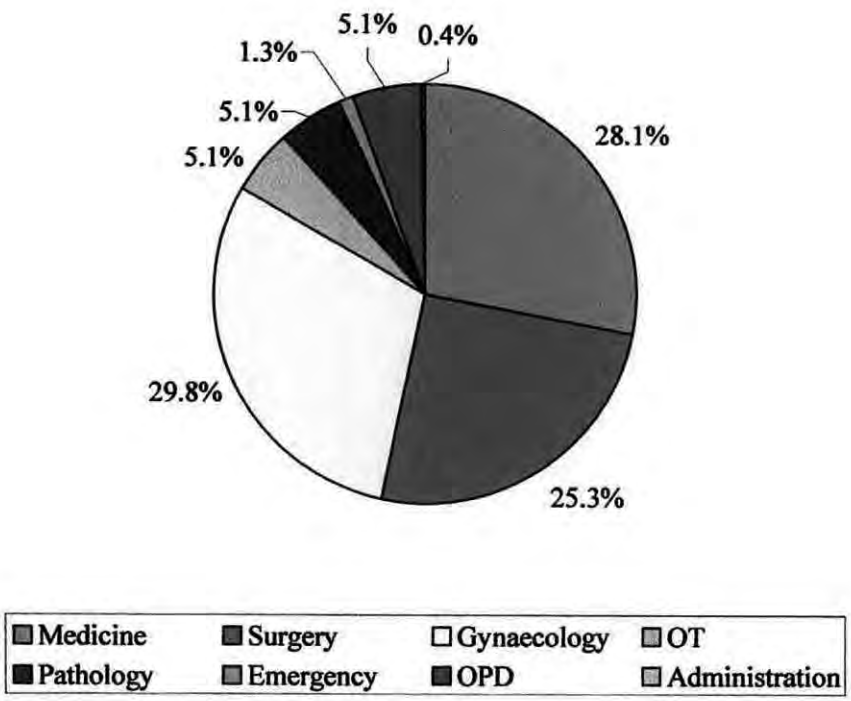


Figure-4.6: Total waste from different departments of CMH Comilla

4.2.17. Distribution of Waste in CMH CTG

The survey showed the total waste generation from Medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration departments of CMH CTG was 442.00 kg, 197.70 kg, 368.00 kg, 88.30 kg, 20.00 kg, 30.00 kg, 70.00 kg and 5.0 kg respectively. Infectious waste was generated more from gynaecology and surgery department, sharp from gynaecology and surgery department and general waste from medicine and gynaecology.

Table-4.21: Distribution of different types of waste in CMH CTG

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	341.88	97.68	2.44	442.00
Surgery	14.00	124.00	59.70	197.70
Gynaecology	48.44	175.36	144.20	368.00
OT	10.00	64.00	12.30	88.30
Pathology	1.50	18.00	0.50	20.00
Emergency	20.00	8.00	2.00	30.00
OPD	65.00	1.00	4.00	70.00
Administration	4.00	0.88	0.12	5.00

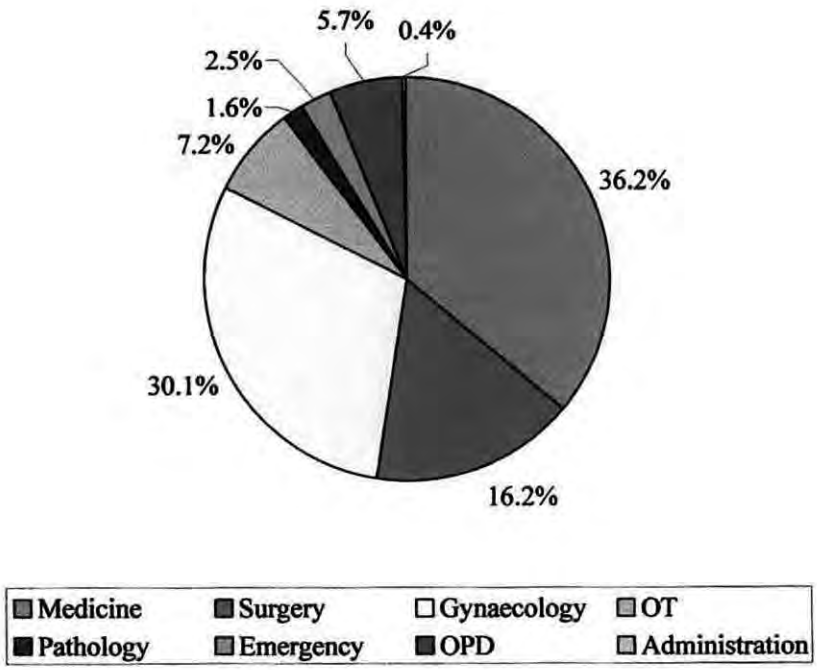


Figure-4.7: Total waste from different departments of CMH CTG

4.2.18. Distribution of Waste in CMH Dhaka

The survey showed the total waste generation from Medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration departments of CMH Dhaka was 1122.00 kg, 1038.00 kg, 1422.00 kg, 174.00 kg, 20.00 kg, 10.00 kg, 10.00 kg and 4.0 kg respectively. Infectious waste was generated more from surgery and gynaecology department, sharp from gynaecology and surgery department and general waste from medicine and gynaecology.

Table-4.22: Distribution of different types of waste in CMH Dhaka

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	456.00	342.00	324.00	1122.00
Surgery	128.00	568.00	342.00	1038.00
Gynaecology	304.00	456.00	662.00	1422.00
OT	10.0	160.00	4.00	174.00
Pathology	1.50	18.5	1.00	20.00
Emergency	5.00	3.00	2.00	10.00
OPD	8.00	1.00	1.00	10.00
Administration	4.00	.0	.0	4.00

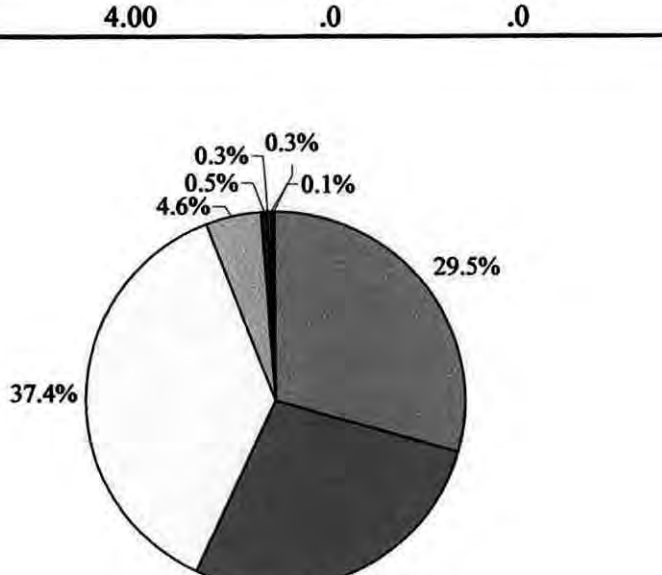


Figure-4.8: Total waste from different departments of CMH Dhaka

4.2.19. Distribution of Waste in CMH Bogra

Table 4.23 shows the total waste generation from medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration departments of CMH Borgra was 198.00 kg, 145.30 kg, 108.70 kg, 16.00 kg, 15.00 kg, 28.00 kg, 35.00 kg and 6.0 kg respectively. Infectious waste was generated more from surgery and gynaecology department, sharp from medicine and surgery department and general waste from medicine, surgery and OPD.

Table-4.23: Distribution of different types of waste in CMH Bogra

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	88.32	66.24	43.44	198.00
Surgery	39.00	72.00	34.30	145.30
Gynaecology	20.70	56.00	32.00	108.70
OT	2.00	12.00	2.00	16.00
Pathology	1.00	9.00	5.00	15.00
Emergency	14.00	7.00	7.00	28.00
OPD	30.00	4.50	.50	35.00
Administration	5.5	0.5	.0	6.00

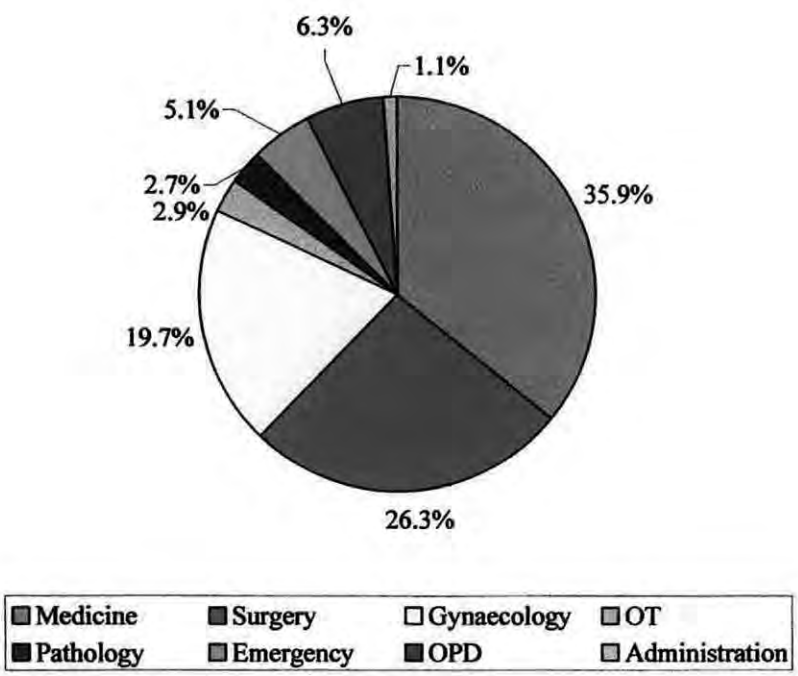


Figure-4.9: Total waste from different departments of CMH Bogra

4.2.20. Distribution of Waste in CMH Rangpur

Table 4.24 shows the total waste generation from medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration departments of CMH Rangpur was 205.00 kg, 103.50kg, 64.30 kg, 20.50 kg, 18.00 kg, 20.00kg, 20.00 kg and 3.0 kg respectively. Infectious waste was generated more from medicine, surgery and gynaecology department, sharp from surgery and gynaecology department and general waste from medicine and Surgery.

Table-4.24: Distribution of different types of waste in CMH, Rangpur

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	113.58	68.15	23.27	205.00
Surgery	15.50	53.00	35.00	103.50
Gynaecology	9.09	36.34	18.87	64.30
OT	2.00	14.50	4.00	20.50
Pathology	3.00	10.00	5.00	18.00
Emergency	15.00	3.00	2.00	20.00
OPD	15.00	3.00	2.00	20.00
Administration	3.00	.0	.0	3.00

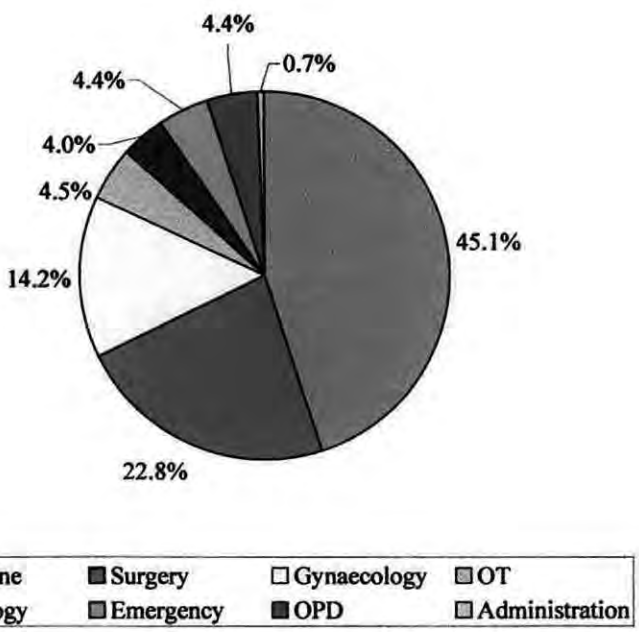


Figure-4.10: Total waste from different departments of CMH Rangpur

4.2.21. Distribution of Waste in CMH Ghatail

Table 4.25 shows the total waste generation from medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration departments of CMH Ghatail was 188.80 kg, 124.90 kg, 133.30 kg, 17.00 kg, 20.00 kg, 15.00 kg, 19.00 kg and 3.0 kg respectively. Infectious waste was generated more from medicine, surgery and gynaecology department, sharp from gynaecology and surgery department and general waste from medicine and gynaecology.

Table-4.25: Distribution of different types of waste in CMH Ghatail

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	83.36	83.36	22.08	188.80
Surgery	13.00	83.00	28.90	124.90
Gynaecology	31.26	62.30	39.74	133.30
OT	8.00	8.00	1.00	17.00
Pathology	5.00	5.00	10.00	20.00
Emergency	10.00	3.00	2.00	15.00
OPD	10.00	5.00	4.00	19.00
Administration	3.00	.00	.0	3.00

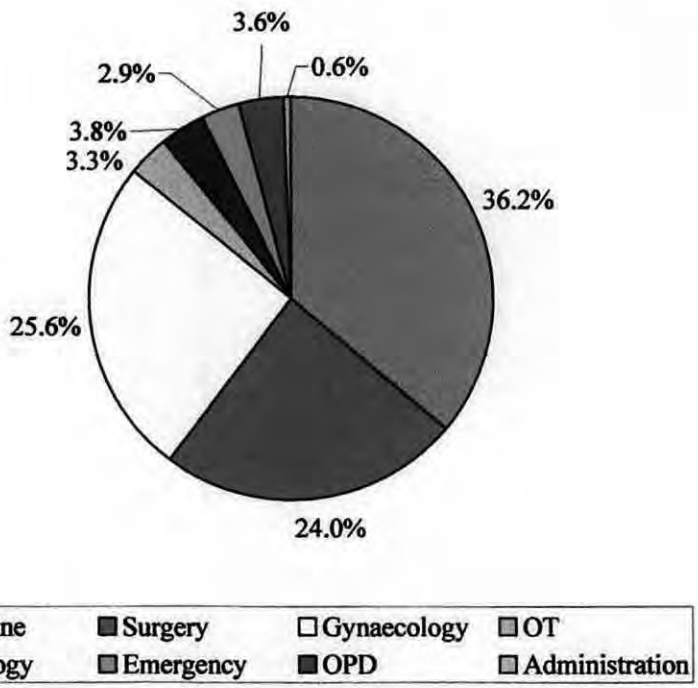


Figure-4.11: Total waste from different departments of CMH Ghatail

4.2.22. Distribution of Waste in DMCH

The table shows the total waste generation from medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration departments of CMH Dhaka was 4525.00 kg, 2633.00 kg, 1678.00 kg, 265.00 kg, 110.00 kg, 40.00 kg, 120.00 kg and 9.00 kg respectively. Hezardous waste was generated more from surgery, medicine and gynaecology department, and general waste from medicine and gynaecology.

Table-4.26: Distribution of different types of waste in DMCH

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	2814.00	1407.00	304.00	4525.00
Surgery	281.40	1764.60	587.00	2633.00
Gynaecology	562.80	750.40	364.80	1678.00
OT	25.00	200.00	40.00	265.00
Pathology	25.00	40.00	45.00	110.00
Emergency	20.00	15.00	5.00	40.00
OPD	100.00	15.00	5.00	120.00
Administration	6.00	2.00	1.00	9.00

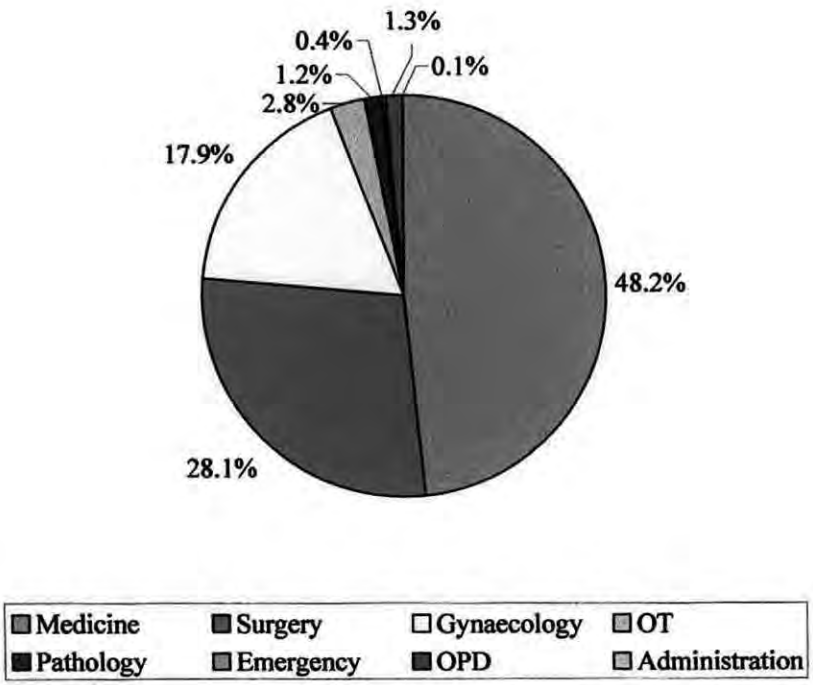


Figure-4.12: Total waste from different departments of DMCH

4.2.23. Distribution of Waste in CMCH

Table 4.27 shows the total waste generation from medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration departments of CMCH was 2996.50 kg, 1780.00 kg, 1105.50 kg, 175.00 kg, 85.00 kg, 45.00 kg, 120.00 kg and 8.00 kg respectively. Hazardous waste was generated more from surgery, medicine and gynaecology department, and general waste from medicine, surgery and gynaecology.

Table-4.27: Distribution of different types of waste in CMCH

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	1578.75	631.50	786.25	2996.50
Surgery	373.00	847.00	560.00	1780.00
Gynaecology	126.30	505.20	474.00	1105.50
OT	25.00	130.00	20.00	175.00
Pathology	15.00	20.00	50.00	85.00
Emergency	20.00	12.00	17.00	45.00
OPD	100.00	15.00	5.00	120.00
Administration	7.00	.50	0.50	8.00

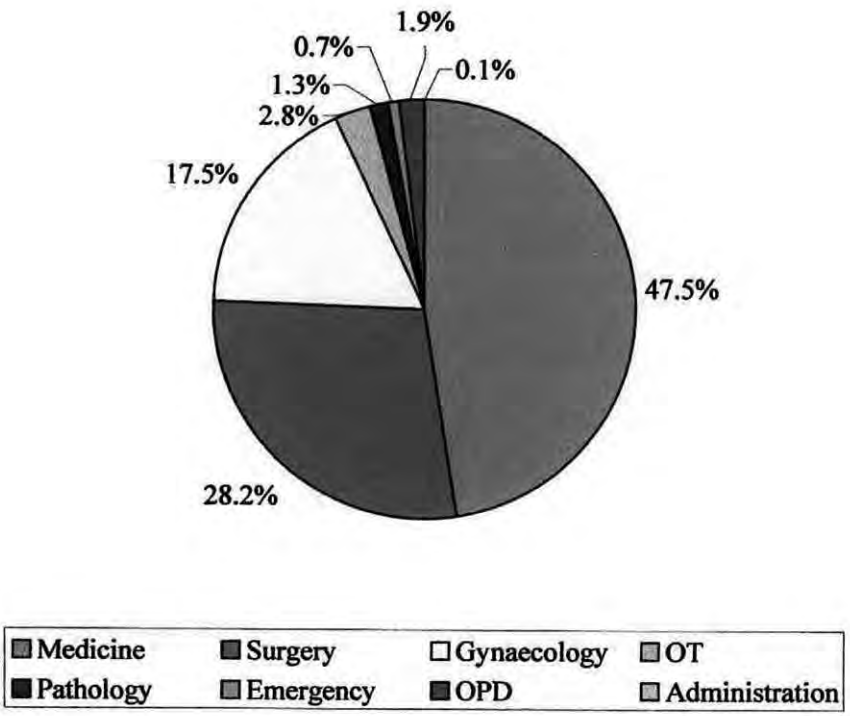


Figure-4.13: Total waste from different departments of CMCH

4.2.24. Distribution of Waste in RMCH

Table 4.28 shows the total waste generation from Medicine, surgery, gynaecology, OT, pathology, emergency, OPD, and administration departments of RMCH was 2392.20 kg, 696.00 kg, 615.50 kg, 199.50 kg, 103.00 kg, 55.90 kg, 105.00 kg and 7.0 kg respectively. Infectious waste was generated more from medicine, surgery and gynaecology department, sharp from also medicine, gynaecology and surgery department and general waste from medicine and gynaecology department.

Table-4.28: Distribution of different types of waste in RMCH

Departments	Waste (kg/wk)			
	General	Infectious	Sharp	Total waste
Medicine	1502.68	500.89	388.63	2392.20
Surgery	50.00	413.00	233.00	696.00
Gynaecology	250.81	230.76	133.93	615.50
OT	19.5	150.2	29.80	199.50
Pathology	50.00	3.00	50.00	103.00
Emergency	50.00	5.00	.90	55.90
OPD	85.00	15.00	5.00	105.00
Administration	5.00	1.00	1.00	7.00

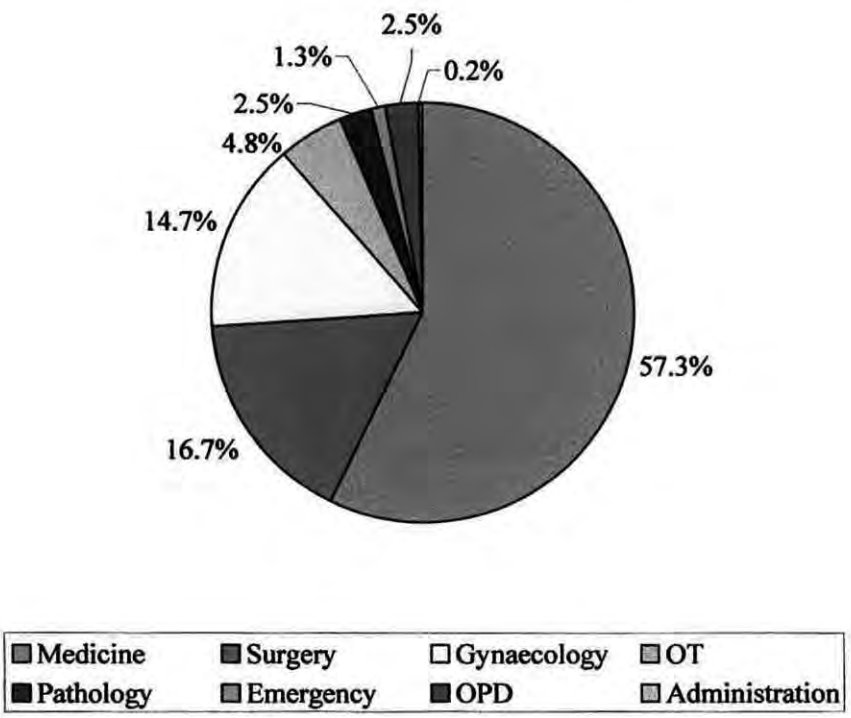


Figure-4.14: Total waste from different departments of RMCH

4.2.25. Distribution of the different types of waste between group A (CMHs) and group B (public hospitals)

Table 4.29 shows the differences between CMHs and public hospitals in term of generated waste during survey period. Significant differences were observed between CMHs and public hospitals in term of generated total waste, total general waste, total infectious waste and total sharp waste ($p<0.01$).

Total waste generation in CMHs and public hospitals was 1093.55 and 6623.03 kg respectively during the 7 days surveyed period. Of them total general, infectious and sharp waste was 900.55 vs. 5437.41, 177.10 vs. 969.68 and 15.90 vs. 215.94 kg respectively. It may be mentioned here that total number of bed for group A are 2691 where the total bed for the group Bare 3006. Average patients for the group A HCEs are 2417 numbers and for the group B HCEs are 4390 numbers.

Table-4.29: Distribution of the different types of waste between group A (CMHs) and group B (public hospitals)

Mean±SD (kg/wk)	Group		p value
	Group A	Group B	
Total Waste	1093.55±1134.90	6623.03±2616.58	0.001
Total general waste	900.55±974.82	5437.41±2273.72	0.001
Total infectious waste	177.10±137.33	969.68±450.86	0.001
Total sharp waste	15.90±24.98	215.94±106.68	0.001

Mean waste generation as per bed was 3.18 (±1.13) kg and 6.58 (±0.14) kg in CMHs and public hospitals respectively and the difference was statistically significant ($p<0.01$). Mean waste generation as per patient was 3.93(±0.42) and 4.53(±0.28) kg in CMHs and public hospitals respectively. No significant difference was observed between groups in term of amount of waste generation as per patients ($p>0.05$).

Table-4.30: Distribution of waste as per bed and patient of both groups

Mean±SD (Kg)	Group		p value
	Group A	Group B	
Waste per bed/wk	3.18±1.13	6.58±0.14	0.001
Waste per bed/day	0.45±0.16	0.94±0.02	0.001
Waste per patient/wk	3.93±0.42	4.53±0.28	0.051
Waste per patient/day	0.56±0.06	0.65±0.04	0.052

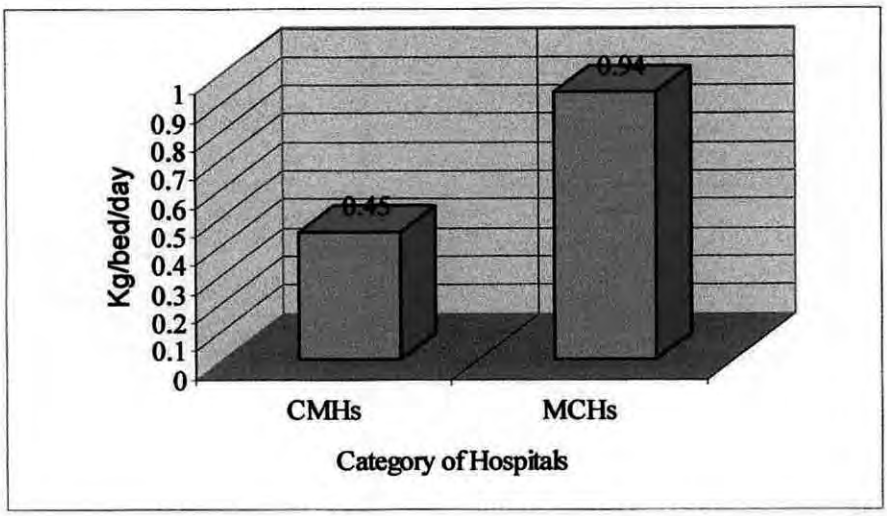


Figure-4.15: Daily waste generation in kg/bed/day between Groups

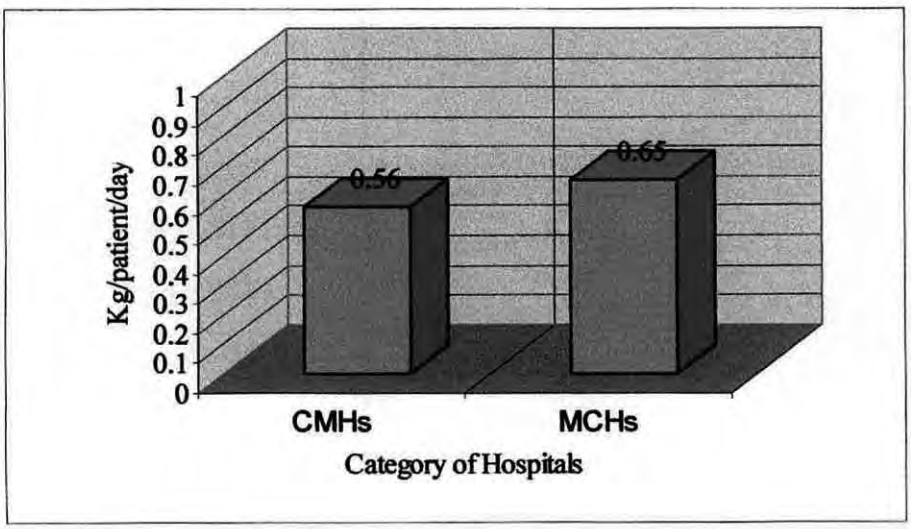


Figure-4.16: Daily waste generation in kg/patient/day Between Groups

4.2.26. Waste Distribution at Different Departments of Both Groups

Table 4.31 shows the mean waste generation from Medicine, Surgery, Gynaecology, OT, Pathology, Emergency, OPD and Administration department of both CMHs and public hospitals was 332.71 kg vs. 3304.57 kg, 264.30 kg vs. 1703.00 kg, 363.06 kg vs. 1133.00 kg, 63.23 kg vs. 213.17 kg, 20.38 kg vs. 99.33 kg, 17.88 kg vs. 46.97 kg, 28.00 kg vs. 115.00 kg, and 4.00 kg vs. 8.00 kg respectively. In all departments of public hospitals significantly more waste generation was noted.

Table-4.31: Waste distribution at different departments of both groups

Mean±SD (kg/wk)	Group		p value
	Group A	Group B	
Medicine	332.71±333.36	3304.57±1099.27	0.001
Surgery	264.30±319.07	1703.00±970.79	0.003
Gynaecology	363.06±446.38	1133.00±531.78	0.038
OT	63.23±60.89	213.17±46.53	0.004
Pathology	20.38±9.84	99.33±12.89	0.001
Emergency	17.88±8.04	46.97±8.13	0.001
OPD	28.00±20.04	115.00±8.66	0.001
Administration	4.00±1.19	8.00±1.00	0.001

Table 4.32 shows waste distribution at different departments of both groups per bed of both the groups. Waste per bed is much higher in the second group. Among the departments medicine, surgery and gynaecology department produce more waste compared to the other departments.

Table-4.32: Waste distribution at different departments of both groups per bed

Mean±SD (kg/bed)	Group		p value
	Group A	Group B	
Medicine	0.124±0.124	1.099±0.366	0.001
Surgery	0.098±0.119	0.567±0.323	0.003
Gynaecology	0.135±0.166	0.377±0.177	0.038
OT	0.023±0.023	0.071±0.015	0.004
Pathology	0.008±0.004	0.033±0.004	0.001
Emergency	0.007±0.003	0.016±0.003	0.001
OPD	0.010±0.007	0.038±0.003	0.001
Administration	0.002±0.001	0.003±0.0003	0.001

4.2.27. Distribution of Hospital Staffs by Diseases

Out of all staffs of hospitals who were all time waste handler 63.3% had skin infection, 26.3% had hepatitis, 55.8% had RTI, 48.0% had gastroenteritis, 48.0% had ocular infection, 76.3% had eczema, 74.7% had ring warm infection and 25.3% had fever. In case of some time waste handler only 18.2% had skin infection, 5.2% had hepatitis, 17.6% had RTI, 7.8% had gastroenteritis, 15.6% had eczema, 9.1% had ring warm infection and 13.0% had fever. Among all respondents 55.3% had history of cut injury during handling of waste. It may be mentioned that out of 275 hospital staffs 198 were all time waste handlers and 77 were part time waste handlers. The figures in the table 4.33 shows the multiples responses, that is a single respondent may have more than one disease. Comparison between two groups of HCEs was not done due to lack of information.

Table-4.33: Distribution of the hospital staffs by different types of diseases

Diseases	Waste handler		Total
	All time	Some time	
Skin infection	126 (63.3)#	14 (18.2)	140 (50.9%)
Hepatitis	52 (26.3)	4 (5.2)	56 (20.4%)
RTI	110 (55.8)	13(17.6)	123 (45.4%)
Gastroenteritis	95 (48.0)	6 (7.8)	101 (36.7%)
Ocular infection	24 (12.1)	0 (0.0)	24 (8.7%)
Eczema	151 (76.3)	12 (15.6)	163 (59.3%)
Ring warm infection	148 (74.7)	7 (9.1)	155 (56.4%)
Fever	50 (25.3)	10 (13.0)	60 (21.8%)
Cut injury	130 (65.7)	22 (28.6)	152 (55.3%)

Multiple responses

Only column percentage of each variable was displayed

#Figure within parenthesis denoted corresponding percentage

From the table 4.33 it is found that the all time waste handlers have more diseases compared to the some time waste handlers which point towards a finding that exposure to

the different types of waste by the all time waste handlers could be one of the reason for such findings. As there were three categories of staffs namely Nurses, Cleaners and the Technicians, a comparison amongst them could lead us to some decision. Table 4.34 shows the distribution of diseases of the all time waste handlers where it was found that the cleaners have the maximum exposure to most of the diseases. All the cleaners were found with Eczema and Ring warm infection. 95.5% of them had skin disease and 92.4% had cut injury.

Table 4.34: Distribution of diseases of the hospital staffs (all time waste handler)

	All time Waste Handler			p value*
	Nurse	Cleaner	Technicians	
Skin disease	5 (7.6)[§]	63 (95.5)	58 (87.9)	<0.001
Hepatitis	7 (10.6)	18 (27.3)	27 (40.9)	<0.001
RTI	15 (22.7)	60 (90.9)	35 (53.0)	<0.001
Gastroenteritis	8 (12.1)	56 (84.8)	31 (47.0)	<0.001
Ocular infection	0 (.0)	10 (15.2)	14 (21.2)	<0.001
Eczema	22 (33.3)	66 (100.0)	63 (95.5)	<0.001
Ring warm infection	29 (43.9)	66 (100.0)	53 (80.3)	<0.001
Fever	15 (22.7)	23 (34.8)	12 (18.2)	<0.001
Cut injury	45 (68.2)	61 (92.4)	24 (36.4)	<0.001

*Chi square test was done to measure the level of significance
§ Figure within the parenthesis denoted corresponding percentage
Multiple responses
Record of life time except fever

4.2.28. Knowledge and Practice of Waste Management of Hospital Staffs

Table 4.35 presents the picture about the knowledge and practice level of waste management by the hospital staffs. The table represents the figure of all the respondents. It was found that only 4.8% respondents have good knowledge about existing waste collection system of the hospital. Only 37.7% of the all time waste handler was found to use safety equipments during waste handling and 34.2% was found without any safety equipments. 62.3% respondents having the feelings of the necessities of HCWM and

treatment system and 37.7% had no idea about it. Only 2.7% respondents had satisfaction on current HCWM practices, 31.6% were not satisfied and 65.8 % had no comment. 61.8% respondents had feelings for the necessities of the training of the people associated with HCWM and 38.2% had no idea. Only 14.4% (40 out of 275) of the hospital staffs were found having training on HCWM system.

Table-4.35: Knowledge and practice of waste management by hospital staffs

	Frequency	Percentage
Knowledge about existing waste collection system of hospital	18	4.8
Use safety equipments during waste handling		
• Yes	74	37.7
• No	68	34.2
• Not always	56	28.1
Feeling of the necessities of HCW management and treatment system		
• Yes	233	62.3
• No idea	141	37.7
Satisfaction over present HCW management		
• Yes	10	2.7
• No	118	31.6
• Not known	246	65.8
Feeling of necessities of the training of the persons associated with HCW management		
• Yes	231	61.8
• No idea	143	38.2
Having training on hospital waste management system	40	14.4

4.3. Discussion

Medical waste contains infectious pathogen and toxic hazardous materials (Blenkharn 2006). Therefore, medical waste is considered highly risk factor compared with general household waste. It is noted that, this is not only due to direct connection to the handling of the medical waste but also improper treatment and management of the waste (MOHFW 2004). Hospitals also generate non-hazardous waste such as left over food, kitchen waste, packing materials from different sources and administrative operations (MOHFW 2004). From the environmental point of view, at present medical waste management in Bangladesh is operating in an improper way due to constraints of financial support, lack of awareness, absence of proper treatment facilities, and poor application of legislation by the law enforcing agencies (Moritz 1995). A few numbers of Hospitals are exceptional from this point. They are doing separately but definitely not complete final safe disposal.

This cross sectional survey was conducted at CMH of Mymensingh, Jessore, Comilla, CTG, Dhaka, Bogra, Rangpur, Gatail and three public hospitals DMCH, CMCH, RMCH from December 2007 to November 2008 with a view to evaluate the existing scenario of medical waste management inselected public hospitals and CMHs in Bangladesh and assess the occupational hazards associated with the waste handlers. Equal numbers of respondents from each hospital were taken in this study; of them 9 were patients, 1 administrator, 6 physicians, 6 nurses, 6 cleaners and 6 technicians. Total 374 respondents from these hospitals were surveyed, among them 275 (73.5%) were hospital staffs and 99 (26.5%) were patients (Table 4.1 and 4.6). All hospital staffs were considered as waste handler (Table 4.7) either all time (72.0%) or some times (28.0%). In this study a survey was conducted on all selected hospitals to collect waste materials from all wards and then segregated and weighed. The age distribution, gender distribution and distribution of occupation is shown in Tables 4.2, 4.3 and 4.5. Distribution of education of all respondents and all time waste handlers are presented in Tables 4.4 and 4.8 respectively. Average monthly family income of the all time waste handlers are shown in Table 4.9.

This study investigated the medical waste management system used by different CMHs and public hospitals in Bangladesh. A comprehensive inspection survey was conducted for 8 CMHs and 3 public hospitals located in different areas of Bangladesh. Investigations

were conducted to provide information on the different medical waste management aspects and occupational hazards of the waste handlers. The results reported here focus on the level of medical waste generation, their types and usual knowledge of hospital staffs on waste management system.

In this study average waste generation rate found 3.18 (±1.13) kg/bed and 6.58 (±0.14) kg/bed in CMHs and public hospitals respectively for 7 days of survey period ($p<0.01$). Mean waste generation as per patient was 3.93 (±0.42) and 4.53(±0.28) kg in CMHs and public hospitals respectively ($p>0.05$) which is shown in Table 4.30.

In this study after surveying all hospitals generated average general waste was found 3359.52 kg/day, infectious waste was 617.98 kg/day and sharp waste 110.72 kg/day (Table 4.9). That is 0.59 kg/bed/day, 0.11 kg/bed/day, 0.02kg/bed/day respectively for general, infectious and sharp waste. Total waste and hazardous waste generation rate of all surveyed hospital of our series was 0.72 kg/bed/day and 0.13kg/bed/day.

Rashid (1996) conducted a study in different hospitals of Dhaka city in 1996 to assess the existing waste management and also to assess different technological options for improvement of the present situation. It has been found that the rate of waste generation was about 1.16 kg/bed/day, and the hazardous waste was 0.169 kg/bed per day. The contribution of infectious, sharps, and pathological wastes was about 10.5%. 3.5% and 1.5% respectively compared to solid waste of 3000 tons/day in Dhaka city. In Sarkar et al (2006) average waste generation rate for hospitals and clinics in Sylhet was found 0.934 kg/bed/day which is comparable with our study. Alam et al (2008) determined the generation rates of HCW in CMCH, the second largest hospital in Bangladesh. Waste materials were collected from these wards and then segregated and weighed. Waste generation per day was found to be 73.22 kg/ward, 1.28 kg/bed and 0.57 kg/patient. A total of 2490 kg of HCW was produced each day in CMCH (37% being infectious and the rest being noninfectious waste). Infectious waste was 27.07 kg/ward, 0.47 kg/bed and 0.21 kg/patient and the non-infectious waste was 46.15 kg/ward, 0.81 kg/bed and 0.36 kg/patient/day.

In our survey total generated waste in CMCH during the survey period was 6315 kg (Table 4.13), of that 5052.00 kg was general and 1263.00 kg was hazardous waste

(1136.7 kg infectious and 126.3 kg sharp). Total generated waste was 6.61 kg/bed and 0.09 kg/bed/day and total generated general waste was 2.35 kg/bed and 0.24 kg/bed/day.

In a survey of Suwannee et al (2002) from different hospital and clinics in Phitsanulok Province of Thailand found the average daily waste generated as general, medical and hazardous waste from all hospitals in at 1.751, 0.284 and 0.013 kg/bed respectively and at 0.323, 0.041 and 0.002 kg/bed respectively from all clinics in Phitsanulok Province. In Bdour et al (2007) average generation rates of total medical wastes in the hospitals were estimated to be 6.10 kg/patient/day (3.49 kg/bed/day), 5.62 kg/patient/day (3.14 kg/bed/day), and 4.02 kg/patient/day (1.88 kg/bed/day) for public, maternity, and private hospitals, respectively. For medical laboratories, rates were found to be in the range of 0.053-0.065 kg/test-day for governmental laboratories, and 0.034-0.102 kg/test-day for private laboratories. In Da Silva (2005) average generation rates of total and infectious-biological wastes in the hospitals were estimated to be 3.245 and 0.570 kg/bed-day, respectively in Bazil.

Medical waste management was evaluated at the three hospitals in the Nisava and Toplica district, in Serbia by Stanković et al (2008). All the stages of existing waste management (segregation, collection, storage, transportation and disposal of waste) were examined by interviewing the personnel involved in the management of waste. The generated waste was a mixture of hazardous and non-hazardous waste. The study found that waste management performance in this district was poor and that there were problems in every stage of management. The results indicate that the waste generation rate was 1.92 kg/bed/day and consisted of 98.7% general waste and 1.3% sharps. In our series 82.0% generated waste was general, 15.0% were infectious and 3.0% were sharp.

Healthcare wastes contain a wide range of microorganisms among which hepatitis B virus (HBV) and hepatitis C virus (HCV) and HIV are the most significant pathogens. BBV infection may follow sharps injury, contamination of pre-existing skin lesions or splash inoculation to the eyes or mucous membranes. Infection may be transmitted by blood or bloodstained body fluids, even where blood staining is minimal and not visually apparent. The Centers for Disease Control, 1987 (CDC) Universal and Standard Precautions, intended to prevent parenteral, mucous membrane and non-intact skin exposures to BBV,

offer protection to healthcare workers CDC and should provide an integrated framework for the protection of waste handlers also (Blenkharn 2006).

The incidence of sharps injury among waste handlers is unacceptably high. It may be prevented though the use of ballistic gloves and trousers, though there are serious deficiencies in the initial segregation and disposal of wastes by healthcare professionals that should provide the primary control measure. All sharps injuries reported in our series were caused by improper disposal and packaging of wastes by users. The fingers and palms were the most common sites for injury, though several individuals suffered injuries to legs as they carried waste sacks having unprotected sharps hidden within them. Infectious waste contains different type of pathogenic micro-organism such as virus and bacteria (Askarian et al 2004; Chintis et a 2004; Coronel et al 2002; Muhlich et al, 2003) which can enter the human body through a number of routs (Ray et al 2005; Sigsgaard et al, 1994): By puncture, abrasion, or cut in the skin; by the mucous membranes; through inhalation; through ingestion.

Many reports in the literature have been shown that infection with human immunodeficiency virus (HIV) and hepatitis virus B and C can present a mechanism for transmission of disease through medical waste (Muhlich et al 2003). These micro-organisms are mainly transmitted through occupational injuries from infectious sharps by human blood and fluid (Hagen et al 2001). In our study we had the limitation of medical test of the respondents as such we were dependent on the statistics as provided by the respondents. Due to the social drawbacks exact data related to sexually transmitted diseases, HIV, HBV and HCV could not be collected. Out of all hospital staffs the all time waste handlers had 63.3% skin infection, 26.3% Hepatitis, 55.8% RTI, 48% Gastroenteritis, 12.1% ocular infection, 76.3% Eczema, 74.7% Ring warm infection, 25.3% fever and 65.7% Cut injury. Pont to note here that they were multiple responder as such one respondent reported more than one disease. In case of the some time waste handlers the corresponding values were 18.2%, 5.2%, 17.6%, 7.8%, 0.0%, 15.6%, 9.1%, 13.9% and 28.6% (Table 4.33). More detail study carried out within the all time waste handlers (Nurse, Cleaner and Technician) to find out the diseases. It was found that the Cleaners are the most affected groups by the diseases. Technicians are more vulnerable than the Nurses (Table 4.34).

There are lot of risks of injuries related to medical waste handling and carrying by waste hauler and/or cleaner. For example a cut-injury, punctured wound, laceration, strain and sprain of the joint of limbs and backache due to load hauling. Akter *et. al.,* (1998) reported that, there were several incident (10 cases out of 17) of injury due to exposure to medical wastes inside or outside of hospital premises. These were as follows: hands cut due to handling broken glass; injured by needle and fingers permanently damaged/ became curved; right hands became paralyzed by the injury by a needle; two legs became paralyzed due to injury by the needle; skin diseases on legs and hands/ body; pus due to injury sometimes; ulcer on legs.

As BAN & HCWH (1999), sharps, which include syringes and needles, have the highest disease transmission potential amongst all categories of medical waste. Almost 85% of sharp injuries are caused between their usage and subsequent disposal. More than 20% of those who handle them encounter 'stick' injuries. The study also mentioned that injuries from needle-stick and sharps occur frequently in developing countries, and that safer disposal facilities and routine hepatitis B vaccine should be adopted. In the present study 55.3% hospital stuff had given history of cut injury during handling of waste.

In our study total waste generation in CMHs and public hospitals was 1093.55 and 6623.03 kg respectively (Table 4.29) during the 7 days surveyed period. Of them total general, infectious and sharp waste was 900.55 vs. 5437.41, 177.10 vs. 969.68 and 15.90 vs. 215.94 kg respectively (Table 4.29). Significant differences were observed between CMHs and public hospitals in term of generated total waste, total general waste, total infectious waste and total sharp waste ($p<0.01$). Mean waste generation as per bed was 3.18 (±1.13) kg and 6.58 (±0.14) kg in CMHs and public hospitals (Table 4.30) respectively and the difference was statistically significant ($p<0.01$). Mean waste generation as per patient was 3.93(±0.42) and 4.53(±0.28) kg in CMHs and public hospitals respectively ($p>0.05$).

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

HCE are the industry where special wastes are generated in a relatively confined area. The waste are heterogeneous in nature, in quantity, in quality and in consistent. The waste produced in the health care delivery activity carries a higher risk of infection than any other types of waste.

The present study was conducted with an aim to evaluate the existing scenario of HCW management, to identify the quantity, physical composition of HCW and the relative proportion of hazardous and non-hazardous waste, to compare the different types of waste generation between different CMHs and MCHs. An assessment of the occupational hazards were carried out were it was found that the all time waste handlers are more susceptive than the some time waste handlers. Among the all time waste handlers the cleaners are the most vulnerable group to induced diseases.

In our study total waste generation in CMHs and public hospitals was 1093.55 and 6623.03 kg respectively during the 7 days surveyed period with varying bed and patient capacity (Patient and bed capacity given in Table 4.10). Of them total general, infectious and sharp waste was 900.55 vs. 5437.41, 177.10 vs. 969.68 and 15.90 vs. 215.94 kg respectively.

Mean waste generation per bed was 3.18 (±1.13) kg and 6.58 (±0.14) kg in CMHs and public hospitals respectively and the difference was statistically significant ($p<0.01$). Mean waste generation per patient was 3.93(±0.42) and 4.53(±0.28) kg in CMHs and public hospitals respectively (Table 4.30).

Mean waste generation from Medicine, Surgery, Gynaecology, OT, Pathology, Emergency, OPD and Administration department of both CMHs and public hospitals were 332.71 kg vs. 3304.57 kg, 264.30 kg vs. 1703.00 kg, 363.06 kg vs. 1133.00 kg, 63.23 kg vs. 213.17 kg, 20.38 kg vs. 99.33 kg, 17.88 kg vs. 46.97 kg, 28.00 kg vs. 115.00

kg, and 4.00 kg vs. 8.00 kg respectively (Table 4.31). In all departments of public hospitals significantly more waste generation was noted.

Out of all respondents 275 (73.5%) were hospital staffs and 99 (26.5%) were patients. Among all enrolled respondents 250 (73.5%) were hospital's staffs and 90 (26.5%) were patients (Table 4.6). Among all staffs 72.0% (nurse, cleaner, and technician) were direct waste handler and 28.0% were occasional (administrator, physicians). Disease survey revealed that out of all staffs of hospitals who were all time waste handler 63.3% had skin infection, 26.3% had hepatitis, 55.8% had RTI, 48.0% had gastroenteritis, 48.0% had ocular infection, 76.3% had eczema, 74.7% had ring warm infection and 25.3% had fever. In case of some time waste handler only 18.2% had skin infection, 5.2% had hepatitis, 17.6% had RTI, 7.8% had gastroenteritis, 15.6% had eczema, 9.1% had ring warm infection and 13.0% had fever. Among all respondents 55.3% had history of cut injury during handling of waste (Table 4.33).

Knowledge and practice in waste management of hospital staffs were very alarming. Out of all hospital staffs 4.8% had knowledge about existing waste collection system of hospital, 37.7% use safety equipments during waste handling, 2.7% had satisfaction over present health care waste management, 61.8% had feeling of necessities of the training of the persons associated with HCW management, 14.4% had training on hospital waste management system (Table 4.35).

From the present study in the existing hospital waste management situation, it is apparent that present system of HCW management is environmentally ineffective, inefficient and hazardous for health. The average production of waste in public hospitals is significantly higher than that of CMHs. The study revealed some problems and lack of proper procedures associated with HCWM in hospitals of Bangladesh.

- Lack of comprehensive waste disposal plans for the disposal of HCW and technical aspects for hazardous wastes.
- Lack of adequate treatment facilities for the treatment of pathological and infectious wastes.

- Lack of knowledge and awareness among the personnel in hospitals about the consequences of the potential risk of infectious, hazardous waste and environmental impact.
- Lack of proper guidelines, legislation, regulations and instructions on HCWM such as segregation, collection and disposal of various categories of wastes in suitable manner to render it harmless.

A comprehensive study on the investments (both fixed and variable) related to HCWM can give a better picture of the HCWM standard. In our study it was not possible due to non availability of required information. Utilization of the resources in appropriate manner can definitely improve the situation and it was felt by almost all the administrative officials of MCHs and CMHs.

5.2. Recommendations from the Study

Following recommendations are made from the conducted study:

a. Total waste generation in public hospitals (MCHs) is significantly higher than CMHs reflects the fact of strict prohibiting role to fetch unnecessary foods and other belongings by the attendants in the hospitals and overall systematic discipline. If public hospitals can maintain the similar policy total generated waste will reduce dramatically.

b. Regular training on HCWM system of the concerned persons should be conducted.

c. All hospital staffs should be aware about the risks and hazards of mishandling the HCW.

d. To reduce the total cost of waste management proper documentation in respect of quantity and quality of waste, manpower, logistic, expenditure and other relevant items to be enhanced.

e. Use of more recyclable items instead of disposable items.

f. Strict control by the government agencies on sale policy of hospital generated recyclable waste.

g. Government should plan and establish acceptable, cost effective, appropriate type, capacity and sustainable treatment technology and disposal methods.

h. Private sectors should be encouraged in HCWM system.

5.3. Recommendation for Further Studies

Subject study was carried out within a limited period of time and within limited HCEs. The data was collected from 8 CMHs and 3 MCHs. Other HCEs were not considered. Again the waste was collected only for 7 days from the selected departments. The seasonal variation was neglected. The personal information about the waste handlers was taken from the respective respondents, no medical history or diagnosis of the disease was carried out. In the analysis of the diseases relative comparison between two groups of the hospitals were not carried out. Considering the above factors following recommendations are made for further studies:

a. Study should be carried out involving all categories of HCEs both private and government sectors to evaluate the difference of the standard between them.

b. Specific study should be conducted to evaluate the HCWM standard of different government and non-government organizations and to establish cooperation between them for smooth HCWM between the groups of HCEs.

c. Study should be carried out to find out the impact of seasonal variation in regards to volume of HCW and its proper management.

d. To get the correct statistics about the occupational hazards of the waste handlers proper medical history and medical test/examination to be done. A long term study is suggested for such evaluation.

e. Impacts of the investment in the field of HCWM should be compared between different categories of HCEs. A detail study in this regard can give specific idea in this regard.

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Appendix I
Questionnaire

Title of the study: Waste Management with Special Emphasis on Occupational Health and Safety at Selected Healthcare Establishments

Place of study: Department of Civil Engineering and Technology (BUET), Dhaka
Investigator: Mirza Md Tayabur Rahman

ID no: Date:

1. Hospital name:
2. Respondent /_____/
    1. Patients
    2. Administrator
    3. Physicians
    4. Nurse
    5. Cleaner and technicians
3. Name of the respondent:
4. Age (years): /_____/
5. Sex: /_____/
    1. Male
    2. Female
6. Education: /_____/
    1. Illiterate
    2. Primary
    3. Secondary
    4. Higher secondary
    5. Graduate and above
7. Occupation /_____/
    1. Service
    2. House wife
    3. Student
    4. Unemployed
    5. Business
    6. Day labourer
8. Monthly family income (BTk) /_____/
9. Is there any facility/availability of hospital waste disposal in this hospital /_____/
    1. Yes
    2. No
    3. Not known
10. If yes, location of the treatment facility /_____/
    1. In hospital
    2. Out side of the hospital
11. Applicable Method: /_____/
    1. Incineration
    2. Incineration and dumping

3. Stream sterilization, dumping and no treatment
4. Stream sterilization, chemical treatment and dumping
5. Chemical treatment and dumping
6. No treatment and dumping
7. No treatment

12. If in-hospital treatment facility is not available, who collects waste from hospital /_____/
    1. Hospital authority
    2. Municipal authority
    3. NGO/others
13. Do you know what type of waste collection system is followed in this hospital /_____/
    1. Yes
    2. No
    3. Not known
14. If yes, type of waste collection system /_____/
    1. Municipal open/covered van
    2. NGO's Open/covered van
    3. Others
15. Do the hospital staff use safety equipments /_____/
    1. Yes
    2. No
    3. Not known
16. Do you feel necessities of hospital waste management and treatment system? /_____/
    1. Yes
    2. No
17. Is the present system of health care waste management satisfactory /_____/
    1. Yes
    2. No
    3. Not known
18. Do you feel the necessities of the training of the persons associated with the HCW management? /_____/
    1. Yes
    2. No
    3. No idea

Only for patients

19. How many attendants you have with you? ----------
20. Which type of waste is generated from you /_____/
    1. Reusable
    2. Sharp
    3. General
    4. Infectious waste
    5. Chemical and Radioactive

For hospital administrator/physicians/Nurses/other stuff

21. Have you any institutional training about hospital waste management system?
/_____/
    1. Yes
    2. No
22. Do you feel the necessities of HW management satisfactory?
/_____/
    1. Yes
    2. No
23. Do you feel the necessities of the training of the persons associated with the HW management?
/_____/
    1. Yes
    2. No

Appendix II

Check list

Name of hospital:
Total number of bed----------
Average number of patient----------
Per day generation of waste
Total----------
Hazardous waste----------
Infectious----------
Sharp----------

Bed and patients distribution:

Bed and patients distribution	Number
Gynae	
Medicine and others	
Surgery	
Total Bed	
Average patients	

Waste distribution:

Departments	Waste (kg)			
	General	Infectious	Sharp	Total waste
Medicine				
Surgery				
Gynaecology				
OT				
Pathology				
Emergency				
OPD				
Administration				

Appendix III

Accident Report Form

---

1. Date and time of incident: _____/

_____

2. Date and time of report: _____/

_____

3. Name of the staff exposed/Injured:

_____

4. Age: _____
5. Sex: _____
6. Job

title/occupation:_____

7. Place (Location) where the incident took place:

_____

8. The area in the body injured:

_____

9. Type of accident (Material involved):

_____

10. How the incident occurred (Details of the incident):

_____

_____

—

11. Main reason for the

incident:_____

12. Is any person directly responsible for the incident? (Yes/No):

_____

If yes,

mention:_____

13. Hepatitis B vaccine taken before the injury (Yes/No):

_____

14. In case of needle stick injury, what immediate measure has been taken by the injured person? (Yes/No)

    a) let the wound bleed freely: _____
    b) wash the affected area/skin with soap and water: _____
    c) rinse the affected area/skin with spirit: _____
    d) the wound is covered with water proof dressing: _____
    e) report to the respective supervisor and infection control officer for recording: ____
    f) report to staff clinic for further medical advice: _____

15. In case of exposure to blood or body fluids incident, what immediate measure has been taken? (Yes/No)

    a) wash the area with copious amount of water: _____
    b) report to the respective supervisor and infection control officer for recording:____
    c) report to staff clinic for further medical advice: _____

* Note: Needle stick or sharps injury and exposure to blood or body fluids incident include the following accident:

- an injury from a used needle or sharp instrument;
- splashing of these fluids into the face, especially the mouth and eyes; and
- Spillage of these fluids on to open skin cut, including areas affected by eczema.

Date:_____

Designation and Signature:_____