

Final Report
on
Consensus Building on Applicability of an Appropriate Waste
Disposal System within Health Care Institutions of
Pokhara Sub-metropolitan City

Supported by:
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Submitted by:
Mr. Rajesh Pyakural: PI
Mrs. Bijaya Bijukachhe: Co-PI
Ms. Bhumika Vaidya: Co-PI
Ms. Lalini Singh: RA

Submitted to:
Nepal Health Research Council (NHRC)
Ramshah Path, Kathmandu
Nepal

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To, The Member Secretary
Nepal Health Research Council (NHRC)
Ramshah Path, Kathmandu

Subject: Submission of final report.

Dear Sir,

Our team has completed the task of preparing the final report entitled “Dissemination workshop Consensus building on applicability of an appropriate waste disposal system within health care institutions in Pokhara Sub-metropolitan City”. The report is enclosed herewith.

I would like to make an apology for delaying in submission of report.

Thank you for your kind cooperation.

Rajesh Pyakurel
PI, NHRC

Chapter- I

1. Introduction

This report on the “Consensus building on applicability of an appropriate waste disposal system within health care institutions in Pokhara Sub-metropolitan City” has been prepared as per the “Terms of Reference” assigned by the Nepal Health Research Council (NHRC). It forms a part of the ongoing NHRC programs on environmental health issues in Nepal. This project had been conducted with an objective to identify the present status and bottleneck of health care waste management system. This report has also analyzed the detail study on existing system; plan and policies related to health care waste to assess the applicability of an appropriate waste disposal system as well as to recommend appropriate waste disposal system within the HCIs of Pokhara Sub-metropolitan City (PSMC).

1.1 Background

Every hospital or any other form of healthcare establishment, no matter what size, is intended to be a place of healing. This is the fundamental purpose of a health care system. Healthcare facilities have improved in Nepal over the last decade. Although the healthcare establishments provide healthcare services to the people, it generates solid waste, which is harmful to public health and environment due to its infectious and hazardous nature. Healthcare waste is the total waste stream that is generated by hospitals, healthcare establishments, research facilities and laboratories. Usually it consist sharps, human or animal tissues/body parts body fluids and other infectious materials. One of the sources of municipal solid waste is hospital or healthcare establishment. However the HCI's service and number has increased, the hazard from the improper waste management has also been increasing to the greater extent.

Out of the total healthcare waste only 20% is hazardous and rest of the 80% is ordinary (Pruss et al., 1999) that is similar to waste generated from households or offices. Most of the HCIs in Nepal are not practicing the waste segregation, due to less awareness about the subject and lack of treatment options for different types of wastes. So hazardous wastes were being mixed with ordinary waste becoming total waste hazardous. This has created difficulty in management of the entire waste stream. This type of mismanagement of healthcare waste can effect environment and the socio-economical aspect of the community. This can spread infectious diseases like HIV/AIDS, Hepatitis B, Tuberculosis etc, and also can cause public and occupational health hazard.

Over the last decade there has been increase in the number of hospitals, private nursing homes, clinics and polyclinics in the Pokhara sub-metropolitancy. This rapid increase has resulted in a significant increase in the volume of healthcare waste generation. Some HCIs dump or bury waste within HCI, some along the river banks where as some gave it to municipality waste collector. Haphazard disposal of health care waste is one of the burning issues in Pokhara sub-metropolitancy. Majority of HCIs were using incinerator for the combustion of their waste but were not efficient and environmentally sound. Very limited studies on healthcare waste management have been conducted in Pokhara. The management committees of HCIs were not aware of waste management. So, far there was

no separate mechanism for the treatment of waste and no rules and policy had developed regarding its safe disposal. Ineffective waste disposal and subsequent contamination of the population through the environment has a negative impact on the morbidity and mortality rates (NHRC, 2002). Pokhara is such a beautiful nature blessed city and the first choice of tourist. So, everyone should try his level best to maintain its environment. As health care waste management is an environmental sensitive issue, there was urgent need to manage waste in an environmentally sound manner. Recognizing the importance of health care waste management, Pokhara municipality has been selected as a study site.

1.2 Expected output

- The present scenario of healthcare waste disposal system followed by the HCIs in PSM
- Bottlenecks of Healthcare waste management within HCIs.
- Recommend appropriate waste disposal system within the HCIs of Pokhara Sub-metropolitan City.
- Ideas and information of the study will help for the decision and policy making in the health care waste management not only in the Pokhara Sub-metropolitan City, but also to other Municipalities of the country.
- Reference for other researchers in the relevant subject matter.
- Health Care Institution will know about healthcare waste management of other HCIs within Pokhara Sub-metropolitan City.
- Provoke health care providers in effective Health Care waste management.

1.3 Objectives of the study

The main objectives of the study were

1. To identify the present status and the bottleneck of the health care waste management system within health care institutions.
2. To assess applicability of an appropriate waste disposal system within health care institution.
3. To recommend appropriate waste disposal system within health care organizing.

1.4 Methodology

In order to meet the objectives of this study various methods have been followed and the methods are explained below

Available national and international literatures on healthcare waste management have been studied in search of required information. All the reviewed documents are enlisted in the reference section. For first field visit structured pre-questionnaires were prepared. For second field visit, different checklists and structured questionnaires were developed. These are two methods adopted for this study. First the list of HCIs in Pokhara sub-metropolitan city was collected then a site-specific survey was conducted in the selected HCIs. 4 Govt. hospitals, 9 private, 2 teaching, and various polyclinics and clinics were identified (detailed list included in Annex: III). First site-specific survey was conducted only in eleven HCIs (1 Govt, 1 NGO, 1 INGO, 1 teaching, 1 community, 4 private and 2 clinics). The selection was conducted on the basis of location and capacity.

The team visited Pokhara sub-metropolitan city office to know the current situation of healthcare waste management as well as solid waste management practices. The team also made a general observation of Landfill site and Wastewater treatment plant. Group discussions and key person interview with structured pre-questionnaires was conducted to gather the required information. For detail study only 5 HCIs (1 Govt, 1 INGO, 1 teaching, 1 community and 1 private) were selected because it's not possible to survey all the HCIs with the available time and resource. Selection was made on the basis of HCIs types, flow of patients and location. The team had segregated waste into three categories: hazardous, non-hazardous and sharps developed by NHRC (for detail see lit. review). The segregated wastes were weighed by using spring balance. From the collected data simple average and percentage have been calculated and analyzed. The necessary data were presented in tabular and diagrammatic form. Data gathered during first field visit were used as baseline information for second field visit. Photographs taken during the field visits were included in the report to show the current status of HCIs in Pokhara Sub-Metropolitan City. These analyzed data will be used as baseline information for further study.

Out line of the methodology:

1. Literature review

- Information collected regarding health care waste by primary and secondary sources.
- Interact with hospitals, health centers, experts and related

2. Selection

- 15 HCIs within PSMC were selected.
- Govt., Private, NGO, polyclinics and clinics (Annex II)

3. Pre-questionnaire development

- Pre-questionnaire were developed for introductory survey (Annex V).

4. Introductory survey

- First survey was conducted in eleven selected HCIs (Annex I)
- To identify the present status of HCWM, general observation, group discussions and key person interview was conducted.

5. Identification of present status

6. Visit of Pokhara Municipality

- Landfill site and treatment plant was observed
- Key person interview and group to find out the applicability and sustainability of landfill site and treatment plant

7. Questionnaire development

- Structured questionnaire and different checklists were developed for detailed survey. (Annex VI)

8. Detailed site specific survey

- Only five HCIs were selected

9. Information collection

- General observations, group discussions, waste measurement and key person interview at different level of concerned bodies

10. Data analysis

- Qualitative as well as quantitative analysis of collected data
- Preparation of appropriate graphs and tables.

11. Report writing

- Interim, Draft and final report was prepared.

12. Dissemination workshop

1.5 Study Limitation

The limitation during the study phase was very limited study found about health care waste management in PSM City for literature review. Also the time and resource limitation was faced while carrying out the study.

Chapter-II

2 Literature Review

2.1 Pokhara sub-metropolitancy

Pokhara is located in the midland region of Nepal at Gandaki zone, which is low lying area in the middle part of Himalayas, sandwiched between Mahabharat range in the south and the higher Himalayas in the north. It is situated 198 km west from Kathmandu and is at elevation of 941 m. It is Sub-metropolitan City with an area of 55.66 sq. km and total population in this city is 1, 81,192 (2000 est.). The rate of population growth at Pokhara has increased by 5.07 per annum (CBS, 2000). Normally the temperature ranges from minimum 6°C and maximum 31 °C.

Pokhara is a rare combination of long arrays of snow-clad peaks, crystal clear lakes, and turbulent rivers with deep gorges and picturesque villages inhabited by simple and friendly ethnic people. Majority of Pokhara valley is of Bahuns and Chettris, while surrounding hilly area are inhabited by Gurungs. Pokhara is spread out city that runs north –south for about 5 km. The oldest section of the city is called Bazaar; it is at north of the town. South of the Bazaar is bus station and at the south of bus station there is domestic Airport. The city is well organized and has an excellent selection of good hotels and restaurants.

There are plenty of tourist interest places, some of which are Phewa Tal, Begnas Tal, Rupa Tal, Devi's Fall, Mahendra Cave, Bindabasini Temple, Bhadrakali Temple, Barahi Temple, Annapurna Regional Museum, Buddhist Monestry, Tibetan Village, Sarangkot, Kahun Danda, Phoksing Danda, etc (ncthakur.itgo.com and online vegetarian restaurant guide)

2.2 Definitions of health care waste

In reference to WHO (2000), health care waste is a by product of health care that includes sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices and radioactive materials generated by laboratories, health-care establishments and research centers. In addition, it also includes the waste generated in the home during the course of health care treatment (dialysis, insulin injections, dressing etc.).

About 80% of the waste coming out from health-care providers is “general” or non-risk waste, comparable to domestic waste that could be disposing by the municipal disposal mechanisms. It comes mostly from the administrative and housekeeping functions of health-care establishments and may also include waste generated during maintenance of health-care premises. Around 15% of health-care waste is regarded as infectious or hazardous waste that may create a variety of health risk. The remaining 1% is sharps and 4% non-infectious but hazardous waste (ENPHO, 2002).

Different terms are used to describe waste generated by HCIs. Such as

Infectious waste This consists of cultures and stocks of infectious agents from laboratories, waste from surgery and autopsy on patients with infectious diseases, waste from infected patients in isolation wards, and dialysis waste from infected patients. (Dave, P.K., 1999)

Medical waste: The term medical waste is used to describe “any waste that is generated in the diagnosis, treatment or immunization of human beings or animals in research pertaining thereto, or in the production or testing of biological "(Sapkota, *et al.*, 2003).

Clinical waste: Any waste generated during the examination and treatment of patients in hospitals or clinics. (Medical Waste Management Guidelines, 2004)

Pathological waste: Tissues, organs, body parts, human fetuses, animal carcasses, blood and body fluid and containers used to store these substances are known as pathological waste. (Medical Waste Management Guidelines, 2004)

2.3 Categories of health care waste according to various classifications

The type of waste produced in hospitals depend on the medical treatment facilities, such as number/nature of beds, number of outpatients, laboratories, type of hospital or Health Care Institute etc. Hospital and health care waste are classified as follows.

Table 1: Classification of healthcare waste according to different categories

	Type of Classification			
	WHO	Indian	Kathmandu Metropolitan City	NHRC or Nepalese
Waste Categories	General Waste	Human anatomical waste	Ordinary Organic Waste	General Waste
	Infectious wastes	Animal waste	Ordinary In-Organic Waste	Hazardous waste or contaminated waste
	Pathological waste	Microbiology and Biotechnology waste	Hazardous Medical Waste Suitable for Incineration	Sharps
	Sharps	Sharps	Hazardous Sharp Waste	
	Chemicals	Discarded medicines and cytotoxic drugs	Non-burnable Hazardous Waste	
	Pharmaceuticals	Soiled waste		
	Genotoxic waste	Solid waste		
	Radioactive waste	Liquid waste		
	Pressurized containers	Incineration ash		

Classification of waste according to WHO or Indian standard or any other standard will be complicated and unnecessary. So rather than becoming more sophisticated and unrealistic, more applied realistic method of designation is necessary. NHRC (NHRC, 2002) has developed more applied realistic methods to classify the medical waste into three categories. Hence, we've followed the same for our study as described below

(a) General waste

It includes paper, cardboard, metal containers, floor sweeping and kitchen waste. It does not need special treatment and storage facilities but needs to be collected separately from infectious waste.

(b) Hazardous waste or contaminated waste

Hazardous wastes are waste with potential to cause hazard to health and life of human being. This includes infectious waste excluding sharps but including anatomical or pathological waste, and waste contaminated with human blood or other body fluids, excreta, and vomit. This category typically makes up about 75% of the hazardous health care waste or about 15% of the total waste produced by health care establishment. Chemical and pharmaceutical residues, e.g. cans, bottle or boxes containing such residues and small quantities of outdated products. Non-recyclable and discarded pressurized containers, which are hazardous only if burned as they may explode. Many undamaged containers may be refilled. The containers for hazardous waste storage shall be colored

yellow and marked: **“DANGER! HAZARDOUS WASTES”** with biohazard symbol (Annex III).

c) Sharps

Sharps include whether infected or not, needles, syringes, scalpels, blades, glass, infusion sets, saws, knives, broken glass and items that can puncture human skin and cause infection. For the collection of sharps, metal container or high-density plastic containers resistant to penetration should be used. The containers should be labeled **“Danger! Contaminated Sharps”** with biohazard symbol (Annex III).

Highly hazardous health care waste, which should be given special attention, includes:

- Sharps, especially hypodermic needles.
- Highly infectious non-sharps waste including microbial cultures, carcasses of inoculated laboratory animals, highly infectious physiological fluids, pathological and anatomical waste.
- Stools from cholera patients or body fluids of patients with other highly infectious diseases.
- Bulk quantities
- Of outdated hazardous chemicals, such as strong disinfectants, or significant quantities of waste containing mercury.
- Genotoxic waste e.g. radioactive or cytotoxic waste typically used in cancer chemotherapy but not in district hospitals. If minimal waste management programmes are being applied, genotoxic substances should not be used in general hospitals, but may be used in the oncological departments of university hospitals (Pruss, et al. 1999).

2.4 Health care waste management scenario

Exposure to hazardous health-care waste can result in disease or injury. All individuals exposed to hazardous health-care waste are potentially at risk, including those within health-care establishments that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management (Pruss, et al. 1999).

2.4.1 Global scenario of health care waste management

Health care waste generation is usually high in high- income countries than in the middle and low-income countries. High-income countries can generate up to 6 Kg of hazardous waste per person per year. Where as the low income and middle income countries generate from 0.5 Kg to 3 Kg total health care wastes per person per year. Approximately 465000 tons of biohazardous waste is generated by United States each year by 377000 health care facilities. The average generation rate (Kg/bed/day) of total hospital waste is about 4.5 in USA, 2.7 in Netherlands and 2.5 in France (Rawal, 2004). The average hospital waste generation rate of Latin American countries like Chile, Brazil, Argentina, and Venezuela (1991) is about 1 to 4.5 Kg/bed/day. The percentage of hazardous waste

of Denmark is 5 and of USA are 28. Worldwide 8 to 16 million Hepatitis B, 2.3 to 4.7 million Hepatitis C, and 80,000 to 160,000 HIV infections are estimated to occur yearly from re-use of syringe needles without sterilization. In developing countries, additional hazards occur from scavenging on waste disposal sites and manual sorting of the waste recuperated at the back doors of health-care establishments. These practices are common in many regions of the world (Sapkota, et al., 2003).

Developing countries in the Asia house some of the most densely populated polluted cities in the world, yet many countries in this region do not have comprehensive systems for dealing with healthcare wastes. US-AEP (United States- Asia Environmental Partnership) a public- private initiative implemented by the U.S. Agency recognized the need for assistance in the development of healthcare waste management regulations, services, and practices in developing countries in Asia in 1995. Since then, US-AEP has been building capacity in these areas by contributing to the development of new regulations for healthcare waste treatment and disposal, and promoting the transfer of appropriate expertise and technology to public and private decision- makers. With the participation of a wide range of partners and a variety of programmatic tools, such as professional exchanges and trade leads, US-AEP has become a flexible, responsive vehicle for delivering timely answers to all kinds environmental questions (www.acoma.org/em/pdfs).

Table 2: Total health care waste generation by the region

Region	Daily Waste Generation (Kg/bed)
North America	7-10
Western Europe	3-6
Latin America	3
Eastern Asia	2.5-4
• High-income countries	1.8-2.2
• Middle-income countries	
Eastern Europe	1.4-2
Eastern Mediterranean	1.3-3

(Source: Pruss, et al.1999)

2.4.2 Standard operating procedures

Standard Operating procedures developed by The City of Gary, Engineering and Environmental Services Department streets Maintenance

To minimize the chance of injury from biologically contaminated materials (such as Hypodermic needles and syringes, etc), personnel are directed to observe the following practices while carrying out their responsibilities:

- Do not handle unknown materials by hand. Use waste scoops and brooms to pick up litter.
- Do not assume that known materials such as newspaper or bags do not contain hidden needles.
- When removing litter from tree grates, etc., use a broom or stick to dislodge litter. Do not do this by hand.
- Wear leather gloves while working.
- When removing garbage bags from receptacles or carrying bags of garbage, carry the load away from your body to prevent injury from unknown contents in the bag.
- Replace waste receptacle bags with clear plastic bags whenever possible

White wings must observe the following procedure to contain and dispose of infectious waste

1. Do not stray off designated routes.
2. Ensure leather gloves are worn.
3. Remove Sharps box and tweezers from buggy.
4. Open the lid of the Sharps box with a blade screwdriver or similar tool.
5. Pick up the infectious waste with the tweezers using EXTREME CAUTION.
6. Deposit both waste and tweezers in the Sharps box.
7. Close the sealed lid on the Sharps box.
8. Replace the Sharps box in the buggy.
9. Notify the Foreman of occurrence before the end of the shift.

When the sharps box is to be emptied, the foreman must

1. Deliver the Sharps box to any Fire Hall.
2. Identify yourself and request access to the "Bio-Hazard Bin" from the Rescue and Safety Officer or the Records Office Firefighter.
3. Dispose of the Sharps box and contents in the Bio-Hazard Bin.
4. Note the occurrence on the Daily Assignment Sheet.

In the event that a worker is injured by biologically contaminated materials

1. Immediately transport the injured person to the nearest Hospital Emergency Ward for treatment.

2. When possible, bring the syringe to the hospital for testing.
3. The Foreman must be notified as soon as possible, at least by the end of the shift, and must complete the appropriate accident reports.

The following safety equipment is required for this job

- Leather work gloves
- Hard hat
- Safety vest
- Safety boots
- Coveralls or long sleeve clothing

(Source: TAC - 1997 Standard Operating Practices - Handling of Biomedical Waste.htm)

2.4.3 National scenario of health care waste

Health care waste management is a major problem in Nepal. With the growing population and rapid urbanization the numbers of Health Care Institutes are also increasing and so the volume of generation of health care wastes (NHRC, 2002). In the year 1999 there were total 6521 hospital beds with a total of 799 tons of hazardous waste generation (taking 70% of occupancy ratio of bed) (Thapa, et al. 2004). In 2001 the number of health care institutes increased to 288 (9091 beds) with the generation of 5530 Kg health care wastes per day (MOH, 2003). Due to the use of disposable needles, syringes and other items waste disposal have become a difficult task. Many studies and surveys have already been conducted related to health care waste management in Nepal. Studies have shown that many institutions do not practice safe waste handling, storage, and disposal methods (NHRC, 2002).

Most of the private health care institutes are running in the residential buildings and they do not have facility for adequate waste management. Most of the Health care institutes have a problem of space. Because of inadequate space they are compelled to rely on municipality containers. Some health care institutes that have their own incinerator are burning their wastes openly. These in spite of decreasing the volume of waste are polluting the air spreading diseases. Burying untreated wastes in the landfill are contaminating underground water tables (ENPHO, 2002). ENPHO in association with the Kathmandu Metropolitan City is currently in the process of designing a centralized healthcare waste treatment system for the healthcare institutions in the Kathmandu City. Implementation of this waste management system would help to manage the haphazard disposal of hospital waste in the capital (ENPHO, 2001).

2.5 Plan, policies of government of Nepal for health care waste management

Most of the health care institutes depend upon the municipality service for the disposal of waste and in addition they use to burn and burry waste materials within the institutional premises. There is no proper mechanism for the treatment and disposal of healthcare waste. In Nepal, there are no special polices, legislation or guidelines related to waste from health care institutions. Policies and plan for safe management of health care waste should address these three elements (NHRC, 2002):

1. The establishments of a comprehensive system of health care waste management from generation of waste to its disposal to be implemented gradually
2. The training for the concerning staff
3. The selection of safe and environment friendly options for the management of health care waste.

2.5.1 Related policies and legislation for health care waste management in Nepal

In Nepal, very few government policies and acts are targeted to health care waste. Till 1996, it has been felt that there were no specific national policies on the waste as such. The main policies, legislation and regulations related Acts of HCIs waste in Nepal are reviewed in the section below.

Table: 3 Policies and Legislation developed for health care waste management in Nepal

Law	Section	Content of Section	Responsible Agencies
The Town Development Act, 1988	Clause 9	Control or prohibit any activity having adverse effect on public health or the aesthetic of town, or pollutes the environment	Town Development Committee
SWMRMC, 1992	SWMRMC Rule, 1989 Section 2, sub section 2.1.1 Section 3, sub section 3.1.1	Manage waste, mobilize resource and prevent public health from pollution and waste	Municipality
Municipality Act, 1992	Section 15, sub section 1	Responsible for public health, removal of hazardous substance and collection and disposal of municipal solid waste	Municipality
The Industrial Enterprises Act, 1992	Section 13	-Industrial license required if related with defense, public health and environment -Establish industrial promotion board for controlling environmental pollution -Industries reusing waste get concession to tax for 2 years	
Solid Waste Management Policy, 1996	Section3, subsection 3.1 / 3.1.1	Involve NGO sector in cleanup, recycling, reusing and managing waste in self sustaining way	
Environmental Protection Act, 1996	Sub section 7.1	Nobody shall create pollution in such a manner as to cause significant adverse impact on environment or likely to be hazardous to public life and people's health	MOPE
9 th Five Year Plan, 1997/2002		Develop policy for the participation of private organization in waste management, reuse waste and income generation from waste	
The Local Self-Governance Act, 1999		Responsibility of solid waste management and imposing fine for improper disposal	Local authorities
National Health Care Waste Management Guidelines 2002		Provide a minimum standard for safe and efficient waste management for HCIs in Nepal	

National Environmental Health Impact Guidelines 2004		To conduct environmental health impact assessment (EHIA) with integrating in existing EIA process of development projects	
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Source: Dons, 2002/2003

2.6 Waste minimization

As treatment and disposal of healthcare waste without causing harm to public health and environment is a difficult and often expensive task, minimizing the amount of waste, particularly hazardous waste, at the source is the most effective means of waste management. The following steps can be adopted to minimize waste generation in hospitals (Medical Waste Management Guidelines, 2004):

- Reduce the amount of hazardous waste to the extent possible by effectively separating hazardous and non-hazardous waste at source.
- Maximize recycling of non-hazardous waste. Organic waste can be composted and most inorganic waste can be sold to scrap dealers. Hazardous waste should not be recycled.
- Reusable items should be used to the extent possible. However, before reusing an item it should be properly sterilized.
- Minimize the consumption of hazardous substances

Waste minimization usually benefits the waste producer: costs reduce for the purchase of goods and for waste treatment and disposal. All health-service employees have a role to play in this process and should therefore be trained in waste minimization and the management of hazardous materials. This is particularly important for the staff of departments that generate large quantities of hazardous waste. Suppliers of chemicals and pharmaceuticals can also become responsible partners in waste minimization programme. The health service can encourage this by ordering only from suppliers who provide rapid delivery of small orders, who accept the return of unopened stock, and who offer off-site waste management facilities for hazardous wastes. Properly manage the procurement, storage and use of necessary supplies so as to minimize wastage.

2.6.1 Minimization and safe recycling of health-care waste

1. Chemical and Pharmaceuticals

Careful and comprehensive management of stores will substantially reduce the quantities of chemical and /or pharmaceutical waste produced by health-care establishments. Ideally, the waste in these categories should be limited to residues of chemical or pharmaceutical products in their original packaging (bottles, boxes, cans etc.). Waste minimization will also give rise to financial savings.

Proper management of chemical or pharmaceutical stores will be supervised by the Chief Pharmacist of the health-care establishment and should include the practices listed below:

- Frequent ordering of relatively small quantities rather than large amounts at one time; this applies particularly to unstable products.
- Use of oldest batch of a product before newer batches.

- Use of all the contents of each box or bottle.
- Prevention of product wastage, e.g. in wards and during cleaning procedures.
- Checking the expiry date of any product at the time of delivery.

2. Pressurized containers

Aerosol cans are not generally recyclable and may be disposed of to landfills together with general waste. Many undamaged pressurized gas containers, however, may be easily recycled, and should be returned to their original supplier for refilling. Pressurized containers must never be incinerated as they may explode, causing injury to workers and/or damage to equipment.

3. Mercury

Metallic mercury is a valuable product. In case of a spill, e.g. from a broken thermometer, all droplets of mercury should be recovered with a spoon for later sale or reuse.

4. Recyclable sharps

Hospitals with very limited resources should use recyclable sharps, such as glass syringes with needles, and scalpels. Only items that are designed for reuse i.e. that withstand the sterilization process should be recycled in this way. Before reuse, scalpels, syringes, needles, and other sharps must be thoroughly cleaned and sterilized; disinfection alone is inadequate. Any failure in the sterilization process may result in the transmission of severe infections. Sterilization may be by chemical means, by flame exposure, or by autoclaving. Smaller district hospital that lack autoclave facilities may consider sending items to the closest general hospital for sterilization.

2.7 Segregation

Careful segregation and separate collection of hospital waste may be somewhat onerous for hospital personnel but it is the key to safe, sound management of health-care waste. Segregation can substantially reduce the quantity of health care waste that requires specialized treatment. It will reduce costs and time to manage waste. It promotes recycling, protect environment, and ensure health and safety of all. Segregation practices may vary to certain extent at different HCIs however, there needs to be some standard practices.

Waste segregation is the practice of classifying waste and placing it into the appropriate waste container immediately after the waste is generated. Colored container should be labeled to facilitate the segregation. Waste segregation practices at different HCIs may vary depending upon the treatment system used and the policies and practices within the individual HCIs. Every HCI should segregate their waste at the source into three categories viz. sharps, hazardous, and general. If autoclave is being used to treat part of the waste, infectious waste should also be separated for autoclaving. In any area that produces hazardous waste- hospital wards, treatment room, operating theatres, laboratories etc.-three bins plus a separate sharps container will be needed.

It is highly recommended that all HCIs recycle their general waste into organic (food residue, garden waste etc) and non-organic waste (paper, glass, plastics etc). In such cases different color bins should be used to collect organic and inorganic waste (NHRC, 2002).

Sharps should be collected in yellow rigid, puncture proof metal container or disposable sharp collection paper box with a sign prominently displaying the biohazard symbol (Press et al., 1999). For this transparent plastic container that do not break upon impact, used jerry cans or mineral water bottles with tight lid can also be utilized. The only criterion that containers should meet is that they should be puncture proof and difficult to break or open. (ENPHO, 2002).

2.8 Collection

Waste should be collected at point of generation. There should be a fixed schedule for the collection of waste bags and containers from each healthcare department. This is to ensure the regular removal of waste from each location and to avoid misunderstanding between healthcare staff and cleaning staff. The minimum frequency of waste removal should be once a day. There should be separate schedules and separate collection times for general waste bags and hazardous waste bags/ sharp containers.

The size of the bucket will vary according to the amount of waste generation, however, should be at least 50% more than the average waste generation in that particular location. In nursing station, there should be a 50-liter capacity container made of tough plastic (bucket) for the collection of hazardous waste. The bag should be removed when it is not more three quarter full and sealed, preferably with self-locking plastic sealing tags and not by stapling.

The plastic bags used for collecting hazardous waste should have the following specification:

- Each bag should be labeled indicating date, point of production/ ward/ HCIs, quantity and description of waste and prominently displaying the label “**Danger! Hazardous Waste** with **biohazard symbol** (Annex III).
- The plastic bag should be bigger than the containers so that bags can be folded out on the rims of the containers.
- Minimum 20- micron thickness LDPE or 35- micron HDPE for 50-100 lit. capacity bags

Bags and containers removed are immediately replaced with new one of the same type and the container should be properly be cleaned before a new bag is fitted there in. (NHRC, 2002).

Whatever the final method of disposal, collection is an important aspect. The method of collection will depend upon the method of disposal. Collection can be done in wastebaskets, wheelbarrows or in trash carts. Timing of collection and removal should be convenient to all departments. It should be avoided during the normal hospital routine or while the patients are resting. Collection should be free from noise to avoid disturbing the patients. Trash removed in cans should be in covered containers to avoid an unsightly appearance (Sharkar, 1998).

2.9 Transportation

Health-care waste should be transported within the hospital or other facility by means of wheeled trolleys, containers or carts that are not used for any other purpose. The trolley should be easy to load and unload with no sharp edge to damage waste bags or containers and should be easy to clean. Waste bags should not be hand-carried around a health care facility since this increases the risk of injury. Wastes should be transported during low patient flow times and should be done in the way where patient and visitors don't walk very often. (NHRC, 2002).

2.10 Storage

A separate central storage facility should be provided for hazardous waste. The central storage facility shall be located within the health care institution premises close to the incinerator, if installed, but away from food storage or food preparation areas. Storage room should be cool and protected from direct sunlight. It should have good lighting system and should be well ventilated. This area should be large enough to contain all the hazardous waste produced by the health care institution. It should be easy to clean and disinfect, with an impermeable hard-standing base, plentiful water supply and drainage. This area should be totally enclosed and secure from unauthorized access like birds, animals, insects etc. These wastes should not be stored for more than 48 hrs in summer and 72 hrs in the winter. Containers with radioactive waste shall be stored in a specially marked area in a lead-shielded storage room. Containers with chemical waste should also be stored in a separate room or area.

2.11 Treatment and disposal

Depending on the types of waste, different types of methods can be used for health care waste treatment. These treatment methods include incineration, chemical disinfection, microwave, encapsulation, steam sterilization/Autoclave, hydroclave, thermal inactivation, sanitary landfill and inertization etc (NHRC, 2002 and Pruss, et al. 1999).

General waste can be categorized as organic and inorganic waste. Organic waste such as food residue and garden waste can be composted and inorganic waste such as paper, glass; plastics etc can be recycled within the HCIs premises or sent off site for the treatment purposes. Hazardous waste should either be incinerated, autoclaved or safely buried.

Syringes and needles should be rendered unusable by the use of a needle destroyer (*Pic.1*) or should be disinfected with a suitable disinfectant. The best option for treatment would be use of chlorine solution and destruction using needle destroyer. There is another way to dispose the used sharps as mentioned below:

- Collect sharps in puncture proof container
- Burn them in a tin putting little kerosene
- After burning, it remains in hard mass
- Dispose hard mass as other waste (NHRC, 2002).



Pic 1: Needle destroyer

2.11.1 Incineration

Incineration is the cost effective method for treatment of solid hospital waste. It is a method of treating waste by controlled combustion. Mainly three types of incinerators are being used

1. Single chamber incinerator has one chamber with a static grill where waste is burned by adding some fuel. Single chamber incinerator can be used for the treatment of different types of waste such as infectious, pathological, sharps, and radioactive. It requires relatively low investment and operation cost and no requirement for highly qualified operators. The burning efficiency may reach 90-95% i.e. 5-10% of the material may remain unburned in the ashes and slag so, periodic removal of slag and soot is necessary. The operating temperature will be around 300° c, which will kill most microorganisms but will be insufficient to destroy thermally resistant chemicals or pharmaceuticals. Due to generation of significant emissions containing atmospheric pollutants, including fuel gases and fly ash, production of odors and inefficiency in destruction of thermally resistant chemicals or pharmaceuticals single chambered incinerator is not recommended these days.
2. Double-chambered pyrolytic incinerator where waste is combusted to a residue of ashes at a temperature ranging between 800-900°C and the gases are burned in the post combustion chamber at 900-1200°C (Pruss, et al. 1999). Pyrolytic incinerator can be used for the treatment of infectious, pathological, sharps, pharmaceutical, and radioactive waste
3. Rotary Kiln with a rotating oven and post-combustion chamber with operating temperature of 1200-1600°C is most suitable for treatment of chemical, infectious and pathological waste.

2.11.2 Chemical disinfections

In chemical disinfections chemicals are added to kill or inactivate the pathogens it contains. This method is primarily used to treat liquid infectious waste such as blood, urine, stools or hospital sewage. However, solid and even hazardous health care wastes, including microbiological cultures, sharps etc., may also be disinfected chemically. Common chemicals used for disinfections are chlorine dioxide, methylated spirits, glutaraldehyde (Cidex), bleaching powder, sodium hypochlorite etc (Pruss et al., 1999).

Chemical sterilization of scalpels, syringes with needles and other recyclable sharps may be considered as an alternative or complementary method to thermal sterilization. After thorough cleaning and drying, the sharps are placed in a tank and exposed to a strong disinfecting gas or liquid, such as ethylene oxide, formaldehyde or glutaraldehyde. Chemical disinfection is highly efficient but it requires trained operators and necessities of safety measures.

2.11.3 Microwave

The most microorganisms are destroyed by the action of microwaves with frequency of about 2450 MHz and a wavelength of 12.24 cm. In this process the water containing

waste is rapidly heated by microwaves and the infectious components are destroyed by heat conduction (Pruss et al., 1999).

2.11.4 Encapsulation

Encapsulation is recommended as the easiest technology for the safe disposal of sharps. Sharps are collected in puncture-proof and leak-proof containers, such as high-density polyethylene boxes, metallic drums, or barrels. When a container is three-quarters full, a material such as cement mortar, bituminous sand, plastic foam, or clay is poured in until the container is completely filled. After this material has dried, the container is sealed and may be land filled, stored, or buried inside the hospital premises (*Pic.2*). It is also possible to encapsulate chemical or pharmaceutical residues together with sharps (Pruss, et al.1999).



Pic

2 : Encapsulation of sharps

2.11.5 Steam sterilization/Autoclave

Autoclave is a low heat thermal process, which is designed to bring steam into direct contact with the waste to disinfect the waste. Proper temperature, pressure and holding time (121° C at 15 lbs for 30-60 minutes) correlation are matched, in order to achieve desired level of sterilization (Pruss, et al.1999).

2.11.6 Hydroclave

It applies steam (which is stored in a double wall/jacket) as an indirect heat source, allowing total dehydration of the waste at 132 °C and 36 psi and also the waste is internally agitated and fragmented to attain a high sterilization level of all components and particles-sharp, PVC pathological waste, etc (WHO, 1998).

2.11.7 Thermal inactivation

It is used primarily to treat cultures and stocks, pathological waste, and fluid animals waste. Generally used for liquid medical/infectious waste, thermal inactivation is a treatment method that uses heat to reduce infectious agents in waste. (NHRC, 2002).

2.11.8 Sanitary landfill

Sanitary landfill are designed and constructed to prevent the contamination of soil surface and ground water and to limit air pollution, smells and direct contact with public. PSM City has also constructed a sanitary landfill site, which was not operated yet (*Pic. 3*). Some essential features of sanitary landfill are:



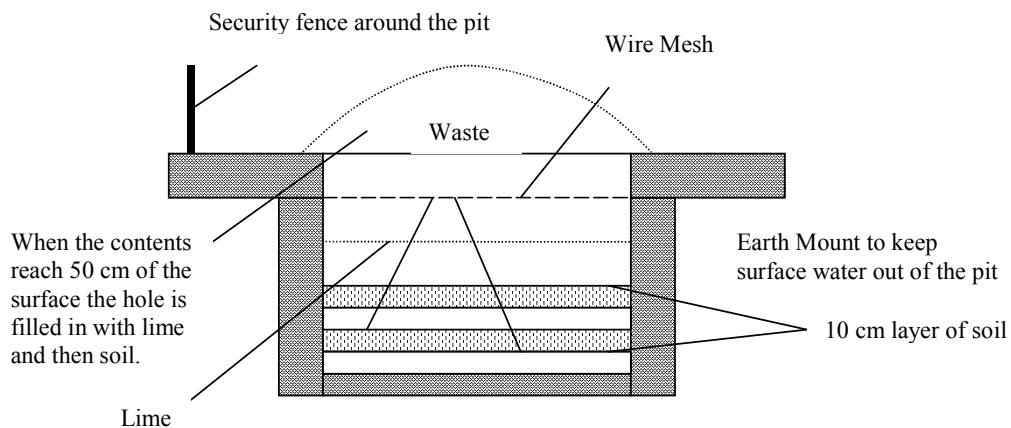
Pic 3: Sanitary landfill of PSM City

- Asses to the site and working areas for waste delivery. Presence of personnel on sites to effectively control the daily operation.
- Adequate sealing and lining of base and sides of the site to minimize the movement of wastewater. Site should be 50 meter away from water sources.

- Adequate methods of leachate collection and treatment.
- Organized depositing of wastes in a small area, spreading, compaction and covering daily with soil.
- Protect with wire bar/fence to prevent unauthorized persons, animals, and birds (NHRC, 2002).

2.11.9 Safe burial pit

In the absence of a special treatment facility, burial of healthcare waste in a pit within the hospital premises or landfill can be regarded as an acceptable measure to reduce environmental and public health risks. It is easy, safe and cost effective method. The pit can be 2 m deep and filled to a depth of 1 m. each load of waste should be covered with soil layer 10-15 cm deep (lime may be placed over the waste if coverage with a soil is not possible). In case of disease outbreak involving especially virulent pathogens (such as the Ebola virus), both lime and soil cover may be added. Access to this area should be restricted and closely supervised by the responsible staff to prevent scavenging. An example of pit is shown in sketch below: (Pruss et al., 1999).



Pic 4: Burial Pit for health care waste

2.11.10 Inertisation

This is the mixture of waste with cement and other substances before disposal in order to minimize the risk of toxic substances migrating into surface water or ground water and to prevent scavenging. Inertization can be used for the treatment of pharmaceutical, cytotoxic, chemical and radioactive waste. It is also suitable for incineration ash with high metal content (NHRC, 2002).

2.12 Alternative methods

2.12.1 Superheated steam sterilization

This system consists of a heated shredder and sterilization unit. In the shredder, organic liquids are vaporized and solids reduced to gas by superheated steam at temperature

between 500⁰C and 700⁰C. The sterilization unit also employs steam at high temperatures and increased atmospheric pressure, thus further reducing the overall weight of waste. The temperatures used (up to 1500⁰C) exceed ordinary steam sterilization. Healthcare equipment is melted into a sterile mass in less than an hour. The remaining reduces are cooled and dropped into a collection bin or ground in a heated shredder. The process employs a continuous batch system and has been shown to reduce healthcare waste by 50% to 80% of its original volume. It is claimed that this technology can handle all waste including chlorinated plastic products and low-level radioactive waste (Dave, 1999).

2.12.2 Wet oxidation technology

This process resembles that of a washing machine. Weighed plastic drums filled with healthcare waste are placed on top of a shredder. The shredded waste drops into a spinning basket in an oxidation chamber. Once full, the chamber is closed and a water-based solution containing 10% sulphuric acid, an iron ion catalyst and a co-catalyst are introduced. Sulphuric acid maintains an acidic PH while mechanical agitation ensures that the entire waste mass is saturated with the solution. The solution is pumped out into a rear holding trench while water is sprayed into a spinning basket to rinse any remaining solution out of the waste. Finally, the remaining waste is doused with a finishing rinse of deionized water. The process claims to oxidize most organic materials at a relatively rapid rate of about 225 Kg per hour. Waste treated by this method can be land filled or recycled (Dave, 1999).

2.12.3 Electron beam gun technology

In this process, medical waste is exposed to an ionized electron beam inducing chemical and biological changes in the waste material. Decontamination occurs when nucleic acids in living cells are irradiated. The equipment emits sufficient radiation to destroy microorganisms and change the molecular structure of materials. However, the technology produces radioactive fields that require costly shielding. Additionally, ozone is produced, but this can be destroyed using a catalyst. The volume of waste is reduced by about 20% and the disinfected remains are shredded and land filled (Dave, 1999).

2.13 Wastewater treatment through Constructed wetland

Constructed wetland is a wastewater treatment technology, which is simple, locally manageable, cost effective and with excellent performance in removal of pollutants. It has settlement tank, horizontal and vertical reed bed which help to clean the wastewater passing through it. Now, there are 11 sub-surface flow constructed wetland systems in operation for treatment of greywater, wastewater and fecal sludge at household to institutional scale. In addition, a large-scale CW system for treatment of 75 m³ of fecal sludge and 40 m³ of leachate has recently been completed for Pokhara Sub-metropolitan City. Many institutions and hospitals are now taking keen interest to install CW at their premises and several are in designing stage. Two hospitals Sushma Koirala Memorial Hospital, Sankhu and Dhulikhel Hospital had installed constructed wetland for treatment of wastewater from hospital, staff quarters and canteen.

Dhulikhel Hospital had 30 beds and the constructed wetland was designed to treat 10 to 15 m³ of wastewater per day. Later the bed was increased to 80 and the flow of wastewater increased to 40 m³/day. In both cases, pollutant removal rate of the

constructed wetland is almost the same and the final treated wastewater consist of BOD 14 mg/L when inlet concentration was above 300 mg/L. Normally BOD level should be less than 20 mg/L in treated effluent for discharge of wastewater into the inland surface water as per European standard.

On the basis of past six-year experience on CW, ENPHO found high pollutant removal efficiency as more than 95 percent of major pollutants such as suspended solids, organic pollutants and ammonia-nitrogen. Similarly, removal of E. coli is also achieved by 99 %. The treated wastewater can be reused for toilet flushing, irrigation and cleaning vehicles. Similarly the construction of fecal sludge and leachate treatment system through CW at Pokhara Sub-Metropolitan City would probably be the largest constructed wetland system for treatment in Asia (http://www.enpho.org/waste_water_treatment.htm).

2.14 Disposal

Disposal means intentional burial, deposit, discharge, dumping, placing or release of any waste material into or on air, land or water (NHRC, 2002). Ash and residues from the incinerator and other methods shall be placed in robust, noncombustible containers and sent to the local authority's designated landfill site (for detail of landfill site see sec.2.11.8) (Pruss, et al.1999). Radioactive liquid waste should be diluted and released in very small amounts over considerable length of time into the existing sewage system. (Dave, 1999).

Land filling in municipal disposal sites

Waste may be land filled in municipal disposal sites (*Pic. 3*) if it cannot be treated before disposal. However, health-care waste should not be deposited or scattered on the surface of open dumps. If land filling is planned, the following minimal requirements should be met:

- measures established by a municipal authority for the rational and organized deposit of municipal wastes that could be used to dispose of health-care wastes;
- if possible, engineering work instigated by the municipal authority to prepare the disposal site to retain wastes more effectively;
- rapid burial of the health-care waste, so that human or animal contact is as limited as possible.

In addition, it is recommended that health-care waste be deposited in one of the following two ways:

- in a shallow hollow excavated in the mature municipal waste, in the layer below the base of the working face, where it is immediately covered by a 2-m layer of fresh municipal waste; scavenging in this part of the site must be prevented.
- in a deeper pit (1-2m) excavated in mature municipal waste (at least 3 months since being land filled), which is then backfilled with the mature waste that was dug out; again, scavenging in this part of the site must be prevented.

Alternatively, a specially constructed small burial pit could be prepared to receive health-care waste only (see section 2.11.9). (Pruss et al 1999)

Table4: Overview of disposal and treatment methods suitable for different categories of health care waste

Technology or method	Infectious waste	Anatomic waste	Sharps	Pharmaceutical waste	Cytotoxic waste	Chemical waste	Radioactive waste
Rotary Kiln	Yes	Yes	Yes	Yes	Yes	Yes	Low level infectious waste
Pyrolytic Incinerator	Yes	Yes	Yes	Small quantities	No	Small quantities	Low level infectious waste
Chemical disinfection	Yes	No	Yes	No	No	No	No
Wet thermal treatment	Yes	No	Yes	No	No	No	No
Microwave irradiation	Yes	No	Yes	No	No	No	No
Encapsulation	No	No	Yes	Yes	Small quantities	Small quantities	No
Safe burial on hospital premises	Yes	Yes	Yes	Small quantities	No	Small quantities	No
Sanitary landfill	Yes	No	No	Small quantities	No	No	No
Discharge to sewer	No	No	No	Small quantities	No	No	Low-level liquid waste
Inertization	No	No	No	Yes	Yes	No	No
Other methods				Return expired drugs to supplier	Return expired drugs to supplier	Return unused chemicals to supplier	Decay by storage

Source: NHRC, 2002.

2.15 Health impact from hazardous waste

All the individuals exposed to hazardous health care waste are potentially at risk, including those within health care establishments that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a

consequence of careless management. Exposure to hazardous health care waste can result in disease or injury. The hazardous nature of health care waste may be due to one or more of the following characteristics:

- It contains infectious agents
- It is genotoxic (affect genetical material)
- It contains toxic or hazardous chemicals or pharmaceuticals
- It is radioactive
- It contains sharps

Infectious waste may contain any of a great variety of pathogenic microorganisms. Pathogens in infectious waste may enter the human body by a number of routes:

- through a puncture, abrasion, or cut in the skin
- through the mucous membranes
- by inhalation
- by ingestion

There is particular concern about infection with human immunodeficiency virus (HIV) and hepatitis B and C, for which there is strong evidence of transmission via health care waste. These viruses are generally transmitted through injuries from syringe needle contaminated by human blood. Concentrated cultures of pathogens and contaminated sharps (particularly hypodermic needles) are probably the waste items that represent the most acute hazards to health. Sharps may not only cause cuts and puncture but also infect these wounds if they are contaminated with pathogens. Because of this double risk of injury and disease transmission sharps are considered as a very hazardous waste class. There is a great diversity of hazardous waste and their adverse effect on human health and environment (Pruss et al., 1999)

Chapter - III

3 Present Situation Analysis and bottlenecks of healthcare waste management in HCIs of PSM

This part of the report focuses on our objective to know the present scenario of healthcare waste disposal system followed by different HCIs in PSM. The present situation analysis was done by the analysis of field visit data from survey and observations.

In different HCIs various kinds of services are provided through different departments. Details of service provided by the five HCIs are given in Annex. IV A. Most of the HCIs considered Maternity Department and Surgical Department as maximum waste generating department.

3.1 Waste generation and estimation

The total waste generated, total hazardous, non-hazardous and sharps were calculated using spring balance (*Pic. 6*) during the second field visit to the selected HCIs of PSM.



Pic 6: Measuring segregated waste

Accordingly the waste generated by the patient in Kg / day was calculated using the formula

$$\text{Total waste generated (Patient / kg/ day)} = \frac{\text{Total waste generated by HCI (kg)}}{\text{Bed Occupancy rate} * \text{Total beds} * (1/100)}$$

$$\text{Bed Occupancy rate (BOR)} = \text{Bed Occupied} / \text{Total Number of Beds}$$

Total waste generated by the HCIs and the waste generated per patient (Kg)/ day is given by the following table with overall average waste generation as well

Table 5: Waste generated by different HCIs of PSM

Name of HCIs	Total Beds	Bed Occupancy Rate	In kg/day				Waste Generated (Kg/ patient / day)
			Hazardous	Non-hazardous	Sharps	Total Waste	
Manipal Hospital	550	25.09	9.00	81.50	2.00	92.50	0.67
Gandaki Hospital	350	66.57	8.75	61.75	1.17	71.67	0.31
Green Pasture	80	100	4.25	18.50	0.01	22.76	0.28
Abhiyan	25	44	1.00	1.75	0.08	2.83	0.26
Total	1005	236	23.00	163.50	3.26	189.76	1.52
Average	251.25	58.92	5.75	40.88	0.82	47.44	0.38

The total health care waste generated in HCIs of PSM was found to be 189.78 kg/day and the total waste generation per patient was 1.52 Kg/day. In an average, 0.38 kg of waste is generated per patient per HCIs. Maximum waste generation per patient is in Manipal Hospital while the minimum waste is generated by Abhiyan community hospital. Western Regional Hospital Kaski has two times lesser waste generation than that of the Manipal Hospital.

In an average, non hazardous wastes are nearly 8 times and 40 times more than that of hazardous waste and sharps respectively. Thus, each of the HCI generates sharps and hazardous waste in small quantity than general or non-hazardous wastes.

According to the categories of waste the following waste composition chart was drawn.

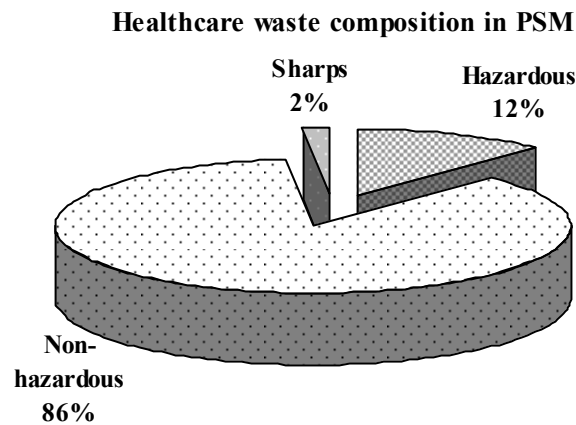


Fig 1: Healthcare waste composition in HCIs of PSM

Based on measurement and above figure, the composition of health care waste in PSM was found to be 2% sharps, 12% hazardous, and 86% non-hazardous waste. If there is proper management of the general waste, then 86% of the total waste is managed effectively. Thus as per this study, only 14% of the healthcare waste needs special treatment and care.

Waste segregation

Waste segregation is very essential so as to have effective waste management. As per our study, only Abhiyan and Green Pasture hospital were following effective waste segregation system while there was no such system found in other HCIs. Only 80% of the HCIs had followed waste segregation, this is shown by the following figure.

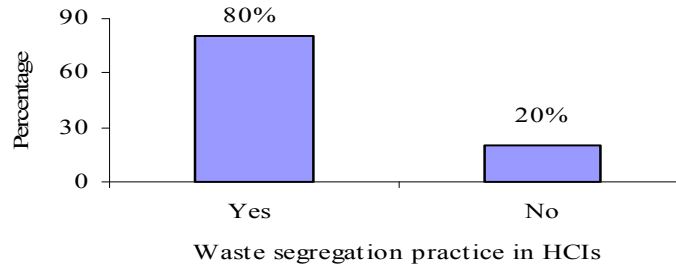


Fig 2: Practice of waste segregation within HCIs

Segregation was done by color coding and labeling in the HCIs. In general, following pattern of color-coding (*Table 6*) was practiced for segregating different types of waste.

Table 6: Color of waste containers for different types of waste

Type of waste	Color of waste container
Hazardous	Red
Non-hazardous	Green
Sharps	Yellow



Pic 7:

General type of color-coding in Abhiyan

hospital

Pic 8. Collection containers for sharps and ampoules in Om hospital

But, Om hospital was using orange container for organic waste, blue for hazardous waste and uncolored tin for collecting sharps and ampoules separately (Pic. 8).

Bottlenecks

Waste segregation system at point of generation was found very poor in most of the HCIs of PSM. Improper waste segregation system has caused mixing of general and hazardous waste, making all the waste hazardous (Pic. 9).

Different HCIs were found using different type of color-coding for segregation system, which may cause confusion to the patients and visitors. In the picture (Pic.10) yellow container was used for sharps, red for paper, water bottles, saline water bottles, cotton, bandages and green were for organic waste. In this waste segregation system, infectious waste (cotton, bandages) was mixed with inorganic waste (paper, bottles) resulting the whole waste infectious. Since paper and bottles could be recycled it would be better if it were not mixed with the hazardous wastes. This will help in the minimization of hazardous wastes.

In some HCIs sharps were also mixed with the general and other wastes, which may cause injury to waste handler/ those who burn them. Sharps not only cause cuts and punctures but also cause infection if they were contaminated with patient's blood, puss etc.



Pic 9: Mixed wastes brought for treatment at incinerator



Pic 10: Mostly used color-coding system

Waste collection system

We found all HCIs used plastic buckets for collection of all types of waste. 60% of HCIs were found using plastic lining in the collection container (Fig. 3).

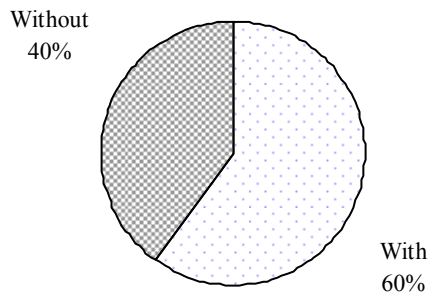


Figure 3: Waste collection containers with and without plastic lining

For collection of syringe and blades leak proof and puncture proof metal container were being used by all HCIs. Abhiyan hospital was using both metal and disposable paper box container (with WHO standard provided by District health office for measles camp) for syringe collection (Pic.11). Waste was collected at least once daily, but more often if necessary.



Pic 11: Disposable sharp container



Pic 12: Covered waste collection container

In almost all HCIs the waste collection containers kept within ward were found uncovered. Only those outside ward were covered. Fig. 4 shows 20% of HCIs used to cover containers within the wards and 80% of HCIs used to cover outside the ward. At Abhiyan Community hospital collection containers within ward was found covered (Pic. 12)

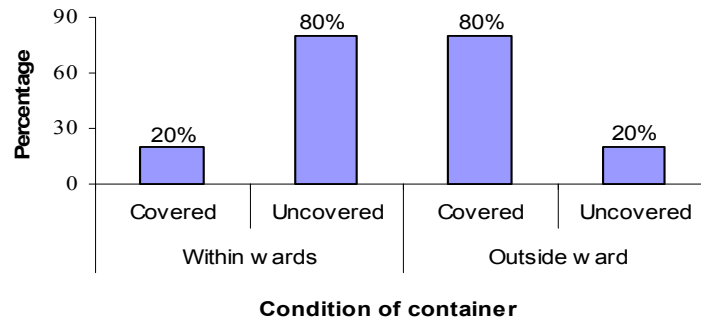


Fig 4: Condition of container (covered / uncovered)

Bottlenecks

At some HCIs waste was mixed during collection though it was segregated properly. Usually the negligence of waste handlers during collection was the reason behind the mixing of waste. This caused problem while burning the waste.

At some HCIs the collection containers were uncovered and lacked plastic lining, which can lead to spread of diseases (*Pic. 13(a)*). Lack of plastic lining can cause problem during waste storage and transportation as well. The HCIs having covered collection containers had bucket with cover. This can be tedious, as the cover has to be opened with hand, which can cause infection. Sharp collection container was without biohazard symbol.

Number of collection containers was less in comparison to the number of bed. At some HCI only one container was kept for the entire ward. That was also the reason of poor segregation of waste.



Pic 13(a): Collection container without cover and plastic lining

3.4 Waste Transportation

None of the HCIs were found using vehicle for waste transport from the point of generation to the treatment/disposal area. Manual transportation of waste (*Pic 14*) was found in most of the HCIs. Only Manipal teaching hospital was using tractor to transfer ash (from Incinerator) and organic waste from incinerator site to ETP Plant.



Pic 14: Manual transportation of waste

Bottlenecks

Waste transportation was done manually at most HCIs, due to the unavailability of proper means of transportation. Manipal had its own tractor for the transportation of waste (residues from the incinerator and organic waste) to the area of disposal, but the waste was found unsealed during transportation (*Pic. 15*). That may cause splitting/scattering of waste. At some HCIs waste container was found to be uncovered during manual transportation.



Pic 15:

Uncovered waste transported by tractor

Due to the uncovered transportation container there may be high risk of infection to the waste handlers. Uncovered waste may be the source of disease causing pathogens, which has unpleasant odor and unaesthetic value.

3.5 Waste storage

HCIs were unaware of designing storage system. Among the surveyed HCIs, Manipal hospital had the provision of short time storage. There was separate lockable room in each ward where the waste was stored in two large containers. In Green pasture, waste was stored in plastic bag within the protected area where the incinerator was installed. Gandaki Regional hospital stores waste openly near the incinerator (*Pic 16*).



Pic 16: Open waste storage near the incinerator

Bottlenecks

Most of the HCIs of PSM lacked proper and effective waste storage system. In Gandaki zonal hospital wastes were stored openly near the incinerator allowing birds and other scavenger to visit the area. This can lead to the air pollution and contamination and transmission of diseases. Also the leachate from the waste can cause ground water pollution and threat to human health.

The waste storage time was not fixed; at some HCI it was found to be stored for more than 2 days. If the quantity of waste was low they stored it at certain place. Storing of waste for longer period can lead to the spread of disease as well as production of offensive smell (*Pic. 16*). Sharps in the open waste stream may injure waste handles and visiting scavengers.

In Western Regional Hospital Kaski there were two separate metal containers to collect sharps (*Pic. 17*) with funnel like feeding section. It was stored openly for a long period, which could cause high risk of injury as sharps may cause cuts, puncture and infection. In Manipal teaching hospital sharp and bottles (that came from sharp collection container) were found to be stored in a separate cemented chamber before disposal (*Pic 18*). Their effort was good, but the chamber without provision of cover was the drawback. Open storing provides access to all (especially dogs or other rag pickers). The mismanaged collection of sharps in the chamber can cause injuries to waste handlers while gathering it for disposal.



Pic 17: Syringe collection for disposal



Pic 18: Syringe collection chamber

3.6 Waste treatment system

HCIs were adopting both chemical and thermal methods for the waste treatment. Different treatment system was there for different categories of waste (*Table 7*). In Manipal and Abhiyan hospital organic waste was buried. At Western Regional Hospital Kaski it was burnt and at Green Pasture hospital it was used in the pig farm. All HCIs used to burn sharps in incinerator. Only Manipal had needle destroyer. From X-rays two types of waste comes out developer and fixer and both considered as radioactive waste. All HCIs sold fixer and developer was burnt or buried with in the disposal area of HCIs. Anatomical waste were burnt at some HCIs and buried at some HCIs. Generally HCIs used to return expired pharmaceuticals to the company, but Green Pasture hospital use to burn since there was very less chance of remaining expired drugs. Ashes from incinerator

were buried near ETP plant at Manipal, buried at Green Pasture and Abhiyan hospital. It was dumped openly at Western Regional Hospital Kaski.

Manipal hospital had needle destroyers and used to burn needle, but satisfactory utilization of the equipment was not seen. Due to lack of waste segregation system in HCIs, sharps were mixed with other waste and burnt together in incinerator.

Table 7: Management of different types of waste in different HCIs

HCIs	Management of waste in different HCIs							Disposal of Ash
	General		Sharp	Radioactive		Anatomical	Pharmaceuticals	
	Organic	Inorganic		Developer	Fixer			
Manipal Hospital	Buried near ETP plant	Burnt	Burnt	Burnt	Sold	Burnt	Returned	Buried near ETP plant
Western Regional Hospital Kaski	Burnt	Burnt	Burnt	Buried	Sold	Buried	Returned	Dumped openly
Green Pasture Hospital	Fed to pigs	Burnt	Burnt	Buried	Sold	Burnt	Burnt	Buried
Abhiyan Hospital	Buried	Burnt	Burnt	Burnt	Sold	Burnt	Returned	Buried

3.6.1 Chemical treatment

Table 8 shows the list of chemicals being used for disinfection of instruments, waste containers and floor

Table 8: Chemicals used for treatment by different HCIs

Manipal Hospital	Western Regional Hospital Kaski	Green Pasture	Abhiyan Hospital	Ohm Hospital
Sodium hypo chloride, Bleaching powder, Phenol	Virex, Phenol	Virkon	Virex, Sirex	Virex, Formalyene

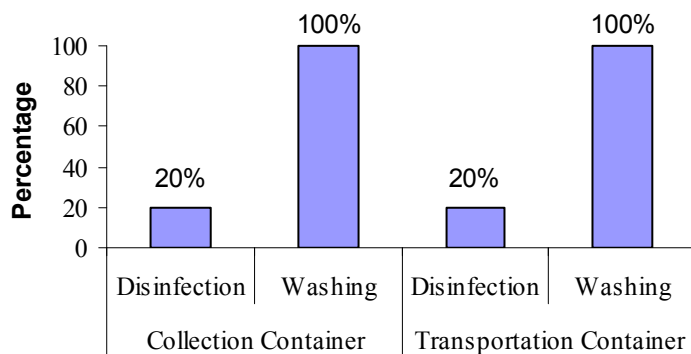


Fig 5: Disinfection of the collection and transportation containers

b) Chemical treatment of floor

HCI should clean their floor with mixture of water and disinfecting chemicals twice daily. Cleaning of floor varied from 1-3 times a day. List of chemicals and cleaning frequency of floor per day was given in table 9.

Table 9: Frequency of cleaning and disinfecting floor in HCIs of PSM

Name of HCIs	Name of chemical	Frequency/day		
		1	2	3
Manipal Hospital	Phenol and soap			√
Western Regional Hospital	Phenol			√
Kaski Hospital	Phenol		√	
Green Pasture Hospital	Phenol	√		
Abhiyan Community Hospital	Virex		√	
Om Hospital	Detergent		√	

Note: √ denotes Yes

Most of the HCIs were found cleaning the floor twice /day. Phenol was the popular disinfectant among HCIs. In Abhiyan hospital Virex was in use for cleaning the floor

Bottlenecks

The hazardous waste was not sterilized before buried, disposed or incinerated. Waste from the maternity ward was deposited in the suction pit directly without application of disinfectants chemicals. This could cause adverse health effect to the waste handlers. Cleaning (disinfection) of waste collection container was found once in a week or month if leakage was observed. After unloading, the tractor was also just washed with plain water (no chemical treatment).

Highly qualified technicians are required for operation of chemical disinfection and that was lacking in most of the HCIs. Use of chemical less or more than required level would not help in disinfection. Haphazard concentration of chemicals may cause adverse effect to handler as well disinfected materials (instruments, containers etc). Safety measures adopting during the process was also lacking. Injuries to the skin mucous membranes of the airways could be caused by contact with flammable, corrosive or reactive chemicals (e.g. formaldehyde and other volatile substances). The most common injury is burns.

Haphazard use of chemicals could increase the chance of health as well as environmental hazard.

Developers generated from the radiology department were buried/burn at most HCIs. Before buried they were found to be stored in the area of generation till the collection container was full. Hazards of such waste may arise from contamination of external surfaces of containers or improper mode or duration of waste storage. Health care workers or waste handling or cleaning personnel exposed to this radioactivity are at risk. Radioactive wastes might cause diseases ranging from headache, dizziness and vomiting and much more serious problems.

3.6.2 Thermal treatment

The thermal method used by HCIs in treatment of different types of waste was shown in table 10.

Table 10: Thermal technology used for treatment at different HCIs

Manipal Hospital	Western Hospital Kaski	Regional	Green Pasture	Abhiyan Hospital	Ohm Hospital
Autoclave, Incinerator, Microwave	Incinerator, Sterilizer, Autoclave, Liquid Sterilizer		Autoclave, Incinerator	Autoclave, Incinerator	Autoclave, Incinerators

Incinerator, Autoclave, Liquid Sterilizer, Sterilizer, Microwave etc were used as Thermal Treatment Technology in different HCIs. Incinerator was used for burning waste and Autoclave, Microwave, Sterilizer, Liquid Sterilizer, etc were used for the treatment of infected reusable instruments. Most of the HCIs had its own CSSD (Central Sterilization Supply Department) to sterilize these instruments for reuse. Table 11 shows different types of incinerator, its capacity and burning frequency of waste.

Table 11: Types of Incinerator, its capacity and burning frequency of waste

HCIs	Type of Incinerator			Capacity of Incinerator (kg/ hr)	Burning frequency per	
	Double Chamber	Single Chamber	Drum Incinerator		Day	Week
Manipal Teaching Hospital		√		NA	1	
Gandaki Regional Hospital		√ (3)		15, 15 and 25	1	
Green Pasture Hospital		√		25		1
Abhiyan Community Hospital			√	NA	1	
Ohm Hospital	√			NA*		

* Incinerator is under construction, NA: Not available, √: Yes

Most of the HCIs were treating their waste in single chambered incinerator. In Western Regional Hospital Kaski there was 3 single chambered incinerators of capacity 15, 15

(Pic 19) and 25 kg/hour respectively. But only one incinerator of capacity 25 kg/hour was in operation. (Pic 23) Abhiyan hospital had used Drum incinerator, which had double stepped processing. First step was for drying the waste by sunlight and another for burning the waste. Double chambered incinerator with three feeding section was under construction in Om hospital (Pic. 21)

In Manipal hospital was operating locally made single chambered incinerator these days (Pic. 21), but they had imported sophisticated German made incinerator of brand Thermax. Fore coming incinerator of Manipal was remaining to observe.



Pic 19: Single chamber incinerator of Western Regional Hospital Kaski



Pic 20: Incinerator of Om hospital



Pic 21: Single chambered incinerator at Manipal

To operate incinerator fuel is required; different types of fuel source using by HCIs was shown in table 12.

Table 12: Types of fuel used by HCIs to operate Incinerator

HCIs	Fuel used	Others
Manipal Teaching Hospital	Petrol	Cardboard
Gandaki Regional Hospital	Wood	None
Green Pasture Hospital	Wood	None
Abhiyan Community Hospital	Kerosene	Cardboard, paper

Kerosene, petrol and wood were mostly used fuel source to operate incinerator. Addition of small quantity of kerosene /petrol was using to start the fire in Manipal and Abhiyan hospital. Cardboard and papers was also used to establish optimal combustion.

Table 13 showing required cost to install and operate incinerator as well as to manage the waste. According to study, cost for waste management includes salary of waste handlers, purchasing cost of soaps / chemicals and wastewater treatment.

Table 13: Investment of HCIs for installment /operation of incinerator and waste management

HCIs	Finance		
	Incinerator installment (Rs.)	Incinerator operation cost (Rs./ month)	Waste management (Rs./month)
Manipal Hospital	40 lakhs*	18,00	3 lakhs
Western Regional Hospital Kaski	3.5 lakhs**		35,00
Green Pasture Hospital	By INF	18,00	25,060
Abhiyan Hospital	9,000		
Om Hospital	42,000		

* Including building ** INF 50% and Hospital 50%

Installment cost of incinerator at different HCIs varied according to its type. It varied from Rs. 9000 to. 40 Lakhs. INF has donated Incinerator to Green Pasture and Western Regional Hospital Kaski. Manipal hospital is in the process of installing German made incinerator (Thermax) in near future. Manipal hospital used to invest about 3 lakhs on waste management including operation cost of ETP plant and generator (boring).

Bottlenecks

HCIs of PSM were found more confused in selection of incinerator. It might be due to lack of proper guidance and awareness. They were operating incinerator of their choice just to burn health care waste. They were not concerned about environment pollution generated through unscientific incinerator. Single chamber as well as drum incinerator (Pic. 22) with very low chimney height were being used at most of the HCIs

The wall of incinerator was also not of required thickness and no provision to close the waste feeding section of incinerator as the incinerators were locally made. It created loss of heat, so required temperature could not be reached inside the incinerator (reduce burning efficiency) that led to incomplete burning. The atmospheric emission released from these incinerators included acid gases such as sulfur dioxide, hydrogen chloride and hydrogen fluoride, black smoke, fly ash (particulates), carbon monoxide, nitrogen oxide, heavy metals and volatile organic chemicals that cause air pollution and badly affect human health.



Pic 22: Drum incinerator in use



Pic 23: Over loaded incinerator

Since there was no segregation system all waste used to burn together, load of waste was beyond the capacity of incinerator (*Pic 23*). Residue of incinerator was also the problem for disposal as it contains unburned waste. Single chambered/drum incinerator was not recommended these days since it creates severe environment pollution.

At some HCI incinerator was built near the residential area due to the location of HCIs. This could cause harm to the health of people and environment around. At Abhiyan hospital, drum incinerator was installed in between the ward and administrative building. There is no need to count the adverse effect creating by that, as it is clear from above explanation.

3.6.3 Wastewater treatment system

Wastewater generated from HCIs also requires proper treatment system but none of the HCIs was practicing this. At Manipal teaching hospital, wastewater (excluding the water from sewage) was treated at ETP plant. Rest of the HCIs was disposing wastewater in safety tank or in municipality sewerage without treatment.

Effluent treatment plant (ETP) (*Pic. 24*) was used to treat wastewater from the hospital, hostel and staff quarter in Manipal Hospital. The raw sewerage was collected and

screened, which will remove the big materials like plastic bags, log etc if any present. Then the wastewater was made free from oil and grease and was transferred to equalization tank and then to sedimentation tank. The sludge collected were extracted as wet cakes and disposed off. The remaining water was again recycled to the equalization basin. The wastewater from sedimentation tank was send to the saff reactor and then to clarification tank. Then the wastewater was disinfected and again filtered using dual media filter and activated carbon filter. Finally the treated water was disposed in the Seti River.



Pic 24: Effluent treatment plant at Manipal Hospital

Bottlenecks

Except Manipal hospital none of the HCIs were found treating the wastewater (including body fluids and water from lab and radiology department). Untreated wastewater was found to be disposed at either river or sewerage or septic tank. This can pollute surface as well as ground water if released without treatment. Water containing chemical residues if discharged into the sewerage system may have adverse effects on the operation of biological sewage treatment plants or toxic effects on the natural ecosystems of receiving waters.

The main health hazards resulting from pollution of surface water are:

- Communicable diseases such as parasite infections, hepatitis, summer diarrhoea and typhoid.
- Non-communicable disease such as heavy metal toxicity.

The principal health hazard of ground water pollution are communicable diseases such as typhoid, diarrhoea and parasite infection; and non-communicable diseases which may arise from the high levels of nitrates or phosphate or pesticides in the ground water.

3.7 Waste disposal system

HCIs were adopting different methods to dispose health care waste. The following figure 6 gives the information about waste disposal methods in different HCIs

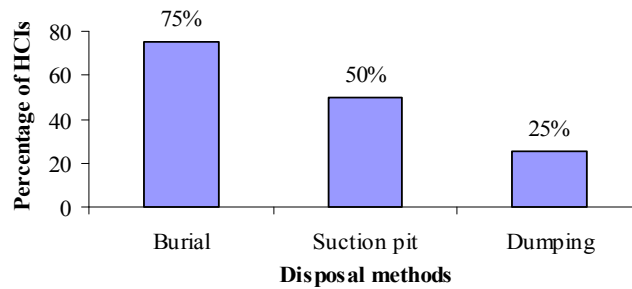


Fig 6: Waste disposal method adopted by different HCIs

Waste disposal within HCIs was not effective, as it was simply buried or openly dumped. Some HCIs were found burying the residues from the incinerator within their HCI. Some were found to be dumping it near the incinerator. Use of suction pit was also found in HCIs of PSM. Suction pit was locally made pit simply by digging the earth. It was quite similar to the burial pit and used in the absence of a special healthcare waste treatment facility within the hospital premises to reduce environmental and public health risks. Western Regional Hospital Kaski used such pit for placenta collection and the pit was covered by the concrete /cemented slab so as to block its connection with the surrounding hospital environment (*Pic. 25*).



Pic 25: Suction Pit in Western Regional Hospital Kaski

Burial method has been adopted by maximum HCIs (75%) but that was not safe burial. In Western Regional Hospital Kaski, burning capacity of incinerator was relatively low compared to volume of generated waste, so waste was dumped openly near the incinerator. The ash/residues of incinerator were also dump openly on the heap of stored waste. Abhiyan Community hospital disposed maternal waste into suction pit and the ash/residue of incinerator was buried in burial pit. The suction pit was not safe as there was no protection against leachate and was not covered properly (*Pic 26*). The location of that pit was also not recommended. Green Pasture hospital was rearing pigs and was fed with the organic waste generated from the hospital. Beside, rest of the waste was burnt in incinerator and remaining of that was buried. Manipal hospital used to burry ash/ residue and organic waste in burial pit near the Seti River.



Pic 26: Suction

pit near open burning and incinerator

Many HCIs treat and dispose their waste within hospital while some HCIs were depended on municipality and private agents. The following fig 7 describes about it:

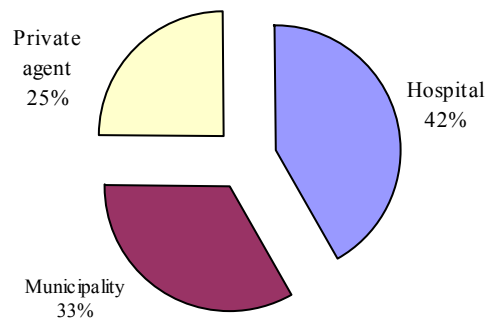


Fig 7: Dependency of HCIs for waste disposal on different institutions

42% of HCIs were found disposing hospital waste by themselves. Municipality was supporting the Green pasture Hospital to manage dead bodies without any cost. 33% of HCIs were getting free municipality service and 25% of HCIs were paying to private agent for waste treatment. Charge of private agents ranged from Rs. 300 to 1500/ month.

Bottlenecks

Disposal system of health care was not so effective and safe as it simply buried or dumped openly within HCI premises. Uncontrolled and scattered deposited wastes at a site lead to acute pollution problems, fires and perceived risk of the release of pathogens to air and water.

The concept of suction pit was not so safe although it was covered. Unlike safe burial pit, it didn't have any impermeable layering around it. Thus there was high chance of leachate discharge through the surrounding soil. Thus it involves great risk of nearby water body pollution especially ground water pollution. The pit can be made as per the requirement of the HCI with permeable layering.

Pokhara sub-metropolitancity was also not taking responsibility, so there was a major problem related to disposal of healthcare waste. Waste collector of municipality or private agents were found collecting healthcare waste from limited clinics/ HCIs where incinerator was not installed and those unsegregated waste was dumped haphazardly at Prithwi Chowk along with other solid waste (Pic 27 (b)). The heap of dumped waste was there near by side of highway and residential area creating offensive visual impact. The dumping site was not prevented from entrance of unauthorized persons and animals so the contact with infectious pathogens was obvious Rag pickers and scavengers were found collecting metals, plastics and left over food. That created the risk of subsequent disease transmission, either directly through wounds, inhalation or ingestion, or indirectly through the food chain or a pathogenic host species.



Pic 27 (a): Rag pickers at Western Regional Hospital Kaski Pic 27 (b): Rag pickers at municipal dumping site

3.8 Human resource and development

3.8.1 Human resource

All HCIs had appointed one staff at incinerator but in Gandaki Regional hospital, there were two staffs at alternate day to dispose waste. The highest no of waste handlers was found at Manipal hospital (40) and the lowest was at Abhiyan (5). But as per patient pressure we found the lowest no. in Gandaki Regional hospital. Result shows 58.3 beds come under one waste handler (Table 14).

Table 14: Number of bed per waste handler

Name of HCIs	Total no. of beds	Total no. of waste handlers	No. of bed/waste handlers
Manipal Teaching Hospital	700	40	17.5
Gandaki Regional Hospital	350	6	58.3
Green Pasture Hospital	80	7	11.42
Abhiyan Community Hospital	25	5	5
Om Hospital	25	6	4.16
Total	1180	64	18.43

3.8.2 Training and awareness programme

Training

Generally HCIs gave trainings to their staffs that directly involved in waste management before starting employment. It was found that at the time of induction of new employees or with the introduction of new equipment, training and education was provided by HCIs itself. INF organized no. of official training programs to teach how to manage waste, where HCIs send their staffs but are in limited no. Figure 8 shows that only 36 % of HCIs have officially trained waste handlers. Green Pasture hospital use to conduct training on waste segregation and dressing periodically to their patients, visitors, and staffs including doctor and administrator.

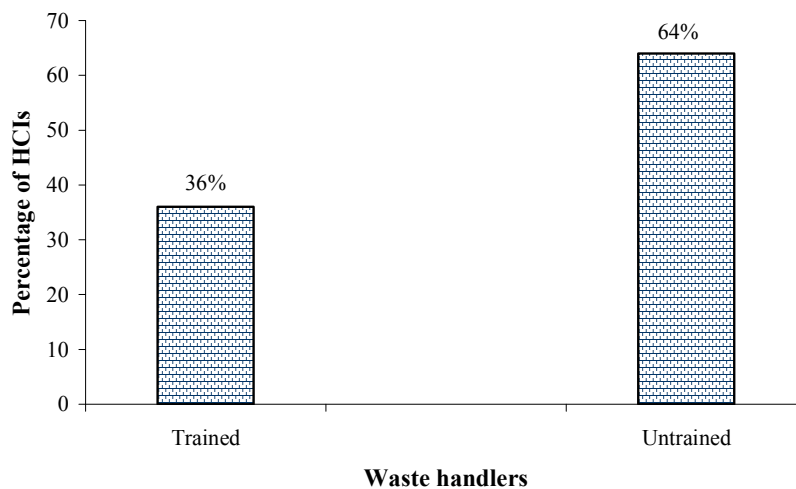


Fig 8: HCIs having trained and untrained waste handlers

Awareness

From our study we found only two HCIs, Manipal and Green Pasture hospital were involved in awareness program. Manipal hospital was in operation of the community awareness program to stay clean. This hospital was disseminating the advantage of waste management and metal containers were provided in the ward where the hospital is situated. Green Pasture hospital had conducted awareness programs on infection control for patients, visitors, doctors, administrator, schools and colleges.

3.8.3 Occupational health and safety

Mace mask and apron was provided by all most all HCIs. Boots and gloves were provided by only 80% and 60 % of HCIs respectively. Most of the HCIs were unaware for immunizing their staffs from Hepatitis, TB, Tetanus etc. Figure 9 shows 20% of HCIs had vaccinated their staffs against Hepatitis B and 40% of HCIs against Tetanus. We found in every HCIs hand washing facilities with soap and water was provided. There was no facility of emergency shower and warm water. There was lacking record keeping of incident and accident. Over all the workers that deals with hospital waste must

take precautionary measures in order to avoid occupational health risk and for that has to support them providing safe and healthy work place.

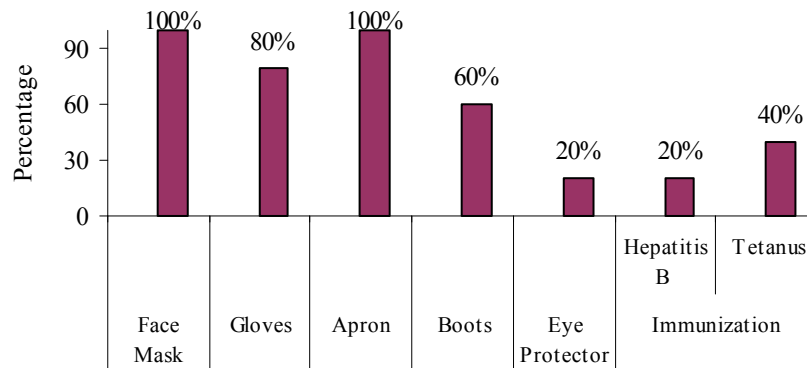


Fig 9: Safety measures and injury response provided by HCIs to waste handlers

Bottleneck

Most of the HCIs had inadequate number of manpower to manage waste. This added workload to the existing waste handlers and also resulted in poor waste management system. Waste handlers and other staffs lacked appropriate training, education, and information to ensure safe health care waste management system.

Some HCIs provided personal protection equipment (PPE) to the waste handlers and some did not. Even the provided PPE was insufficient in most of the HCIs. Some waste handler did not wear any PPE during waste handling even though they were provided with it. This is because of their negligence and insufficient awareness about the safe waste handling. Most of the waste handlers in different HCIs were not given proper vaccination (such as Hepatitis B, Tetanus etc) but some conscious staffs were taking vaccine on their own expense.

Lack of policy and formal body committee for effective waste management was found. They were just focusing to keep the generated waste out of their sight. This could lead to many environmental problems like air pollution, ground and surface water pollution as well as land pollution. Moreover it can cause risk to the waste handlers and public health too.

3.8.4 Monitoring and Evaluation

Monitoring is an important tool that measures success or failure of the waste management system. It is helpful to add timely information for progressive improvement of the system and each HCI must perform regular monitoring. Manipal hospital has assigned one staff that is responsible for the day-to-day implementation and monitoring of the waste management and sends feedback to the concerned officer for future action. The manager of General department also used to monitor periodically. Environment department has been established in Gandaki Regional hospital for this purpose. But the performance was not satisfactory. Infection control department performed monitoring in the Green Pasteur hospital and set board meeting once in two month to evaluate the success of the management system. Beside these, monitoring was not seen in other HCIs.

Chapter - IV

4 Recommendation for sound management of Health care waste in PSM

4.1 Recommendation of appropriate waste management system within healthcare institute

This part of the report focuses on our objective to know the appropriate system to manage healthcare waste with in HCIs of PSM.

Waste segregation

Waste should be segregated at source point following various categories of separation (*see section 2.7*)

Sufficient number of collection container for different types of wastes should be placed as convenient.

Color-coding should be standardized at national level. There are various methods for labeling or color-coding containers according to categories of health care waste can be as per guideline for effective waste segregation.

Mostly used color-coding of health care waste segregation in PSM was as shown in *Pic. 9*. The little thing that should be kept in mind was, red container was for both infectious as well inorganic wastes, so whole waste became infectious; it would be better to add one more container to collect recyclable waste (*as shown in sketch below*) or collect those along with organic wastes in green container. This will help to minimize the volume of hazardous waste.

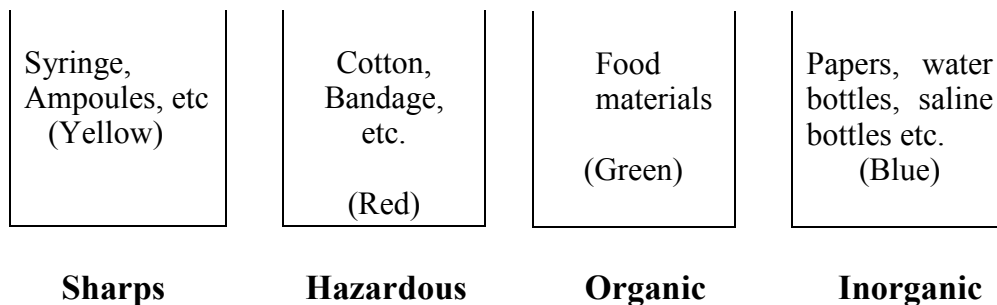


Fig 10: Color coding and labeling of waste containers for segregation of healthcare waste

Posters explaining the segregation process should be placed in all eye-catching locations. As some patients are illiterate, they can't understand the labeling and color-coding systems, they should be made aware accordingly. To make effective segregation system possible, hospital personnel at all levels, especially nurses, support staff and cleaners should be trained to sort the waste they produce.

Waste collection

Waste should be collected at least daily and more often if required. All bags should be labeled before removal, indicating ward and contents. Bags and containers, which are removed, should immediately be replaced with new ones of the same type. Plastic bag used for hazardous waste collection should have specification like 20-micron thickness for up to 20-liter capacity or minimum 50 micron for 50-100 liter capacity (*see section 2.8*).

Containers should not be overfilled; after it is $\frac{3}{4}$ filled it should be taken to the storage room. Moreover, the collection containers should be covered. The collection container should be designed such that during its use it should not infect the hands of the user. For example, foot operating collection containers. (*Pic 13(a)*) When a waste bag is removed from a container, the container should be properly cleaned and disinfected before a new bag is fitted there in. A timetable for waste collection should be drawn up which should be followed strictly. Timing of collection and removal should be convenient to all departments. It should be avoided during the normal hospital routine or while the patients are resting. Collection process should be free from noise to avoid disturbance to the patients. Collection container for the sharp should be rigid and puncture proof with biohazard symbol.

Waste from OT especially pathological waste should be collected in double bags and taken to storage area directly as soon as collected. If an autoclave is used for treating infectious waste, the infectious waste should be collected in plastic bag, which should never be incinerated. The capacity of collection container should be at least 50% more than the average volume of waste generated in that particular location. Besides it should have the symbol for hazardous waste.

Waste transportation

While transporting the waste it should be ensured that there is no leakage and the container is covered. Waste transportation route should be designed focusing low patient flow timing and in the way where patient and visitors don't walk very often. If trolleys are used for waste transportation then it should not be used for other purposes. There should be no sharp edges on them, which can puncture or damage waste bags or containers. Besides, trolley should be easy to clean and the personnel involved in loading and unloading of waste in the vehicle should be protectively dressed.

Waste storage

A separate central storage facility shall be provided for hazardous waste. The designated central storage facility should be located within the HCI premises close to the incinerator, but away from the food storage or food preparation areas. Infectious and pathological waste should not be stored for more than 48 hrs in summer and 72 hrs in the winter. Containers with radioactive waste and chemical waste should be stored in a separate room or area. Storage room should be well ventilated, cool and protected from direct sunlight. Also, it should be large enough to contain all hazardous waste, which can be easily cleaned and disinfected. The floor of storage area should be hard and impermeable with a good drainage system. The area should be secure from unauthorized access and especially inaccessible to animals, insects and birds for which the storage room/ area should have a proper locking system.

Waste treatment

Disinfection of waste collection/ transportation containers should be carried out with suitable and available chemicals following the instructions written on the pack of chemical. The user should be well trained and educated. Wastewater should not release in natural water resource. They should be treated before releasing.

General waste can be categorized as organic and inorganic waste. Organic waste such as food residue and garden waste can be composted or given to the pig farm (*see Annex pic. 3*) and inorganic waste such as paper, glass, plastics etc can be recycled within the HCIs premises or sent off site for the treatment purposes.

Hazardous waste should be sterilized before sending them to incinerator, autoclave or safe burial pit. For the treatment of infectious, pathological, sharps, pharmaceutical, cytotoxic, chemical and radioactive waste rotary kiln can be used. Pyrolytic incinerator can be used for the treatment of infectious, pathological, sharps, pharmaceutical, and radioactive waste. Single chamber and Drum or Brick incinerator are not recommended as it causes environmental pollution and public health hazard. Incase sophisticated incinerator is not affordable or available this should be carried out as emergency situation. To limit the hazardous emissions, the incinerator should be properly operated and carefully maintained and sources of pollution should be excluded from the waste to be incinerated whenever possible.

Safe burial method can be used for the waste such as infectious, pathological, Sharps, pharmaceutical and chemical waste. A separate pit at the landfill site for disposal of healthcare waste can be prepared when no other treatment facilities are available. When hazardous healthcare wastes are put in pit, it should immediately be covered with lime and soil. Sanitary landfill can also be used for infectious waste (*Pic. 3*).

Syringes and needles should be rendered unusable by the use of a needle destroyer (*see section 2.11*) or should be disinfected with a suitable disinfectant like Chlorine solution. Safe sharp pit can be built as shown in (*Fig. 11*). The sharps enclosed in the containers can be dropped and buried in the Sharp pit. Else the sharps can also be buried directly with the help of funnel (*Pic. 28 a and b*). Generally these pits are 1.5 by 1.5 meters pit and are about 1.5 meters deep. It contains a volume of about 3.3 m³. It will be cemented internally with a cement slab covering it.

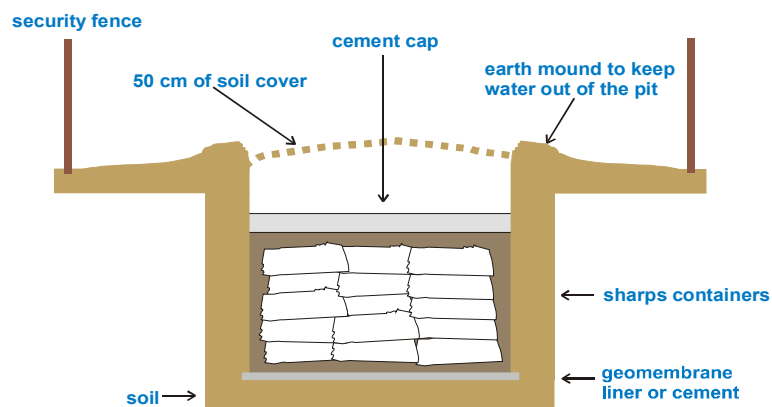


Fig 11. Sharp burial pit with concrete cover



Pic. 28 (a) Sharps poured in the pit with help of funnel



Pic 28 (b) The sharps pit with two openings to ensure even distribution of sharps

Chemical disinfections, Autoclave and Microwave can be used to treat infectious waste and sharps. Similarly Encapsulation can be used for the treatment of Sharps, pharmaceutical, and chemical waste (*see section 2.11.4*).

Open burning of infectious wastes was also observed in one HCI but it should be carried out only in emergency situation. If possible, the burning should take place in pit of final disposal (i.e. where the residues will be buried) and the responsible person should supervise the process. It should be performed downwind of and as far as possible from the facility or other communities. The area should be fenced.

Installment of ETP plant may be technically and financially difficult for many HCIs/ municipalities, but instead of that “constructed wetland” could be built for wastewater treatment as in Dhulikhel hospital (*Pic. 5*) and Land fill site of PSM. It is too economic.

Inertization can be used for pharmaceutical waste and cytotoxic waste with mixture of water, lime and cement (*see section 2.11.10*).

Centralized Treatment Facility (CTF) is needed for treatment of the HCI waste in PSM, as most of the private HCIs don't have enough space for installing effective treatment systems.

Waste disposal

Ash and residues from the incinerator and other methods should be placed in robust, noncombustible containers and sent to the local authority's designated landfill site. Pokhara sub-metropolitancy had developed sophisticated sanitary land fill site (*Pic. 3*) but that was only for solid waste (not health care waste). To dispose the healthcare waste in the sanitary landfill site a specially constructed small burial pit can be prepared to receive health care wastes only (*see section 2.13*). Scavengers, dogs, animals birds shouldn't enter the area. Radioactive liquid waste should be diluted and released in very small amounts over a considerable length of time into the existing sewage system. Low-level liquid radioactive waste and small quantities of pharmaceutical waste can be discharge to sewer. But it should not discharge into natural water such as river, lakes. Sophisticated incinerator posses good results with regard to disinfections however, if that is not available waste should be buried in a dumpsite. Treated waste also required to

dispose and for that safe burial pit can be used. Leachate from burial pit can pollute ground water. Therefore pit should be made with proper treatment of leachate. The concept of suction pit was not environmentally sound as it pollutes ground water through leaching. It would be better to construct safety tank instead of suction pit.

Occupational health safety

HCI is responsible to provide safe, healthy workplace and safe system of work for all. HCI is responsible for providing appropriate information, education, training and ensuring that safe systems of work are developed and maintained. Appropriate work practices should be documented and promoted. Standard Operating Procedure should be developed which should:

- Specify the Waste Management Plan, waste segregation procedures and approved waste handling procedures
- Detail appropriate training required for waste generators, and handlers
- Specify personal protective equipment required for waste handling tasks
- Specify how to operate the information, education, training and safe working systems

Waste management committee can be formed and can be given responsibility to look after occupational Health and Safety activities. The committee should have responsibility for

- Provision and installation of PPE, vaccinations etc.
- Work practices
- Incidents and accidents
- Provision and status of information, education and training
- Relevant records and
- Material safety data sheets.

Beside these some other important points should be noted and followed such as

- Record keeping of incidents and accidents for identifying and reducing the causative factors to waste handling injuries
- Provision of hand washing facilities and promotion of regular hygiene procedure
- Team handling procedure or mechanical aids for manual handling and transportation of waste if the load exceeds to 16 Kg.
- Compulsion to wear PPE while handling waste.

4.2 Integrated healthcare waste management practice

Integrated healthcare waste management practice should be planned and implemented to have coordination and cooperation among every sector for the sound healthcare waste management. All the government, non-government, private organizations, media as well as individuals should go hand in hand for its achievement and sustainable implementation.

4.2.1 Role of different organizations for healthcare waste management

Healthcare institutions

One healthcare institute can support or help the other to manage the waste effectively. Manipal hospital is going to import an incinerator of 40Kg/hour capacity; other HCIs not having incinerator can send their waste with certain financial incentive to Manipal for

effective and environment friendly treatment. This will be beneficial to Manipal as the incinerator has more capacity and to other HCIs as well.

There are various clinics in PSM; the sharps from these clinics are the major waste, which needs special treatment. This can be well managed by sending them to near by HCI having sharp effective treatment facility e.g. incinerator, sharp pit with certain charge.

Government bodies

Government is the vital body for effective waste management. Government can act as a planner, facilitator and inspector for proper healthcare waste management. The role of the government for the sound Healthcare waste management is explained by the following figure:

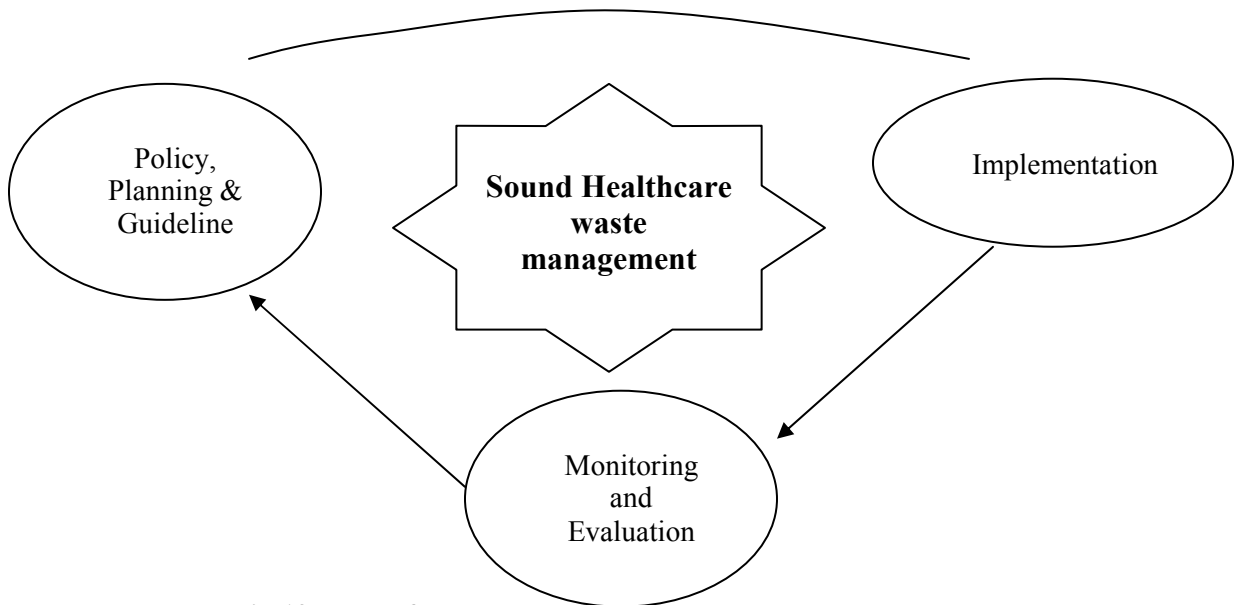


Fig 12: Role of government in Sound waste management

Roles and responsibilities of government bodies for effective waste management system are shown in the table below:

Table 15: Roles and responsibilities of government bodies for effective waste management system

Organizations	Roles and responsibilities
Pokhara Sub-metropolitan City	Monitoring and Evaluation Effective HCW treatment and disposal Awareness raising
Department of Health Services, MoH	Planning and policy making Standard setting Making action plans Awareness raising activities Monitoring and Evaluation
Western Health Directorate Office	Planning and policy making
Local Development Office	Awareness raising activities Monitoring and Evaluation
Ministry of Environment, Science and Technology	Planning and policy making Standard setting
National Planning Commission	Planning and policy making

Other organizations

Other organizations includes INGOs, NGOs, CBOs, clubs, solid waste management groups, tourism related organizations etc that can be involved directly or indirectly with healthcare waste management. The roles and responsibilities of these organizations can be as follows:

Table 16: Roles and responsibilities of organizations for effective waste management system

Organizations	Roles and responsibilities
INGOs, NGOs, CBOs, Clubs and solid waste management groups	Awareness raising activities Trainings, workshops etc HCW Management practices
Tourism related agencies	Public awareness

Public and media

The major role should be of the public; without public participation none of the activities are fruitful. The role of the public can be good cooperation with the planning and implementation of the rules. The media also plays an important role for dissemination and implementation of the plans. It also helps to raise awareness among the public.

4.2.2 Centralized healthcare waste management system

Centralized healthcare waste management system can also be one of the best options for the effective waste management. As some HCIs lack the technologies, space and budget for effective waste treatment, they can pay some amount for effective treatment and disposal of healthcare waste to centralized waste management system. This system will help to manage the healthcare waste in environment friendly manner and cost effectively as well. This system can be initiated or managed by the government, private organization or HCI.

Chapter – V

5 Conclusions

The increase in the number of hospitals, private nursing homes, clinics and polyclinics in the Pokhara sub-metropolitancy has resulted into a significant increase in the volume of healthcare waste. Very limited studies on healthcare waste management have been conducted in Pokhara. What, why, and how, the HCW is managed is still unknown to most of the responsible authorities and stakeholder in Pokhara sub-metropolitancy. As health care waste management is an environmental sensitive issue, there is an urgent need to assess present situation of HCW and to manage them in an environmentally sound manner.

Recognizing this importance, the main objectives of this study were to identify the present status and bottlenecks of health care waste management system and to recommend the appropriate technology for HCWM. Out of 15 identified HCIs, 11 were selected for preliminary survey and out of 11 only 5 were selected for detail study. Selection of HCIs was made on the basis of its location, flow of patient and type of HCIs.

Waste segregation system was very poor among the HCIs. Among the 5 HCIs, proper waste segregation was found only in Abhiyan and Green Pasture Hospital. The mixing of waste might be due to lack of proper instructions about waste segregation system. But, in some HCIs instead of instructions about waste segregation, mixing of waste was found due to carelessness of patients, visitors and staffs. On the basis of analysis done in PSM, composition of health care waste measured in HCIs was found to be 2% sharps, 12% hazardous, and 86% non-hazardous. So, proper waste segregation could minimize the amount of hazardous waste that facilitates cost effective and easy treatment/disposal. Common color-coding or labeling is suggested for effective waste segregation and to avoid confusion while segregating the waste. Suggested colors are yellow for sharps, red for hazardous and green for general.

Waste collection system was quite satisfactory but the problem was lack of disinfection of collection container. Due to the ignorance of staff the wastes were mixed during collection even if it was segregated properly at the point of generation. Effective collection system for the HCIs was suggested including covering, disinfection of collection container, proper collection container for sharps, collection frequency, timely replacement of container etc. The collected wastes were transported manually at all the HCIs. Only Manipal hospital was using tractor to transport organic waste and ash from incinerator to site near ETP plant for burial. Some of the HCIs had insufficient budget to purchase the transportation containers. While transporting the waste the containers should be covered and leak proof so as to avoid infection. The transportation containers should be timely disinfected and proper route for waste transportation should be designed.

Most of the HCIs lacked effective central storage system for the healthcare waste. Some HCIs had provision of short time storage and but mostly openly stored. This open storage could cause air / water pollution as well as risk of spreading epidemic diseases. For this, effective central waste storage system was suggested for the hazardous waste, which should be away from patients, settlement and food storage or preparation areas.

HClIs were adopting both chemical and thermal treatment methods to treat waste. Incinerator, Autoclave, Liquid Sterilizer, Sterilizer, Microwave etc. were used as thermal treatment technology for disinfecting reusable instruments. The incinerators in use were unscientific and environmentally unfriendly. Some of them were overloaded. Most of the HClIs used single chamber incinerators or drum or double chamber incinerator. Harmful smokes from the incinerators were adding risk to the public health and waste handlers. Thus, for the treatment of infectious, pathological, sharps, pharmaceutical, cytotoxic, chemical and radioactive waste rotary kiln and pyrolytic incinerator were suggested.

Similarly, the segregated organic waste such as food residue and garden waste can be composted and inorganic waste such as paper, glass, plastics etc can be recycled within the HClIs premises or sent off site for the treatment purposes. Hazardous waste should either be incinerated, autoclaved or safely buried with proper management of its leachate.

The health care wastes were disposed either by the HClIs themselves or by the municipality. Both of them don't have safe disposal method. Some HClIs disposed their waste in suction pit while the municipality disposed the waste openly in the dumping site. This could cause severe health hazard to the public and also could lead to outbreak of the communicable diseases. Therefore, safe and affordable disposal methods like encapsulation, safe burial system, sharp pit etc. were suggested.

Occupational health safety was not given due attention by the HClIs. Moreover the waste handlers themselves were unaware about their health. Though some HClIs provided gloves, masks and aprons, waste handlers were not found properly used during their working hour. Individual HClIs should strictly develop their own waste management policy forming HCWM committee prioritizing occupational health and safety issues of waste handlers. Waste management policy should also include regular record keeping, monitoring and evaluation of HCWM.

Integrated waste management system and centralized waste management system were suggested for the overall healthcare waste management. As individual effort is not enough for sound management of HCW, equal contribution from all the government, non-government and private organizations as well as media is very essential.