Health Care Waste Management Guideline

Government of Nepal
Ministry of Health and Population
Department of Health Services
2014

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Phone : 4-262534, Fax : 4-262565

Government of Nepal
Ministry Of Health & Population
Ramshahpath, Kathmandu, Nepal

Ref :

Hon'ble Khaga Raj Adhikari
Minister for Health and Population
Date : .....

Message

It is my great pleasure to present the Health Care Waste Management Guideline 2014. In Nepal health-care waste typically generates from different sources: health-care facilities, health campaigns and emergency relief assistance. Health-care services in a clean environment always aim to reduce health problems and to prevent potential health hazards. In doing so, however, waste is often generated that is potentially harmful to public health and the environment. Some categories of waste are very hazardous in nature and can impose risk on health-care workers, waste transport staff, patients and their attendants too, if they are not managed properly. Poor waste management and poor sanitation in health-care facilities can promote other unforeseen health risks such as hospital-acquired infections, sharp injuries to anybody or even further spread of communicable diseases in the communities. Hence proper management of health-care waste poses a great challenge in the health sector, especially health care providing facilitities.

In developing countries like Nepal, where many health concerns often compete for very limited resources, the management of health-care waste must be given priority. Although some of the national level hospitals in this country have started very encouraging initiatives towards the safe management of health-care wastes, in majority of health-care facilities hazardous wastes are still being dumped haphazardly. In this scenario, I hope this health care waste management guideline will help to raise awareness among the all stakeholders about the importance of safe management of health care waste. This guideline will be very useful to understand the various types of health care wastes and practical ways to assess and improve health care waste management at every step from generation to disposal in a variety of settings.

Lastly, I would like to extend my sincere thanks to Dr. Senendra Raj Uprety, Director General, Department of Health Services for his dynamic leadership during the preparation of this guideline. I would also like to thank all those involved in preparing this guideline.

Khaga Raj Adhikari
Minister
30 July 2014

Government of Nepal
Ministry of Health & Population
Phone : 4. 262987
262590
262802
262706
262935
262862
Ramshahpath, Kathmandu
Nepal

Ref: .....

Date : 21 July 2014

Foreword

Health care waste management is the responsibility of all health care facilities or the ones who produce waste. Various fatal infections such as HIV/AIDS, hepatitis B can spread as the result of the mismanagement of health care waste. Health care institutions in Nepal are lacking organized and systematic health care waste management practices. Many of these facilities have not adopted proper segregation, collection, transportation, treatment and disposal of health care waste till date. Currently, it is the common phenomena that the general wastes are being mixed with the highly infectious waste and are being disposed at municipality containers.

It is my immense pleasure to know that the present painstaking initiative has focused on the health care waste management issues in our country. I envisage that the present guideline for health care waste management will definitely bring some positive vibes towards the proper and scientific management of health care waste. I believe that this guideline will beacon the strategies to adopt the best available technique and the best environmental practice in terms of available resources for the proper management of health care waste

I would like to thank most sincerely Ms. Shrijana Shrestha, Senior. Public Health Administrator (DoHS), Mr. Terrence Thompson, Senior Environmental Health Advisor (WHO) and Dr. Sudan Raj Panthi, NPO (WHO) for their untiring efforts in bringing out this guideline. I also thank all those personnel who contributed to the guideline. This guideline will encourage the use of appropriate, safe and cost-effective methods and techniques for the segregation, collection, transportation, storage, treatment and final disposal of health care wastes.

Finally, I wish to request all the concerned stakeholders to be united in ensuring consistent and persistent support for the successful implementation of this guideline in all health care facilities in our country.

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Dr. Praveen Mishra
Secretary

Government of Nepal
Ministry of Health & Population
DEPARTMENT OF HEALTH SERVICES
Tel. : 4261436
: 4261712
Fax : 4262238
Pachali, Teku
Kathmandu, Nepal

Ref. No.

Date : .....

Foreword

Health care waste management is one of the major public health problems and burning issues in the present context. Health care sector is expanding and generating large quantities of health care wastes and there is lack of proper health care waste management system in these health care facilities. Health care wastes are either dumped along with household wastes in the landfill site or burned openly.

Health care wastes are hazardous in nature and therefore requires special precautions and arrangements for the proper management which is different from other household wastes. Systematic and coordinated approach is important for the proper and safe segregation, collection, storage, treatment and final disposal of health care wastes.

Solid Waste Management Act 2011, indicates that it is the prime responsibility of the waste producers to manage wastes properly. The present health care waste management guideline is remarkable step for the proper management of health care wastes. This guideline provides practical information regarding safe, efficient and environment-friendly waste management options in the context of Nepal.

I offer special thanks to Ms. Shrijana Shrestha, Senior Public Health Administrator (DoHS), Mr. Terrence Thompson, Senior Environmental Health Advisor (WHO) and Dr. Sudan Raj Panthi, NPO (WHO) for their hard work and dedication in bringing out this guideline. I express my sincere thanks to all the contributors including Civil Service Hospital HCWM team and other organizations involved in the preparation of this guideline. I am particularly grateful for the support provided by WHO Nepal.

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(Dr. Senendra Raj Upreti)
Director General
22 July 2014

Government of Nepal
Ministry of Health & Population
Department of Health Services
Management Division

Phone No. 4262063
4251173

Kathmandu, Nepal

Ref. No:

Acknowledgement

Government of Nepal, Ministry of Health and Population has been providing different health services; preventive, curative, promotive and rehabilitative services to people of Nepal. It is Government's commitment to provide quality health services. Recent Health Policy 2014 of Nepal focuses on good quality health services. As we know, infection prevention is one of the important aspects of quality health services and it is important at all levels; primary, secondary and tertiary levels of health facilities. Proper management of health care wastes can contribute to reduce infection prevention.

Management of health care wastes in different health care facilities is still seen as a big challenge in resource constraint setting like Nepal. Different diseases are being transmitted in health care facilities due to improper management of health care wastes. Health care facilities are emerging and expanding day by day and generating huge quantities of wastes including hazardous wastes. The majority of health care facilities dispose wastes in a haphazard way causing human and environment in danger. Therefore, health care wastes should be managed properly. I am hopeful that this guideline will help users to practice general and hazardous wastes in a proper and safe way, which is need of the country.

I would like to offer my sincere appreciation to Ms. Shrijana Shrestha, Senior Public Health Administrator (DoHS), Mr. Terrence Thompson, Senior Environmental Health Advisor (WHO) and Mr. Sudan Raj Panthi, NPO (WHO) for their tireless efforts in bringing out this guideline. I would also like to extend my sincere appreciation to all the contributors from Government and non Government organizations including Civil Service Hospital and Bir Hospital who helped to bring this guideline.

Finally, I hope this guideline will be helpful in the proper management of health care wastes in health care facilities and will improve the current situation in Nepal.

Dr. Bhim Acharya
Director
26 July 2014

Contents

Abbreviation

AIDS	:	Acquired Immune Deficiency Syndrome
BAT	:	Best Available Technique
BEP	:	Best Enviromental Practice
CEPHED	:	Center for Public Health and Environmental Development
COMAT	:	Communication and Management Institute
CSH	:	Civil Service Hospital
CTF	:	Central Treatment Facility
DDT	:	Dichlorodiphenyltrichloroethane
DoHS	:	Department of Health Services
DHO	:	District Health Office
DPHO	:	District Public Health Office
EDCD	:	Epidemiology and Desease Control Division
EIA	:	Environmental Impact Assessment
ESM	:	Environmentally Sound Management
GEF	:	Global Environment Facility
gTEQ	:	Gram Toxic Equivalent
HBV	:	Hepatitis B Virus
HCB	:	Hexachlorobenzene
HCF	:	Health Care Facility
HCV	:	Hepatitis C Virus
HCW	:	Health Care Waste
HCWM	:	Health Care Waste Management
HCWMC	:	Health Care Waste Management Committee
HCRW	:	Health Care Risk Waste
HECAF	:	Health Care Foundation
HIV	:	Human Immunodeficiency Virus
IEC	:	Information, Education and Communication
IEE	:	Initial Environment Examination
MD	:	Management Division
MoE	:	Ministry of Environment
MoHP	:	Ministry of Health and Population
MoSTE	:	Ministry of Science, Technology and Environment
MoUD	:	Ministry of Urban Development
NHTC	:	National Health Training Center

NCASC	:	National Center for AIDS and STD Control
NHRC	:	Nepal Health Research Council
NSI	:	Needle Stick Injury
PCBs	:	Polyclorinated
PEP	:	Post Exposure Prophylaxis
PHCORC	:	Primary Health Care Outreach Clinic
PPP	:	Public Private Partnership
PTMI	:	Provisional Tolerable Monthly Intake
POPs	:	Presistent Organic Pollutants
PVC	:	Polyvinyl Chloride
SBC	:	Secretariat of Basel Convention
SGNHC	:	Sahid Gangalal National Heart Center
SOP	:	Standard Operating Procedure
SPHA	:	Seminor Public Health Administrator
SWM	:	Solid Waste Management
SWMTSC	:	Solid Waste Management Technical Support Center
TB	:	Tuberculosis
UNDP	:	United Nations Development Programme
UNEP	:	United Nations Enironmentment Programme
WB	:	World Bank
WHO	:	World Health Organization

1. Introduction

1.1 Background

The goal of 'Health for all' through primary health care approach was set by World Health Assembly. The Interim Constitution of Nepal 2063 has given emphasis that every citizen has right to a clean environment and right to basic health care. Government of Nepal has a major concern in providing good quality of health services to all the people in the country. Different types of diseases and problems that the country is facing are being solved through different programs by governmental and non-governmental organizations. One of the major problems the country is facing is proper management of health care waste (HCW). Poor management of HCW causes high risk of infection and environmental pollution. Health care wastes not only affect the waste generators but also the waste handlers and general public. One of the manifested impacts of mismanagement of HCW is the alarming incidence of hospital acquired infection.

HCW includes all the wastes generated by health-care establishments, research facilities, and laboratories (WHO, 1999). According to Solid Waste Management Act 2011, medical waste means the hazardous waste produced and discharged from hospitals, clinics, pharmacies, dispensaries, blood banks, pathology laboratories, veterinary institutions and health research centers. Health care facilities (HCF) generate large amount of diverse wastes, which require proper treatment and disposal to protect the persons handling it and the environment. Accroding to UNEP/SBC/WHO, 2004 waste from the HCFs includes following categories of wastes:

- Non-risk HCW
- HCW requiring special attention
- Infectious and highly infectious waste
- Other hazardous waste
- Radioactive waste

Wastes in HCFs are around 20% hazardous and 80% general wastes (WHO, 1999). Improper management of HCWs in the HCFs is mainly responsible for producing a high volume of hazardous wastes. Thus, proper management i.e. proper minimization, segregation, storage, transportation, treatment and disposal of infectious and hazardous wastes will greatly reduce the risks to public health. Early recovery of the patient and health of clinical staff directly depends on infection prevention practices used in HCFs. Health care waste management (HCWM) is considered as one of the essential components of good infection prevention practices.

1.2 Objective of the Guideline

This guideline provides HCFs a minimum standard for safe and efficient HCWM in Nepal. HCF has the prime responsibility of ensuring that there are no adverse health and environmental consequences on handling, storage, treatment and disposal of HCWs. Though this guideline does not provide any details about the proper management of liquid and gaseous waste, through this guideline, HCFs will be able to install appropriate waste management system that can provide other benefits such as:

- Protection of public health by reducing the exposure of employees, patients, attendents, and entire community to hazardous HCWs in the work environment
- Facilitate compliance with regulatory requirements
- Enhance community relation by demonstrating a commitment to environmental protection
- Reduce waste handling and disposal volumes along with costs without compromising the quality of health care
- Increase employee morale resulting from a healthier and safer working environment

1.3 Health care waste and its management in Nepal

Ministry of Health (MoH) report (2003) revealed that the HCW generation is 1.7 Kg/person/day. Out of the generated waste of HCFs, 26 % of the waste is hazardous. Table 1 shows the amount of health care waste generated by the HCFs with bed and corresponding waste generation.

Table 1. Total health care facilities with bed and corresponding waste generation

Hospital with beds (Public+ Private+ Mission+Teaching)	No. of Hospitals	Total Bed	HCW (Tons/Year)	HCRW (Tons/ Year)
Government Hospital including Teaching under MoHP)	92	6601		
Government Hospital including under other Ministry	3	1036		
Government Total	95	7637	3080.19	905.94
Private Hospitals	157	9207		
Private Teaching Hospitals	14	8626		
Private Total	171	17833	7192.49	2115.44
Mission Hospitals	8	612	246.83	72.60
Country Hospital	274	26082	10519.51	3093.98

Source: MoHP Poster Presentation in first HCWM International Workshop, Nepal; 2012

Recent publication revealed that the total health care waste from Nepal is estimated at 0.533 kg/bed-day. Out of which 0.256 kg/bed-day is general, non-hazardous, and non-biodegradable waste, 0.147 kg/bed-day is biodegradable waste, 0.120 kg/bed-day is infectious waste including sharps and 0.009 kg/bed-day is hazardous chemical/pharmaceutical waste. (UNEP, 2012)

Average HCW generation rate per bed in Pokhara city is estimated at 1.22 kg and per patient waste generation in outdoor facility is estimated at 0.34 kg per day (Enayetullah et al., 2011). All hospitals and outdoor facilities in Pokhara city are generating 2.8 ton waste per day. Out of the total waste generated, 22% HCWs is hazardous and infectious and the rest (78%) is harmless general waste. The study also revealed that different categories of waste remain un-segregated due to lack of proper in-house waste segregation activity inside the HCFs. These wastes remain untreated and later disposed as such. Table 2 shows the HCWs generated at different hospitals of Pokhara city.

Assessment study at Civil Service Hospital in Minbhawan, Kathmandu shows that waste generation of the hospital is 64.58 kg per day with an occupancy rate of 55.86% with waste generation rate of 1.73 kg per bed per day. The report has compared the waste generated from the hospital as risk

and non-risk waste in cases of pre-separation and post-separation conditions. Pre-separation scenario showed that 71% of the waste is risk waste and 29% of the waste is non-risk. Post-separation scenario shows that the risk HCW is around 25% and non-risk health care waste is around 75% (CSH, 2011).

Table 2. Average waste generation per bed in different hospitals of Pokhara

Name of the Hospital	Total no of beds	Average Waste Generation Per Bed (kg)
Manipal Teaching Hospital	858	1.22
Kaski Model Hospital	25	
Western Regional Hospital	450	
Padma Nursing Home	51	

Source: Enayetullah et al, 2011

A study by Bhatta, 2013 revealed that almost all of the study that covered HCFs was focussing only on solid waste management mostly by method of incineration. Seventy percent of the incinerators were found not working properly as planned due to the lack of skilled manpower, spare parts, high fuel consumption, cultural and public objection and lack of management commitment. Secondly, most of the HCFs mainly district and below level, are managing their solid waste by adopting very poor method of waste disposal such as drum incinerator, pit burning, earthen pit disposal and open burning. Further many institutions are dumping or throwing waste on the back yard, ditches, rivers, open field, corners of hospital buildings, nearby ponds or anywhere around the premises. The third scenario is use of municipal waste container. About 60% of the big hospitals in different parts of the country are using municipal waste disposal system for final disposal of the HCW.

The study conducted at hospitals of Nepal by MoHP with support from WHO (MoHP, 2012) concluded that the waste management system is poor and 38.7% hospitals adopted correct segregation of HCWs. In Kathmandu, municipal vehicles collect waste and the collected waste including medical waste is disposed at Okharpauwa dumping site without any pre-treatment. Most of the rag pickers are often seen collecting plastic bottles, plastic bags, syringes, needles, and iron materials in and around hospital areas and at the waste disposal sites. These are the common practices, which put rag pickers and the community people at the greatest risk of infection and injury. According to a study conducted in Western region of Nepal (DoHS, 2013), 70% of clinical staff and 63% of non-clinical staff reported a needle stick injury (NSI) or other sharps injury at some time.

A study (CEPHED, 2012) showed that 90.32% hospitals do not practise environment sound waste treatment system at all, 61.29% hospitals have very poor source separation including complete absence of such practices in 6.45% hospitals. Among them, 80.65% hospitals do not practise appropriate and separate waste collection; 67.42% hospitals have very poor transportation, however, the criteria for determining the presented data are not so clear.

Above scenario shows the very poor management of HCWs and need to be taken seriously. Liquid wastes including hazardous chemicals and laboratory wastes have not been addressed in almost all institutions. Recently some HCFs in Nepal such as Western Regional Hospital, Bir Hospital, Civil Service Hospital, Manipal Teaching Hospital, Shahid Gangalal National Heart Centre and some other HCFs are practising HCWM systems, which are very encouraging initiatives towards the proper management of HCWs.

2. Policy, Legal Provisions and Commitments

2.1 International Agreements and Underlying Legislative and Regulatory Principles

International agreements have been reached on a number of underlying principles, which govern either public health or safe management of hazardous waste. Nepal is signatory on number of international conventions. Some of the conventions and guiding principles outlined here should be taken into consideration while making plans for the HCWM.

2.1.1 Basel convention 1989

The Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal was adopted in 1989 and entered into force in 1992. This convention is a global agreement, ratified by 178 member countries to address the problems and challenges posed by hazardous waste. The central goal of the Basel Convention is "environmentally sound management" (ESM), the aim of which is to protect human health and the environment by minimizing hazardous waste production whenever possible. ESM means addressing the issue through an "integrated life-cycle approach", which involves strong controls from the generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal. HCW is one of the categories of hazardous wastes covered by the convention.

2.1.2 The stockholm convention on persistent organic pollutants 2001

This Convention is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of living organisms. POPs are toxic to humans and wild life and have adverse effects on human health and the environment. Exposure to POPs can lead serious health effects including cancers, birth defects, dysfunctional immune and reproductive systems, increased susceptibility to disease and even diminished intelligence. POPs circulate globally and can cause damage wherever they travel. To response these problems, the Stockholm Convention, was adopted in 2001 and entered into force in 2004. The convention requires the concerned parties to take measures to eliminate or reduce the release of POPs into the environment. POPs listed under Stockholm Convention are given in the table 3.

2.1.3 Tort law and principles

a. Duty of care principle

This principle stipulates that any organization that generates waste has a duty to dispose the waste safely. Therefore, it is the HCF that has ultimate responsibility for how waste is containerized, handled on-site and off-site and finally treated and disposed of.

b. Polluter pays principle

According to this principle, all waste producers are legally and financially responsible for

the safe handling and environmentally sound disposal of the waste they produce. In case of an accidental pollution, the organization is liable for the costs of cleaning it. Therefore, if pollution results from poor management of HCW then the HCF is responsible. However, if the pollution results because of poor standards at the treatment facility then the HCF is likely to be held jointly accountable for the pollution with the treatment facility. Likewise, this could happen with the service provider. The fact that the polluters should pay for the costs they impose on the environment is seen as an efficient incentive to produce less and segregate well.

c. Precautionary principle

This is a key principle governing health and safety protection. When the magnitude of a particular risk is uncertain, it should be assumed that this risk is significant, and the measures to protect health and safety should be designed accordingly. Following this principle one must always assume that waste is hazardous until it is proved to be safe. This means that where it is unknown what the hazard may be, it is important to take all the necessary precautions.

Table 3. POPs listed under Stockholm Convention

Chemical	Stockholm Convention Annex	Use
Aldrin	A	Insecticide
Chlordane	A	Insecticide, termicide
DDT	B	Insecticide
Dieldrin	A	Insecticide
Endrin	A	Insecticide, rodenticide
Heptachlor	A	Insecticide, termicide
Hexachlorobenzene	A	Fungicide
Mirex,	A	Insecticide, termicide
Toxaphene	A	Insecticide
Polychlorinated Biphenyls	A	Industry manufacture; co-planar PCBs are by-product of combustion
Hexachlorobenzene	A	By-product of manufacture (chlorinated solvents, pesticides), application of pesticides, incineration of HCB containing wastes
Dioxins	C	By product
Furans	C	By product
Alpha hexachlorocyclohexane	A	By product
Beta hexachlorocyclohexane	A	By product, pesticides
Chlordecone	A	By product, pesticides
Hexabromobiphenyl	A	Industrial chemical
Hexabromodiphenyl ether, Heptabromodiphenyl ether	A	Industrial chemical
Pentachlorobenzene	A and C	Pesticide, Industrial chemical, By-product
Lindane	A	Pesticide
Tetrabromodiphenyl ether and pentabromodiphenyl ether	A	Industrial chemical
Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride	B	Industrial chemical
Endosulfan	A	Pesticides

Note : A = Parties must take measure to eliminate the production in use
B = Parties must take measure to restrict the production in use.
C = Parties must take measure to reduce the unintentional releases.

d. Proximity principle

This principle recommends that treatment and disposal of hazardous waste take place at the closest possible location to its source to minimize the risks involved in its transport. According to a similar principle, any community should recycle or dispose of the waste it produces, inside its own territorial limits.

2.2 Existing National Acts, Rules and Regulation related to HCWM

Considering that waste producers, HCFs have a legal and financial responsibility ("polluter pays principle") for managing HCW safely ("duty of care principle"), taking all necessary measures to minimize risks ("precautionary principle"). Nepal has endorsed policy, acts, rules and regulations, some of them which help to achieve these goals in the most cost-effective and sustainable way as possible are described below.

2.2.1 Solid waste management Act 2011

Solid Waste Management (SWM) Act 2011- provides legal basis and regulation for HCWM. The main objectives of the acts are:

- To make arrangement for the systematic and effective management of solid waste by minimizing the solid waste at source, re-using, processing or disposing of the solid waste, and

- To maintain the clean and healthy environment by minimizing the adverse effects of the solid waste in the public health and environment.

Section 2 of the act has defined medical waste and hazardous waste. According to this act, "medical waste" means the hazardous waste produced and discharged from hospitals, clinics, pharmacies, dispensaries, blood banks, pathology labs, veterinary institutions and health research centers and "hazardous waste" means the goods, substances and radioactive rays discharged in different forms which cause to degrade the natural environment and harm human health and the life of other animals.

Section 4 sub-section 1, 2 and 3 has made provisions for the responsibility of the management of the solid waste as given below:

1. The responsibility to manage or cause to manage solid waste shall rest with the local body.

2. Notwithstanding anything contained in sub-section 1, the responsibility for processing and management of hazardous waste, medical waste, chemical waste or industrial waste under the prescribed standards shall rest with the person or institution that has generated the solid waste.

3. If any industry or medical institution requests for the management of solid waste

remained after processing of hazardous waste, medical waste, chemical waste and industrial waste or other solid waste, or for using a sanitary landfill site constructed by the local body, the local body may manage the solid waste or allow the institution to use the sanitary landfill site by levying fees as determined by the local body.

Section 5 of the act has spelled the reduction in production of solid waste and states that it shall be the duty of every person, institution or entity to reduce the quantum of the solid waste by making arrangements to dispose the disposable solid waste within their own area or making arrangement for the reuse and discharging the remaining solid waste thereafter.

Section 6 of the act on segregation of the solid waste states that:

(1) The local body shall have to prescribe for segregation of solid waste at source by dividing the solid waste into different categories including at least organic and inorganic.

(2) The responsibility to segregate solid waste at source as prescribed by the local body pursuant to sub-section 1 and carrying them into the collection center shall rest with the person, institution or entity who produces the solid waste, and for this purpose the local body may provide necessary technology, goods, equipment, containers, etc. to them.

Section 7 sub-section 2 and 3 of the act on discharge of solid waste states that the person, organization and entity that produce hazardous waste or chemical waste shall have to manage such solid waste as prescribed; and the hazardous waste and chemical waste shall not be discharged in the solid waste collection center or transfer station.

Section 39 sub-section 8 of the act on punishment states the local body may impose a fine from fifty thousand to one hundred thousand rupees on anyone who commits offence as mentioned below:

- To throw, keep, discharge or cause to discharge chemical waste, industrial waste, medical waste or hazardous waste haphazardly;

- To throw, keep, discharge or cause to discharge hazardous waste produced by any industrial enterprise or health institution haphazardly; And if the same offence is committed again, it may also punish with a double fine as was imposed earlier and recommend to the concerned authority for cancellation of the license.

Section 43 sub-section 1 and 2 of the act on Management of Medical Waste states that the authority that grants license to establish a health institution as per the prevalent law shall, before granting license for establishment and operation of the health institution, confirm whether appropriate management has been made for solid waste management or not and it shall have to grant license only if appropriate arrangement is made. While granting license pursuant to sub-section 1, the special conditions to be abided by or the standards to be maintained by the health institution regarding solid waste management may also be prescribed.

2.2.2 The town development act 1989

The Town Development Act 1989 was promulgated in order to provide necessary services and facilities to the residents of the town by reconstructing, expanding and to develop existing towns and by constructing new towns and to maintain health, convenience and economic interest of general public. Section 9 of this act empowers the Town Development Committee to regulate, control or prohibit to do any act and activity which causes adverse effect on natural beauty, tourism site and public health or which causes environmental pollution.

2.2.3 The local self-governance act 1999

The Local Self-Governance Act 1999 has empowered the local body to fine anyone up to Rs.15,000 for haphazard dumping of solid waste. The act has made provisions for managing domestic solid waste; however, the act does not require the local governments to manage hazardous waste. According to the act, municipalities are supposed to preserve water bodies such as lakes and rivers and assist in controlling water, air and noise pollution.

2.2.4 The environmental protection act 1997 and environmental protection rules 1997

The Environmental Protection Act 1997 and Environmental Protection Rules 1997 were formulated to reduce adverse impacts on the environment likely to be caused from environmental degradation on human beings and ensure the proper use of natural resources for environmental conservation. Section 2 and sub-section (h) of the act defined waste as the liquid, solid, gas, slurry, smoke, dust, radiated element or substance or similar other materials disposed in a manner to degrade the environment. The act and the rule have made compulsory provisions for Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA), depnding upon the size of the project. Chapter 2 of the rule states that a proponent shall be required to carry out the IEE of the proposals for final disposal management of biological lethal substances emitted from health center, hospital, or nursing home with at least twenty five beds (The schedule 2 subsection H point 4 (c) of the rule and for operation of hospitals or nursing homes with more than twenty five beds (The schedule 2 subsection J point 1). Amendment of the rule has made provisions for the EIA for operation of Health Care Facility with more than hundred beds. Section 7 and sub-section 1 of act states that "Nobody shall create pollution in such a manner as to cause significant adverse impacts on the environment or likely to be hazardous to public life and people's health, or dispose or cause to be disposed sound, heat radioactive rays and wastes from any mechanical devices, industrial enterprises, or other places contrary to the prescribed standards." It is important to note that IEE for the health-care facilities has been administrated by MoHP whereas EIA has been administrated by Ministry of Science, Technology and Environment (MoSTE).

2.2.5 Solid waste management policy 1996

Solid Waste Management Policy is formulated relating to the management of solid wastes. The objectives of this policy are:

- To make management work of the solid wastes simple and effective.
- To minimize environmental pollution caused by the solid wastes and adverse effect thereof to the public health.
- To mobilize the solid wastes as resources.
- To privatize the management work of the solid wastes.
- To obtain public support by increasing public awareness in the sanitation works.

The policy has made a provision for the establishment of a separate unit concerning sanitation works in each municipal corporation, sub-municipal corporations, municipality and town-oriented village development committees where the management works of solid wastes has become a problem and such unit shall operate its works in close co-ordination with the national level institution concerning solid wastes management. The responsibilities of such an institution shall be as follows:

- To carry out collection, preservation, movement, site management, transportation and final disposal works of solid wastes by the local bodies having involved the private sector also, if necessary.
- To mobilize the human resources and other means available in the local body at the maximum.
- To introduce the concept and criteria of sanitation accepted by Government of Nepal.
- To involve non-governmental social organization in the sanitation works.
- To collect service charges from the person or organization generating solid wastes on the basis of volume and nature of the solid wastes.
- To punish or impose fine to a person who generates solid wastes in an unmanageable way and to use such amount in the sanitation works.

2.2.6 The industrial enterprises act 1992

The Industrial Enterprises Act 1992 was promulgated to facilitate the employment opportunities by creating an environment of industrial investment. The act states that for the establishment of a industy affecting safety, public health and environment permission from the concerned department is required. The act also has provisions to make arrangements for controlling environment by establishment of the industrial promotion board. The act gives priority to industries which manufacture pollution control devices. The act has also empowered the concerned authority to punish those who do not comply with the conditions mentioned in the license or registration certificate.

2.2.7 The labour act 1992

The Labour Act 1992, administrated by the Ministry of Labor, is the main regulation governing the working environment by making provisions for the rights, interests, facilities and safety of workers and employees working in enterprises of various sectors. Chapter 5 Section 27 of the act is related with the health and safety and some of the points included on this section are as follows:

- To make arrangements of removal and disposal of solid waste during production process.

- To make arrangements of prevention of accumulation of dust, fume, vapor and other impure materials in working rooms which would adversely affect the health.
- To make arrangements of necessary preventive personal devices for protection of health from adverse effects from any other source, and make provisions that this would produce less noise during the work process.
- To cause to conduct compulsory health check-ups of the workers or employees once every year in the enterprises where the nature of works is likely to affect the health adversely.

Section 28 sub-section 1 and 2 have the provisions of necessary protective devices for the protection of the eyes of the workers and employees from injuries likely to be caused by dust or pieces of glass, mercury, magnet, lime, stone, explosive substances and harmful rays. Section 29 has made provisions from chemical substance. The proprietor shall have to make provisions for necessary personal protective devices for the protection of workers or employees.

2.2.8 Guideline for health institutions establishment, operation and upgrade standard 2070

This guideline contains the code of conducts required for the operation of health institution. This guideline deals with the infrastructure and standards required for the operation of health institutions like emergency services, OPD and in-patient services, pharmacy, emergency preparedness, waste disposal and management and all other prerequisites.

In addition to the above mentioned national and international legislations and commitments, there are also other legal provisions and commitments, some of them are as follows:

- UN Minamata Convention on Mercury, adopted on October 2013 in Japan
- Second Long Term Health Plan 1997-2017
- Nepal Health Sector Program Implementation Plan 2010-2015
- National Guidelines on Clinical Trials with the use of Pharmaceutical Products 2005
- Standards for medical college and hospital as per the Ministry of Health and Population (MoHP) and Medical Council
- Standards of Medical College as per the university to be affiliated

Certain standards have also been endorsed which also need to be maintained for managing the sound environmental conditions of HCFs. Some of the standards are as follows:

- Waste water/effluent standards 2060
- National Drinking Water Quality Standard 2062
- National air quality standard 2069

3. Categorization

3.1 Definition

Actually HCW embraces all the wastes generated through all the medical activities. Medical activities include the activities of:

- Diagnosis, preventive, curative and palliative treatments for human beings
- Research pertaining to the above activities and
- Production or testing of biologicals

Some examples of sources of HCWs are:

- Hospitals
- Primary health care centers, health post, sub-health posts, immunization (EPI clinic), primary health care outreach clinics (PHC ORC)
- Clinics (medical, primary health care, alternative medicines, dental, maternity homes, dialysis centers, physician offices)
- Laboratories and research centers (medical and biomedical laboratories, medical research centers and institutions, blood banks and blood collection centers, biotechnology laboratories, pathological laboratories, microbiological laboratories)
- Pharmacy and medical store
- Institutions (medical, nursing home, dental, nursing, paramedics, drug rehabilitation centers)
- Mortuary and autopsy centers
- Ambulance and emergency care

3.2 Categorization based on the UNEP/SBC/WHO

Health care wastes have been classified into different categories by different organizations. Below provided HCW categorization is based on the Technical Guidelines on Environmentally Sound Management of Biomedical and Health care waste provided by the Conference of the Parties to the Basel Convention on the Control of Trans-boundary Movements of Hazardous Waste and their Disposal. (UNEP/SBC/WHO, 2004) According to this, HCW is basically divided into five categories.

3.2.1 Non-risk health care waste

Non-risk HCWs are those wastes generated from the HCFs which have not been infected. This type of waste does not pose any problem or hazard to human health or to the environment and are comparable to the domestic waste. It is usually generated from the administrative and house-keeping services of HCFs. Examples of such wastes includes: general office waste, garden/yard waste, packaging or left over food. These wastes can be composted to make manure or can be recycled or can be managed by the municipal waste services. Researches have shown that non-risk HCWs constitute about 75% to 90% of the total amount of HCWs generated by HCFs. Non-risk HCWs are again classified as follows:

i. Recyclable HCW

It includes paper, card board, non-contaminated plastic or metal, cans or glass which can be recycled. These can be sold to the recycling company to generate money.

ii. Biodegradable HCW

This category of waste consists of the waste that can be composted. Examples are left over food scraps or gardens. Food scraps can provide most of the nitrogen while bulking agents such as wooden chips could provide carbon. The composting techniques range from the simple anaerobic to vermin-composting. The resulting rich compost can be used as manure by the community people or it can be used for plants around the HCF.

iii. Other non-risk HCW

This category of non-risk waste includes all the non-risk waste that does not belong to categories of recyclable HCW and biodegradable HCW.

3.2.2 Health care waste requiring special attention

This category of HCW constitutes the biomedical HCW which needs special attention for disposal and it includes five types of wastes namely; human anatomical waste, sharp waste, pharmaceutical waste, cytotoxic pharmaceutical waste and blood and body fluids, as described below:

i. Human anatomical waste

Human anatomical waste consists of human body parts, organs and tissues. Examples of such wastes are: tissue waste, removed organs, amputated body parts, placentas, blood, body fluids, human fetus, animal and carcasses obtained through medical procedures.

ii. Sharp Waste

Sharps are all objects and materials capable of cutting or penetrating skins. These wastes pose a potential risk of injury and infection due to their puncture or cut property. For this reason, sharps are considered as one of the most hazardous waste generated in the HCFs and they must be managed with utmost care. Sharp waste may be contaminated with blood, body fluid, microbiological materials and toxic or cytotoxic substances. Examples of such wastes include: all types of needles, broken glass ware, ampoules, scalpel blades, lancets, cover slips, glass slides, vials without content, various plastic items such as amniotic membrane perforators and broken plastic pipettes.

iii. Pharmaceutical waste

Pharmaceuticals include a multitude of active ingredients and types of preparations. Pharmaceuticals range from heavy metal containing disinfectants to highly specific medicines. This category of waste also comprises pharmaceuticals that have passed their recommended shelf life or pharmaceuticals that are unusable. Pharmaceutical wastes are again divided into three classes.

- **Non-hazardous pharmaceutical waste**
  This class includes pharmaceuticals such as camomile tea, normal saline, dextrin or cough syrup, which pose no hazard during collection, intermediate storage

and waste management. They are not considered hazardous wastes and should be managed as non-risk HCW.

- **Potentially hazardous pharmaceutical waste**
  This class of pharmaceutical waste poses a potential hazard when used improperly by un-authorized persons. They are considered as hazardous wastes and their management must take place in an appropriate way.

- **Hazardous pharmaceutical waste**
  This pharmaceutical waste comprises heavy metal containing unidentifiable pharmaceuticals as well as heavy metal containing disinfectants, which owing to their composition require special management. They must be considered as hazardous wastes and their management must take place in an appropriate way.

iv. Cytotoxic pharmaceutical waste

Cytotoxic pharmaceutical wastes are HCWs that can arise by use (administration to patients), manufacture and preparation of pharmaceuticals with a cytotoxic (antineoplastic) effect. These chemical substances can be sub-divided into six main groups: alkylated substances, antimetabolites, antibiotics, plant alkaloids, hormones, and others.

- Alkylating agents cause alkylation of DNA nucleotides, which leads to cross-linking and miscoding of the genetic stock.
- Anti-metabolites inhibit the biosynthesis of nucleic acids in the cell; mitotic inhibitor; prevent cell replication.

Persons who handle cytotoxic pharmaceuticals are exposed to potential health risk from the mutagenic, carcinogenic and teratogenic properties of these substances. Special measures and precaution must be taken to handle such pharmaceuticals for occupational health and safety provisions. Cytotoxic drugs are being increasingly used in HCFs to treat various malignant and non-malignant conditions such as cancer, rheumatoid arthritis, multiple sclerosis, psoriasis, systemic lupus erythematosus (SLE) and some ophthalmic conditions. Examples of such wastes include: discernible liquid residues of cytotoxic concentrates, post-expiration-date cytotoxic pharmaceuticals and contaminated materials from drug preparation and administration such as syringes, needles, gauges, vials; urine, feces and vomit from patients which may contain potentially hazardous amounts of the administered cytotoxic drugs or of their metabolites and these should be considered genotoxic for at least 48 hours and sometimes up to 1 week after drug administration and these must be disposed of as cytotoxic pharmaceutical waste. It is recommended to prepare separate guideline for management of cytotoxic pharmaceuticals by HCFs handling cytotoxic drugs.

v. Blood and body fluids waste

It includes wastes that are not categorized as infectious waste but are contaminated with human or animal blood, secretions and excretions. These wastes might be contaminated with pathogens. Examples of such wastes include: dressing material, swabs, syringes without needle, infusion equipment without spike, bandages.

3.2.3 Infectious and highly infectious waste

These wastes consist of the pathogen and its contamination cause the spread of the diseases. These wastes must be imposed whenever waste is known or expected to be contaminated by causative agents of diseases. This category of waste has been divided into two groups depending on the degree of infectiousness that is expected.

i. Infectious waste

This category of HCW comprises of those kinds of infectious waste, which is known or clinically assessed by a medical practitioner or surgeon to have the potential of transmitting infectious agents to humans or animals. Waste of this kind is typically generated in the following places: isolation wards of hospitals; dialysis wards or centers caring for patients infected with hepatitis viruses (yellow dialysis); pathology departments; operating theatres; medical practices and laboratories which mainly treat patients suffering from the diseases specified above. It includes following wastes:

- Discarded materials or equipment contaminated with blood and its derivatives, other body fluids or excreta from clinically confirmed infected patients or animals with hazardous communicable diseases. Contaminated waste from patients known to have blood-borne infections undergoing hemodialysis (e.g. dialysis equipment such as tubing and filters, disposable sheets, linen, aprons, gloves or laboratory coats contaminated with blood).

- Carcasses as well as litter and animal feces from animal test laboratories, if transmission of the above-mentioned diseases is to be expected.

Blood from patients contaminated with HIV, viral hepatitis, brucellosis, Q fever, feces from patients infected with typhoid fever, enteritis, cholera and respiratory tract secretions from patients infected with TB, anthrax, rabies, poliomyelitis are also considered as infectious waste.

ii. Highly infectious waste

This category of HCW includes:

- All microbiological cultures in which a multiplication of pathogens of any kind has occurred. They are generated in institutes working in the fields of hygiene, microbiology and virology as well as in medical laboratories, medical practices and similar establishments.

- Laboratory waste (cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories). Examples of such wastes: sputum cultures of TB laboratories, contaminated blood clots and glassware material generated in the medical analysis laboratories, highly concentrated microbiological cultures carried out in medical analysis laboratories.

3.2.4 Other hazardous waste

This category of HCW include waste chemicals, waste with high contents of heavy metals such as batteries, pressurized containers, etc. Chemical waste consists of discarded gaseous, liquid and solid chemicals that are generated during diagnostic and experimental work and from disinfecting procedures, cleaning processes and house-keeping. Not all of them are hazardous and chemical waste is considered hazardous if it has at least one of the following properties:

- Toxic,
- Corrosive (acids of pH <2 and bases of pH >12),
- Flammable,
- Reactive, (explosive, water-reactive, shock sensitive)
- Cytotoxic or genotoxic properties.

They must be used and disposed of according to the specifications provided with each type of chemical. Waste with high contents of heavy metals and their derivatives are potentially highly toxic. They are considered as a sub-group of hazardous chemical waste and are usually highly toxic; should be treated specifically. Mercury wastes are usually generated by spillage from broken clinical equipment (thermometer, blood pressure gauges, etc). Residues from dentistry have high mercury content. Cadmium waste comes from the discarded battery. Many types of gases used in HCFs are often stored in pressurized cylinders. Pressurized containers either full or emptied should be handled with care these containers may explode if incinerated or accidently punctured. Examples of such wastes: thermometers, blood-pressure gauges, photographic fixing and developing solutions in X-ray departments, halogenated or non-halogenated solvents, organic and in-organic chemicals, containers or aerosol cans with pressurized liquids, gas or powdered materials.

3.2.5 Radioactive waste

Radioactive wastes include materials contaminated with radio-nuclides, which arise from the medical or research use of radio-nuclides. It includes disused sealed radiation source, liquid and gaseous material contaminated with radionuclide, excreta of patients who underwent radionuclide diagnostic and therapeutic applications, paper cups, straws, needles syringes, test tubes and tap water washing of such paraphernalia. These wastes are generated from in-vitro analysis of body tissue and fluid, in-vivo body organ imaging and tumor localization, and investigative and therapeutic procedures. These wastes with ionizing radiations have genotoxic effects. It is produced during nuclear medicine, radio-immuno assay (RIA) and bacteriological procedures. The ionizing radiations in medicine include X-rays and γ-rays as well as α- particles and β- particles. It concerns mainly therapeutic and imaging investigation activities where Cobalt (60Co), Technetium (99mTc), Iodine (131I) and Iridium (192Ir) are most commonly used. Certain radionuclide e.g. C-14 contaminated wastes have much longer half-life more than a thousand years, this needs special management, if possible in a centralized treatment facility (CTF) for radioactive wastes. Similar treatment is recommended for the management of disused radiation sources used for cancer treatment. In case of unavailability of CTF, it should be stored safely till it decays.

3.3 Categorization at nepalese context

At the present context, HCFs in Nepal are still at infancy in the HCWM practices. Proper management of above categorized HCWs is a big challenge for Nepal. Wherever possible, the above classification by UNEP/SBC/WHO is recommended for the segregation of HCWs. Considering the geographic and climatic variation of the country, the categorization should entirely depend on the nature of the HCFs generating wastes and the available techniques of their treatment and disposal. Based on the amount and categories of generated HCWs, the number and types of HCWs can be decreased or increased. However, it is recommended that the non-risk HCW should not be mixed with other types of HCWs. Non-risk HCW should at least be separated into:

- Bio-degradable
- Non-biodegradable

Risk health care wastes should at least be separated into six categories as mentioned below:

- Pathological Waste
- Infectious waste
- Sharp waste
- Cytotoxic waste
- Pharmaceutical waste
- Other hazardous waste

4. Possible Environmental and Health Impacts

In Nepal, health care sector is expanding enormously and this has resulted in generation of large quantities of HCWs. HCWs are either being dumped by the river bank or go to the landfill site along with domestic waste. In many cases HCWs are burned in metal drums or just openly. This results in the emissions of by-products and toxic substances into the environment. Improper disposal of HCWs pollute environment either due to the contamination of ground water, soil or by releasing several toxic gases like dioxin and furan along with the heavy toxic metals like lead, mercury and cadmium. All individuals exposed to HCWs are potentially at risk of being injured or infected specially due to infectious and sharp waste.

4.1 Occupational and public health risks

All individuals, who are exposed to hazardous HCWs are potentially at risk of being injured or infected. They include:

- Medical staff: doctors, pharmacists, laboratory technologists, nurses, paramedics, sanitary staff and hospital maintenance personnel
- In and out patients: receiving treatment in HCFs as well as their visitors
- Workers in support services: linked to HCFs such as laundries, waste handling and transportation services
- Workers in waste disposal facilities: including scavengers
- The general public: mostly the children playing with the items they can find in the waste outside the HCFs when it is directly accessible to them.

During handling of wastes (especially infectious and sharps), the medical and auxiliary staff as well as the sanitary staffs can be infected and injured if the waste has not been packed safely. Many injuries occur because syringes, needles or other sharps have not been collected in safety boxes or because these have been over filled. The unsafe disposal of HCWs (for example, contaminated syringes and needles) poses health risks to medical personnel or the public. One cross-sectional study carried out in Gandaki Medical College Teaching Hospital showed that 70.79% health care workers had experienced Niddle Stick Injury (NSI) among them 52.5% suffered from NSI with unused needles and 47.5% health care workers suffered NSI from used needles; 68.42% of NSI sufferer of used needles reported the incident. (Gurung, et al, 2010)

Contaminated needles and syringes creat a big threat if we failure to dispose them safely. Contaminated injections and equipments may be scavenged from waste areas and dump sites and are either reused or sold keeping the public at risks. Experts working on health care and solid waste management expressed that the recycling practices, particularly the reuse of syringes, is certainly the most serious problem in Nepal. WHO estimates that over 20 million infections of hepatitis B, C and HIV occur yearly due to unsafe injection practices (reuse of syringes and needles in the absence of sterilization) and transmits via HCWs. Generally, these viruses are transmitted through injuries from syringe needles contaminated by human blood. WHO estimated that, in 2000, contaminated injections with contaminated syringes caused:

- 21 million hepatitis B virus (HBV) infections (32% of all new infections);
- 2 million hepatitis C virus (HCV) infections (40% of all new infections); and
- at least 260000 HIV infections (5% of all new infections).

Sharps not only cause cuts and punctures but may also infect these wounds if they are contaminated with pathogens. Because of this double risk of injury and disease transmission, sharps are considered as one of the most dangerous categories of HCWs. The general public can be infected by HCWs either directly or indirectly through several routes of contamination.

Infectious waste may contain variety of pathogenic microorganisms. Pathogens in infectious waste may enter the human body through a puncture, abrasion, cut in the skin; mucous membranes; inhalation or by ingestion and can have major adverse effects to the community. Examples of infection caused by the HCWs are given in 4.

Table 4. Infection caused by the HCWs

Type of infection	Examples of causative organisms	Transmission vehicles
Gastroenteric infections	Enterobacteria (Salmonella, Shigella spp.); Vibrio cholerae; helminthes	Feces and/or vomit
Respiratory infections	Mycobacterium tuberculosis; measles virus; Streptococcus pneumoniae	Inhaled secretions; saliva
Ocular infection	Herpes virus	Eye secretions
Genital infections	Neisseria gonorrheae; herpes virus	Genital secretions
Skin infections	Streptococcus spp.	Pus
Anthrax	Bacillus anthracis	Skin secretions
Meningitis	Neisseria meningitides	Cerebrospinal fluid (CSF)
HIV/AIDS	Human immunodeficiency virus (HIV)	Blood, sexual secretions
Hemorrhagic fevers	Junin, Lassa, Ebola, Marburg viruses	All bloody products and secretions
Bacteremia	Coagulase-negative Staphylococcus spp.; Staphylococcus aureus; Enterobacter, Enterococcus, Klebsiella, Streptococcus spp.	
Candidemia	Candida albicans	Blood
Viral hepatitis A	Hepatitis A virus	Feces
Viral hepatitis B and C	Hepatitis B and C viruses	Blood and body fluids

Source: WHO, 1999

In addition, the existence of bacteria resistant to antibiotics and chemical disinfectants in HCFs may also contribute to the hazards created by poor management of HCWs. It has been demonstrated that plasmids from laboratory strains contained in HCWs were transferred to indigenous bacteria via the waste disposal system. (WHO, 1999) Moreover, antibiotic-resistant Escherichia coli survive in an activated sludge plant, although there is no significant transfer of this organism under normal conditions of waste water disposal and treatment.

4.2 Indirect risks via the environment

Besides patients and health care personnel, consideration must be given to the impact of HCWs to the general public and environment. Care must also be paid to the possible pollution of air, water and soil including the aesthetic beauty. The dumping of HCWs in uncontrolled areas can have a direct environmental effect by contaminating the surroundings including the ground water. Obsolete pesticides (especially DDT used for the treatment of malaria in HCF), stored in leaking drums or torn bags, can directly or indirectly affect the health of anyone who comes into contact with them. Poisoning can occur through direct contact with the product, inhalation of vapors, drinking of contaminated water, or consuming of contaminated food. Other hazards may include the possibility of fire as a result of inefficient disposal such as burning. Pharmaceutical residues, which may include antibiotics and other drugs, heavy metals such as mercury, phenols and derivatives, and disinfectants and antiseptics may have toxic effects on the natural ecosystems.

Mercury has been used over centuries in the HCFs. The mercury exposed to the environment due to broken thermometers, sphygmomanometer, due to accidental spills and emissions from the incineration of HCWs increase the risk of various hazards resulting due to acute and chronic exposures. The most common potential mode of occupational exposure to mercury is via inhalation of metallic liquid mercury vapors. Mercury, due to its potent neurotoxic nature, can affect brain, spinal cord, kidneys and the development of children. Due to the growing awareness on mercury related hazards on the public health and environment, Nepal has recently banned the purchase and use of mercury containing devices in all the HCFs. Mercury based medical devices are being slowly replaced with mercury-free alternative devices in the HCFs.

Inefficient incineration and open burning of HCWs are the main sources of dioxins, furans, and are major sources of mercury pollution in HCFs. In the last few years, there has been growing controversy over the incineration of HCWs. Under some circumstances, including when wastes are incinerated at low temperatures or when plastics that contain polyvinyl chloride (some plastics, some blood bags and fluid bags) are incinerated, dioxins, furans and other toxic air pollutants may be produced as emissions and/or in bottom or fly ash. Dioxins, furans and co-planar polychlorobiphenyls (PCBs) are persistent organic substances that do not readily break down in the environment and bio-accumulate in the food chain. Most human exposure to dioxins, furans and co-planar PCBs is through the intake of food. Long-term, low-level exposure of humans to dioxins and furans may lead to the impairment of the immune system, nervous system, endocrine system and reproductive functions. Short-term, high-level exposure may result in skin lesions and altered liver function. WHO has established a Provisional Tolerable Monthly Intake (PTMI) for dioxins, furans, and polychlorinated biphenyls (PCBs) of 70 picograms (10-12 g) per kilogram of body weight. The PTMI is an estimate of the amount of chemical per month that can be ingested over a life time without appreciable health risk. (WHO, 1999)

National Implementation Plan for Stockholm Convention on POPs has estimated the annual release of dioxin and furan at about 335.97 gTEQ. Out of which 12 gTEQ is coming from medical waste incinerators and 159 gTEQ is coming from uncontrolled burning of biomass including waste. (MoEST, 2007)

Thus, dioxins, furan and mercury emissions from HCFs are a major environmental and health challenges. Substantive steps need to be taken to reduce these emissions by waste minimization, environmentally safe alternatives and in-house management of waste in the HCFs.

5. Organizational Issues

Government of Nepal has been conducting various programs and activities on HCWM including awareness raising, orientation, training to health care workers; however, HCWM is not so effective due to following reasons:

- Lack of specific policy and legislation on HCWM
- Weak implementation of existing policy, acts, rules and guidelines
- Inadequate coordination with the concerned stake holders
- Low priority to HCWM.
- Inadequate awareness regarding the impacts of HCWs to the public health and environment
- Inadequate monitoring and evaluation
- Lengthy procurement procedure

Experts' opinion and experiences show that installation of individual treatment facilities by small HCFs requires comparatively high capital investment. Furthermore, it requires separate human resource and infrastructure development for proper operation and maintenance. Thus concept of Central Treatment Facility (CTF) for HCWs addresses such problems. This concept of CTF can be one of the options for the proper HCWM. In such a scenario, individual HCFs should manage their HCWs on their own efforts. Some HCFs such as Civil Service Hospital and Bir Hospital are managing their HCWs by applying 'zero waste concept' for HCWs generated from wards and operation theater and are the encouraging model of the HCWM practices in Nepal.

Whether the generated HCWs are treated and disposed in CTF or in the hospital premises or in the municipal landfill site, HCF shall be responsible for the proper treatment and disposal of the generated HCWs. In this context, HCF itself can manage the HCWs or can contract the civil society organization/private organization for the proper management of HCWs. Each HCF shall be responsible for the development of waste management plan for their HCF, outlining the accountabilities and responsibilities of managers, employees and staffs. The HCF shall comply with guidelines, to ensure proper HCWM i.e. proper classification, segregation, collection, transportation, treatment, and disposal. Options for HCWM plan depend entirely on the local context. Additionally, locally available technology and maintenance is an important consideration while making HCWM plan. Generally, a HCWM plan should be implemented from the onset of planning a HCF. So, every HCF must develop its HCWM Plan. Certain basic steps are needed for the development of proper HCWM plan, which are discussed in the next heading.

5.1 Planning and organization

Efficient and appropriate HCWM practices depend entirely on the administration and management of the organization. This requires adequate legislative and financial support along with the active participation by trained, skilled and dedicated staff. The entire organizational structure and service of HCF must be responsible for the proper management of HCW; however, certain units and individual

have more responsibility. Thus, particular services/units within the HCF must be identified to have major role on HCWM. The functions of the administrations are provided in the paragraph below.

5.1.1 Function of the administration office

- Form a health care waste management committee (HCWMC) to develop a written waste management plan for the HCF.
- Designate a waste management officer to supervise and coordinate the waste management plan.
- Keep an up-to-date waste management plan.
- Ensure that monitoring procedure is incorporated in the plan. The efficiency and effectiveness of the waste management system should be monitored in such a way that the system can be updated and revised whenever necessary.
- Ensure adequate training for the key staff members and designate the staff responsible for coordinating and implementing the training course.
- Establish good working relationship with related organizations concerning HCWM.
- Establish good community relationship through the awareness raising activities to the community people.

5.1.2 Health care waste management committee (HCWMC)

As mentioned above, every HCF should have HCWMC and the committee should constitute at least following members:

- Chief/Director of the HCF
- Department Heads
- Matron
- Waste Management Officer
- Representative from support staff (sweeper)

For other smaller HCF, the waste management committee must have the following members:

- Chief of the HCF
- Technical staff
- Support staff (sweepers/worker)

The functions of HCWMC will be as follows:

- Promulgate a strategy formalizing the commitment of HCF to proper HCWM with the prime goal of protecting health and environment.
- Establish baseline data and develop the HCWM plan which must include, training and written guidelines on waste management from waste generation to waste treatment and final disposal.
- Implement the HCWM plan and review and update the plans and guidelines in an annual basis.
- Ensure adequate financial and human resources for the implementation of HCWM plan

(to support this, the authorized body can recommend the formulation of strategy to allocate certain percentage of total budget for HCWM).
- Assign responsibility to each member of the committee.

5.1.3 Health care waste management plan

A comprehensive waste management plan is essential for safe and efficient waste management in a HCF. While developing the waste management plan, first step is the assessment of the generation of waste within the facility. The assessment begins with establishing a baseline of how much and what kind of waste is being generated by whom in each department/ward. This involves gathering data regarding the waste streams, processes and operations, types of practices, information on input materials and economic information. Waste audit is an important tool for the assessment phase, providing data on the source of waste, compositions, generation rates and waste flow within the HCF. Data can be collected in-house using self-audit forms and questionnaires. Data collected for few days provides a snapshot of the waste flow and data collected for continuous seven days provides a clear picture of waste generation, as the waste generation pattern differs from day to day. Through this data the HCF can establish the flow of waste and generation rates from every unit/department of the HCF. Waste composition data can be used to determine segregation practice. Data from the waste generation survey should form the basis while developing HCWM plan. Following procedures should be taken into consideration while developing HCWM plan:

- Existing policies, laws, regulations and guidelines related to HCWM
- Review and assess the current waste management stream within HCF before drafting or revising HCWM plan, some of the issues to be addressed are:

    - Where waste is generated
    - What types of wastes are being generated
    - How the waste are being categorized
    - How the waste are being segregated
    - How and where the waste are being collected, stored and transported
    - How the waste are being treated and disposed
    - The cost effectiveness of the current handling process
    - Personal safety of the waste handlers.

- Design the plan taking in consideration the existing and future needs of the HCF. Care must be taken such that the plan is capable of handling the current waste stream properly and efficiently.
- Comprehensive training and orientation on how the plan is to be implemented and each of the staff should know their individual roles and responsibility.
- The plan should be regularly reviewed and updated based on the recommendations of the implementation and monitoring and evaluation teams.

5.2 Implementation

Implementation of the HCWM plan includes the following activities:

- Interim measures to be introduced to complete implementation of the new waste management system according to the HCWM plan.
- Appoint personnel responsible for waste management.
- Organize and supervise training program to all staffs.
- Launch educational and communication program.
- Install necessary new equipment and ensure that the waste management operation is put in place as per waste management plan.
- HCWMC should review the plan annually and initiate change to upgrade the system, interim revisions may also be made if and when necessary.
- Prepare an annual report for the disposal of HCW, providing data on waste generation, equipment requirement and costs.

5.3 Monitoring and Evaluation

Regular monitoring and evaluation of the plan in each HCF should be performed. It helps to find out the loop holes, bottle necks and reveal the new issues which have come in managing the HCWs. It helps to have recommendations and shortcoming of the programs and also provides an opportunity to educate staff and reinforce good practices. Three types of monitoring mechanism need to be enforced for the progressive improvement and sustainability of the HCWM system. They are:

- Baseline monitoring
- Compliance monitoring
- Impact monitoring

Baseline and compliance monitoring should be performed by the person(s)/authority designated by existing HCWMC. Impact monitoring and evaluation should be conducted through a third party i.e. externally. A comprehensive list of indicators for compliance and impact monitoring must be developed for effective implementation of HCWM plan.

Baseline monitoring identifies the changes in basic environmental conditions whereas compliance monitoring identifies whether the concerned parties follow the rules and guidelines or not. Compliance monitoring should be done at two stages, one during construction of treatment unit/facility and another during the operation of entire plan. At the construction phase, it is important to check out whether the appropriate equipment is being installed properly. During operation, it has to be ensured that infectious and hazardous wastes are being handled properly and the equipment is being operated as per the Sanderd Operating Procedure (SOP). The monitoring should be in compliance with EIA and IEE requirements along with the HCF requirements.

Impact monitoring pinpoints the positive and negative changes that have been brought about by the establishment of HCWM system. Impact evaluation should thoroughly analyze:

- Impact
- Relevance
- Effectiveness and efficiency
- Sustainability

- Replicability

During impact evaluation, the recommendation and major lesson learnt should also be provided through opinion survey, consultation and secondary data analysis.

6. Waste Management

Health care waste includes a large component of general waste and a smaller proportion of hazardous waste. According to the WHO estimation, among the total amount of HCW generated, 80% is general HCW, 15% is pathological waste and infectious waste, 1% is sharp waste, 3% is chemical or pharmaceutical waste and less than 1% special waste such as radioactive or cytotoxic waste, pressurized container or broken thermometer and used batteries. Thus, very less amount of HCWs is hazardous if it is properly managed.

Solid Waste Management Act 2011 has clearly indicated that processing and management of hazardous waste, medical waste, chemical waste or industrial waste under the prescribed standards shall rest with the person or institution that has generated the waste. The Stockholm Convention is related with the reduction and total elimination of unintentional production of persistent organic pollutants (POPs) and has given priority for Best Available Technique (BAT) and Best Environmental Practice (BEP). In our context, following basic steps are considered essential for the proper waste management:

- Waste minimization
- Waste segregation
- Waste collection and storage
- Waste transportation
- Waste treatment and disposal

6.1 Waste Minimization

Waste minimization is defined as the prevention of waste production and/or its reduction. Waste minimization usually benefits the waste producer by reducing the costs for the purchase of goods. It involves specific strategies of changes in management and behavioral change. At the top of the waste minimization options is waste avoidance strategy. Achieving this goal means changing work practices. How we choose to go about our work often dictates how much waste we generate, for example what is our behavior? do we use disposable or reusable equipment? do we send paper memos or e-mails? do we bring our own cup or use a disposable one? Thus, methods of waste reduction include modification of purchasing procedures, control of inventory, and production of less toxic materials when discarded as wastes. However, no actions should be taken that would impact on the quality and limit the access to health care. Waste minimization can be achieved through:

- Waste reduction at source (product substitution, product change, procedural change)
- Giving preference to recyclable and reusable items

6.1.1 Waste reduction at source

Reduction involves measures that either completely eliminate use of a material or generate less waste. Examples are improving house-keeping, reviewing purchasing policies without compromising work standards or environmental outcomes. Reduction can also be achieved through product substitutions, and modifications. While purchasing the product, it should

be carefully assessed in terms of its potential to generate problematic waste, result in toxic emissions, or be detrimental to the operation and maintenance of treatment facilities in the long turn. Some of the examples are: mercury thermometer should be replaced with electronic/ digital thermometer, work with supplier to reduce packaging of the products. Simple changes to patient care procedures can also be made to minimize the wastes generated. Some of the examples are as follows:

- When preparing for dressing, cleaning and sterile procedures, practitioners should critically assess material required. Unwanted extra materials should be removed for re-sterilization or reuse. This should occur prior to the commencement of the procedure, which minimize the potential of contamination.
- Review frequency of waste collection, size and location of containers and bags.

Some of the reduction policies include:

- Purchasing reductions: selection of supplies, which are less wasteful or less hazardous
- Use of physical rather than chemical cleaning methods (e.g. steam disinfection instead of chemical disinfection)
- Prevention of wastage of products, e.g. in nursing and cleaning activities.

6.1.2 Giving preference to reusable and recyclable items

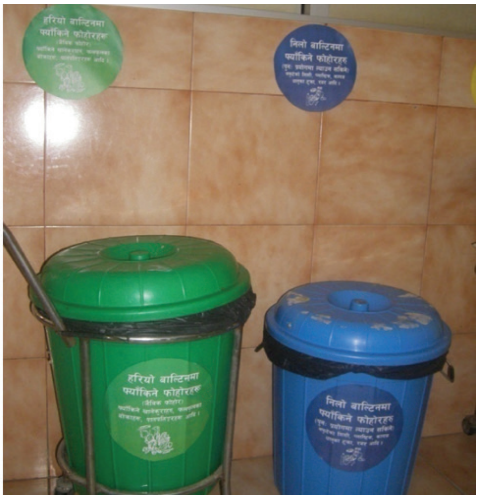
Product recycling and reuse can minimize the volume of HCWs, though a high standard of patient care and worker safety may preclude reuse of some items. Plastic syringe, catheters and waste contaminated with radioactive substances such as plastic, disposable gloves, syringes and needles can not be recycled or reused. Medical and other equipments used in HCF may be reused provided that it is designed for the purpose and will withstand the sterilization process; some examples are scalpels, glass bottles and containers. After use, reusable items should be collected separately from non-reusable items, carefully washed and sterilized by one of the available processes; however, infectious waste should not be washed before sterilization. Instead, washing is recommended after sterilization before sending it into recycling. HCFs should critically examine current waste streams and determine what product can be separated out at the point of generation to be effectively recycled. Some of the materials which can be recycled are given below:

- Glass
- Plastics
- Aluminium cans
- Paper and card board
- Iron

Before beginning any reclamation/recycling program, it is recommended to review the possible uses for these products.

6.2 Waste Segregation

Waste segregation refers to the process of separation of waste at the point of generation and keeping them apart during handling, collection, interim storage and transportation. Segregation of the waste at source is the key principle of successful and safe waste minimization and is the most important step for a successful management of HCW. In fact, it reduces the quantity of that wastes, which are hazardous and require special attention and treatment. It is highly recommended that segregation of HCW occurs on-site at the time the waste is generated, for example, when an injection is given, needle and syringe are placed in a different waste container, or when packaging is removed from supplies and equipment and kept separately. Thus, segregation must take place at the bed site, at the operation theater, at ward, at laboratory, wherever it is generated. Non-risk waste (e.g. paper, glass, plastic, iron) can be recycled. Non-risk biodegradable organic wastes (i.e. food waste, garden waste) can be composted. Infectious waste must never be mixed with non-infectious waste to keep the volume of infectious waste as low as possible.



Segregation of waste (Source, MD-DoHS)

Given the fact that only about 10-25% of the HCW is hazardous, treatment and disposal costs can be greatly reduced if a proper segregation is performed. Segregating risk wastes from non-risk waste greatly reduces the risks of infecting workers handling HCWs. Based on the hazardous properties of the waste, the type of treatment and disposal practices that are applied to the waste generated. A recommended way of identifying HCW categories is by sorting the waste into color-coded and well-labeled bags or containers. Sturdy (rigid walled) containers should be used and container should be selected according to the following criteria:

- The opening must be wide enough to allow disposable materials to be dropped into the container by a single hand operation. Depending on the bulk of the disposable material for which the particular container is designed, the aperture should, under normal conditions of use, inhibit removal of the contents.
- If retractable lids are incorporated, they should be designed or long forceps should be provided so that there is never need to push material into the container by hand.
- Container should be designed to minimize the possibility of external surface being contaminated when disposing of a used item.
- The container wall must be impermeable to fluids and non-readily penetrable. Hance, card board containers are never acceptable for this purpose.

- After being sealed, all types of containers must be leak-proof.
- The container must be capable of being securely sealed and remaining sealed during transport.
- The container must be safe and easy to handle.

All the specific procedures of HCW segregation, packaging and labeling should be explained to the medical and auxiliary staff and displayed in each department/ward on charts located on the walls nearby the HCW containers that should be specifically suited for each category of waste. Segregation should:

- Always take place at the source, i.e. at the ward, bed side, operation theater, medical laboratory, pharmacy or any other room or ward in the HCF, where the waste is generated.
- Be simple to implement for the medical and auxiliary staff and applied uniformly.
- Be safe and guarantee the absence of infectious HCWs in the domestic waste flow.
- Be well understood and well known by the medical and ancillary staff of the HCFs.
- Be regularly monitored to ensure that the procedures are followed strictly.

Apart from these, following should also be followed:

- All sharps should be collected together, regardless of whether they are contaminated or not. Container should be puncture proof made of either metal or high density plastic and fitted with covers. It should be rigid and impermeable to contain not only sharps but any residual liquids from syringes. To discourage abuse, containers should be tamper proof and needles and syringes should be rendered unusable.
- Bags and containers for infectious and highly infectious waste should be marked with the internationally approved symbol for infectious waste.
- Waste with high content of heavy metals (e.g. cadmium or mercury) should be collected separately.

The recommended color-coding of the containers for different categories of the wastes is provided in Table 5.

Table 5. Recommended color-code for the container, labeling and international signs for segregation of HCW

Waste Category, symbol and labeling		Color Code for Container	Examples of wastes
Non-risk HCW	Non-risk waste Biodegradables	Green	Left over stuff foods, gardens, fruits peels, flowers etc.
	Non-risk waste Recyclable 	Dark Blue	Non-biodegradable, which can be recycled: plastic bottles, cans, metals, glass, plastics, papers, rubber etc.
	Other non-risk HCW	Light Blue	Other HCW, that do not belong to bio-degradable and recyclable.

HCW requiring special attention	Pathological waste  Danger! Pathological waste	Red	Human body parts, organs, human tissues, removed organs, amputated parts, bone marrow.
	Hazardous Sharps  Danger! contaminated sharps Do not open	Red	Needles, glass syringes with fixed needles, scalpels, blades, glass, etc. which may cause puncture and cuts.
	Pharmaceuticals	Red	Unused and date expired drugs
	Cytotoxic pharmaceutical waste  Danger! Hazardous Infectious waste	Red	Waste with anti-neoplastic effect such as: alkylated substances, anti-metabolites, antibiotics, plant alkaloids, hormones, etc.
Infectious and Highly infectious waste	Danger! Hazardous Infectious waste  	Brown	Discarded items contaminated with blood and body fluids from clinically confirmed infected patients including cotton, dressings materials, soiled plaster, linen, bedding, swabs, gloves, syringes without needle, infusion equipment without spike, bandages, other materials contaminated with blood, dialysis equipment, blood from patients infected with HIV, viral hepatitis, brucellosis, respiratory tract secretion from patients infected with TB, anthrax, rabies.
	Danger! Highly infectious waste . 	Brown	Waste generated from the microbiological cultures, laboratory waste, such as sputum cultures of TB laboratories, highly concentrated microbiological cultures

Other hazardous waste	Danger! To be discarded by authorized staff only  	Yellow	Waste with high content of heavy metals, such as batteries, pressurized container, organic and inorganic chemicals
Radioactive Waste	Danger! Radioactive waste  or 	Black	Waste includes solid, liquid and gaseous waste contaminated with radionuclides such as Cobalt, Technetium, Iodine, Iridium, generated from in-vitro analysis of body tissue and fluid, in-vivo body organ imaging and tumor localization

Note: If the container with the recommended color is not available, any colored container can be used to segregate wastes with proper labeling and hazardous sign as shown in the above table.

Since categorization of the waste entirely depends on the types of the waste generated, available technology for the treatment and disposal, and the local environmental conditions of HCFs. If possible, HCFs should categorize and segregate the HCWs as mentioned above. However, it is recommended that HCFs should at least categorize and segregate the HCWs into non-risk HCW and risk HCW as mentioned in section 3.3.

6.3 Waste Collection and Storage

In order to avoid accumulation of the waste, it must be collected and transported to a central storage area within the HCF on a regular basis before being treated or removed. All the collected HCWs should be stored in waste storage area until transported to a designated off-site treatment facility. This area must be marked with warning sign. Storage facilities for waste should be suitably established within the HCF; however, these areas should be located away from patient rooms, laboratories, hospital function/operation rooms or any public access area. The storage facility should be lockable, hygienic and appropriately sign-posted. They must be kept secured at all the times. HCFs are responsible for providing:

- Designated storage areas with adequate lighting, ventilation and provision for the containment of spills within the storage area.
- Water supply for cleaning purposes.
- Waste security and restriction of access to authorized persons.
- Easy access for waste collection vehicle.
- Protection from sun, rain, strong winds and floods.
- Storage areas designed so that routine cleaning, maintenance to hygienic standards and post-spill decontamination are all easy to undertake.
- Supply of cleaning equipment, protective clothing and waste bags or container should be located conveniently close to the storage area.

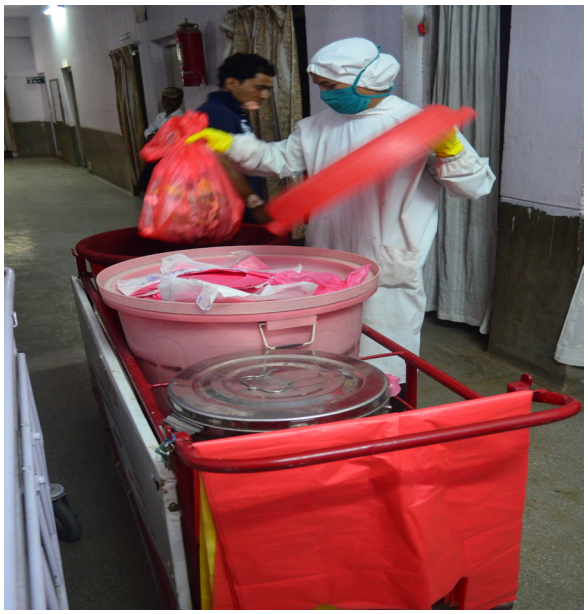
- Bio-degradable general and hazardous waste should not be stored longer and should be removed within 24 hours to minimize microbial growth, putrefaction and odors.
- Segregation should be well maintained in the storage area.

For small waste generators, the requirement for a designated storage area may be achieved by the use of suitable rigid-walled container. The container should be kept in secure area and measures should be taken to prevent obnoxious odors or nuisance. Appropriate labeling for any forms of waste stored in the area should be included.

6.4 Waste Transportation

Health care waste collection and transportation practices should be designed to achieve an efficient movement of waste from point of generation to storage or treatment. A program for collection of HCW should be established as part of the HCWM plan. Certain recommendations should be followed by the auxiliary worker in-charge of waste collection:

- Suggested collection frequency on room to room basis is once every shift. Time of collection regardless of category should be at the start of every shift. In case of difficulty in the collection of waste in every shift, waste should be collected on daily basis (or as frequently as required) and transported to the designated central storage site of HCF.
- No bags should be removed unless they are labeled with their point of production (hospital and ward or department) and contents.
- The bags or containers should be replaced immediately with new ones of the same type.
- A supply of fresh collection bags or containers should be readily available at all locations where waste is produced.



Transport of infectious waste (Source: Katy Thompson, 2012)

6.4.1 On-site transport

The waste disposal plan of HCF should include procedures for on-site and off-site transport of wastes. During movement of wastes segregation must be maintained and the batch of

waste should be managed according to the component with the highest level of risks. On-site transport of waste from the point of generation to an assembly storage or treatment area should be carried by wheeled trolleys, containers or carts. Wherever possible, the transport of clinical waste should be separate from general traffic. Hazardous/infectious HCW and non-risk HCW should be transported on separate trolleys. The transportation must follow specific routes through the HCF to reduce the passage of loaded carts through wards and other clean areas. The carts or trolleys should be:

- Easy to load and unload.
- Have no sharp edges that could damage waste bags or containers during loading and unloading.
- Easy to clean.

The on-site collection vehicle must be cleaned and disinfected daily using chlorine solution, phenolic compounds and persons transporting the waste should be equipped with appropriate protective equipment.

6.4.2 Off-site transport

The HCW producer is responsible for safe packaging and appropriate labeling to the waste to be transported off-site and for authorization of its destination i.e. either at the CTF or at the landfill site. Vehicles used for transporting clinical and related waste should be reserved for this purpose wherever possible. They must be easy to load, unload and clean, and should be equipped with spillage collection sumps or other suitable spill controls. The vehicle should be marked with the name and address of the waste carrier. The hazardous/infectious sign should be displayed on the vehicle container.

HCFs are responsible for small clinical and related waste spills that may accidently occur both on-site and off-site transportation areas. HCF must include a spill management plan with well defined procedures for handling spills safely in its HCWM plan. Personnel responsible for spill management must receive education and training in emergency procedures and handling requirements and should be fully aware of how, when and which emergency service should be called for advice and assistance. Spill kits should be made easily accessible and should contain absorbents, disinfectants, buckets, shovel, broom, gloves, disposable overalls, facemasks/shield, torch, disposable containers, plastic waste bags with appropriate labeling.

6.5 Waste Treatment and Disposal

The methods for treatment and disposal of HCWs depend on specific factors applicable to the HCF, relevant legislation and environmental aspects affecting the public. The bulk of HCW falls into the category of non-risk HCW, much of which can be recycled or reused. With correct segregation, low amount of waste can be categorized as risk HCW requiring specific attention and are hazardous waste. The hazardous waste and infectious waste must be managed by approved treatment methods. Once treated, the waste may be re-classified accordingly for disposal. Currently available waste treatment options have various capabilities and limitations. As technology changes, HCFs should evaluate treatment alternatives for their safety, effectiveness, environmental impacts, costs and compliance

with country requirements. Any treatment option for HCWs should:

- Render sharps incapable of causing penetration injury.
- Achieve a significant volume reduction with no hazardous by-products.
- Result in residues being suitable for approved landfill disposal without harmful leaching to the environment.
- Result in minimum levels of hazardous or toxic by-products including POPs such as polychloro biphenyls.
- Reduce the potential for the transmission of infection.
- Be verifiable for the treated wastes.
- Have automatic controls and built-in safe mechanism.
- Have continuous automatic monitoring and recording.
- Ensure that the waste cannot bypass the treatment process.
- Meet occupational health and safety standard.
- Have safe alternative treatment and disposal in case of emergency.
- In case of autoclave, be tested at least annually to ensure that optimal performance is maintained.

HCW can be treated and disposed through the following techniques:

a. Biological procedure
b. Autoclave
c. Chemical disinfection
d. Encapsulation
e. Sanitary landfill
f. Burial
g. Septic/concrete vault
h. Incineration
i. Inertization

a. Biological Procedure

Biological process uses an enzyme mixture to decontaminate HCW and the resulting by-product is put through an extruder to remove water for sewage disposal. The technology requires regulation of temperature, pH, enzyme level and other variables. Presently, biological procedure is getting popularity for the disposal of non-risk HCW. Composting (aerobic and anerobic composting) of the biodegradable waste is one of the options for the disposal of HCWs.

i. Composting

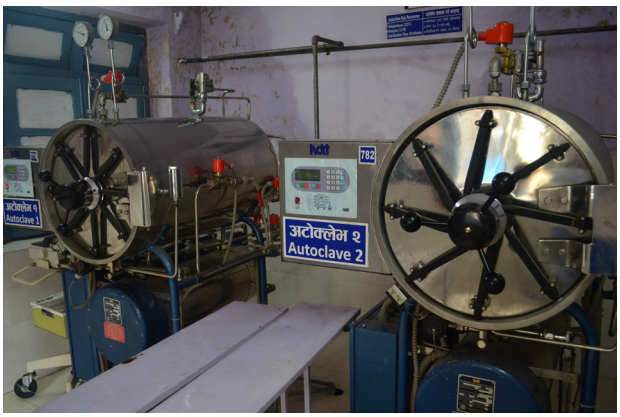
Composting technique is recommended for non-risk HCWs. Composting is the natural, biological decomposition of organic matter by fungi, bacteria, insects, worms and other organisms. Successful composting entails the management of the decomposition process so that it is relatively quick, safe and clean. Poorly managed composting may produce offensive odors, encourage pests and vermin, spread plant and animal pathogens, cause environmental contamination and generate a product of inferior quality through extended processing times that will be inefficient and

inappropriate in a commercial composting operation. Organisms that decompose organic matter require the following basic inputs and conditions to maximize their processes and efficiency:

- A suitable food source;
- A suitable temperature;
- Water; and
- Oxygen (if decomposing aerobically)

b. Autoclave

Autoclave is a process of steam sterilization under pressure. It is a low heat process in which steam is brought into direct contact with the waste material for duration sufficient to disinfect the material. Typically, autoclaves are used in hospitals for the sterilization of medical equipments to render waste harmless. This technique has been used for long time in HCFs for sterilization of reusable medical equipment. Autoclaves are commonly used for the treatment of highly infectious waste, such as microbial cultures or sharps. It has been reported that the effective inactivation of all vegetative micro-organisms and most bacterial spores in a small amount of waste (about 5–8kg) requires a 60 minute cycle at 121°C (minimum) and 1 bar (100kPa); this allows for full steam penetration of the waste material (WHO, 1999); however, the effective penetration of steam and moist heat depends on many factors including time, temperature, pressure, load size, stacking, configuration and packing density, types and integrity of bags or containers used, physical properties of the materials in the waste (such as bulk density, heat capacity and thermal conductivity), amount of residual air and the moisture content in the waste. (UNEP, 2012) Validation of the autoclave should be conducted and standard operating



Autoclave (Source: Katy Thompson, 2012)

procedure (SOP) should be followed while operation of the autoclave. The microbial inactivation efficacy of autoclaves should be checked periodically. For autoclaves that do not shred waste during steam disinfection, color-changing indicator strips may be inserted inside the yellow bag in the middle of each load and that the strip shall be checked to ensure that steam penetration has occurred. In addition, a microbiological

test (using commercially available validation kits containing Bacillus stearothermophilus spore strips, vials or packs) shall be conducted periodically or as per the requirements. It is recommended that all general hospitals, even those with limited resources, be equipped with autoclaves.

c. Chemical disinfection

Chemical disinfections are usually applied for the treatment of infectious and highly infectious HCW. Aldehydes, chlorine compounds, phenolic compounds are added to HCW to kill or inactivate pathogens. It is the preferred treatment for liquid infectious wastes, but can also be used in treating solid waste too. This technique is most suitable in treating blood, urine, stools and sewage. Some chemical systems use heated alkali to destroy tissues, organs, body parts and other anatomical waste. Chemotherapy waste (including bulk cytotoxic agents) can be treated by chemical decomposition. Examples are: reaction with 5% sodium hypochlorite; acid hydrolysis followed by alkaline hydrolysis; reduction using zinc powder, degradation using 30% hydrogen peroxide; and destruction using heated alkali. Micro-organism types, degree of contamination, type of disinfectant, contact time; and other relevant factors such as temperature, pH, mixing requirements and the biology of the micro-organism should be considered when using chemical disinfections. Occupational health and safety should be taken in consideration while using chemical disinfection. Ultimate disposal of chemically treated waste should be in accordance with national and local requirements.

d. Encapsulation

Encapsulation involves the filling of the containers with waste, adding an immobilizing material and sealing the container. The process uses either cubic boxes made of high-density polyethylene or metallic drums. When containers are three quarters filled with sharps, pharmaceuticals and chemical waste, an immobilizing agent such as plastic foam, bituminous sand, cement mortar or clay is poured into it. Material is allowed to be dried and the container is sealed and disposed safely. Encapsulation is effective in reducing the risk of scavengers gaining access to the hazardous waste. It is particularly suitable for sharps and pharmaceutical waste.

e. Sanitary landfill

Sanitary landfill is an engineered method, designed and constructed to keep the waste isolated from the environment. So, it shuuldn’t contaminate the soil, surface, and ground water and should limit air pollution, smells and direct contact with public. Disposing of certain types of HCW (infectious waste and small quantities of pharmaceutical waste) in sanitary landfills is acceptable. Some essential features of sanitary landfills are:

- Easy access to the site and working areas for waste delivery.
- Personnel should be available on-site for effectively controlling the daily operation.
- The site should be planned appropriately and divided into manageable phases, before starting the landfill.

- Lining of the base and sides of the sites must be adequately sealed to minimize the movement of waste water. Landfill site should be at least 50 meter away from water sources.
- There must be landfill gas control measures, environmental monitoring points and bore holes (for monitoring air and ground water quality).
- There must be adequate and efficient mechanism of leachate collection and treatment.
- The site must be well organized in a small area, i.e. proper spreading, compaction, and daily covering the waste with soil.
- The landfill site must be protected with wire bar/fence to prevent from unauthorized persons, animals and birds.
- Final cover must be constructed to prevent/minimize rain water infiltration when each phase of the landfill is completed.

f. Burial

Hazardous waste can be buried in a special pit. Burial is recommended in those HCFs that have minimal programs for HCWM, especially in remote locations, in temporary refugee encampments, or in areas experiencing exceptional hardship and in those cases where the safe burial of waste on hospital premises may be the only feasible option available at the time. For the purpose, the pit should be 2-5 m deep and 1-2 m wide. The bottom of the pit should be at least 2 m above the water table. After each waste load, it should be covered with a 10–30 cm thik soil layer. If coverage with soil is not possible, lime may be deposited over the waste. In case of outbreak of an especially virulent infection (such as Ebola virus), both lime and soil cover may be added. When the level of the waste reaches 30 to 50 cm to the surface of the ground, fill the pit with dirt, seal with concrete and dig another pit. Certain rules need to be established for proper HCWM in burial pit, as follows:

- Access to this dedicated disposal area should be restricted to authorized person only.
- The use of a pit would make supervision by landfill staff and thus prevent scavenging. The water deposition around the burial pit should be prevented.
- The burial site should be lined with a material of low permeability, such as clay, to prevent pollution of ground water.
- Large quantities (higher than 1 kg) of chemical/pharmaceutical wastes should not be buried.
- The burial site should be managed as a landfill, with each layer of waste covered with a layer of earth to prevent from rodents and insects and odor as well.
- Burial site should not be located in flood prone areas.
- The burial site should be fenced with warning signs.
- The location of waste burial pit should be down-hill or down-gradient from any nearby wells and about 50 meters away from any water body such as rivers or lakes.
- HCF should keep a record of the size and location of the existing burial pits to prevent construction works.

g. Septic/concrete vault

This method can be used for the disposal of used sharps and syringes. In this technique, the following process is applied.

- Dig a pit (1m x 1m x 1.8m depth), enough to accommodate sharps and syringes for certain period without reaching the ground water level. The site must be isolated and at least 500 feet away from the ground water sources and dwelling units.
- Construct concrete walls and slabs of the pit. Provide slab with opening or manhole for easy deposition of collected sharps and syringes. The manhole should be extended a few centimeters above the soil surface to overcome infiltration of the surface water.
- Deposit the collected safety boxes filled with used sharps and needles inside the septic/concrete vault.
- Install a security fence around the site.

h. Incineration

Incineration converts combustible materials into non-combustible residue or ash. Incinerators can be oil-fired or electrically powered or a combination of both. Broadly, three types of incinerators are used for treatment of HCWs: multiple hearth, rotary kiln and controlled air type. All the three types can have primary and secondary combustion chambers to ensure optimal combustion. Gases are ventilated through the incinerator stacks, and the residue or ash is disposed in a sanitary landfill. Wastes containing mercury or cadmium should never be burned or incinerated because of the risk of atmospheric pollution with toxic vapors. When wastes are incinerated at low temperatures or when plastics that contain polyvinyl chloride (PVC) are incinerated, dioxins, furans and other toxic gases may be produced as emissions and/or in bottom or fly ash (ash that is carried by air and exhaust gases up the incinerator stack). This happens particularly when wastes are incinerated at temperatures lower than 800°C or when the wastes are not completely incinerated. Even in high temperature incinerators (>800°C), temperatures are not uniform and dioxins and furans can form in cooler pockets or during start-up or shut-down periods.

Where incineration is used, two chambered incinerator should be used and must follow the standard operating procedure (SOP). HCF must utilize emission limits and other requirements to ensure effective waste treatment, minimize emissions and decrease exposure and risks to workers and the community. This should include the use of approved incinerator designs that can achieve appropriate combustion conditions (e.g., proper temperature, required chimney heights); appropriate location (e.g., away from populated areas or where food is grown); adequate training to the operator (including both class room and practical training); appropriate waste segregation, storage and ash disposal facilities; adequate equipment maintenance; managerial support, supervision; and sufficient budgeting. The temperature must be at least of 850°C to ensure minimal emission of toxic gases at the primary chamber. High chimney is also required (higher

than nearby roofs) and following wastes should never be incinerated:

- Pressurized gas containers
- Large amounts of reactive chemical waste
- Radioactive waste
- Silver salts or radiographic wastes
- Halogenated plastics (e.g. PVC)
- Mercury or cadmium
- Ampoules of heavy metals

i. Inertization

Inertization is usually suitable disposal method for the pharmaceuticals and incinerated ash with heavy metal content. (WHO, 1999) In this technique, the HCW is mixed with cement and other substances in a composition of 65% waste, 15% lime, 15% cement and 5% water. The formed mixture is allowed to set into cubes or pellets and then these are transported to suitable storage site. For proper setting of the mixtures into cubes and pellets, the waste must be grinded. In an alternative procedure, the formed homogeneous mixture in liquid state can be transported to a landfill and poured safely. This technique helps to minimize the risk of contamination of toxic substances migrating to surface water or ground water and prevent scavenging.

7. Health and Safety Practices

Management of HCW is an integral part of hospital hygiene and infection control. HCW should be considered as a reservoir of pathogenic micro-organisms, which can cause contamination and give rise to infection. If waste is inadequately managed, these micro-organisms can be transmitted by direct contact, in the air, or by a variety of vectors. Infectious waste may lead to the risk of nosocomial infections, putting the health of hospital personnel and patients at risk. It has to be emphasized here that other environmental health considerations, such as adequate water supply and sanitation facilities for patients, visitors, and health care staff are of prime importance. HCWM plans should include provision for the continuous monitoring of workers' health and safety to ensure that correct handling, treatment, storage and disposal procedures are being followed. Essential occupational health and safety measures include the following basic measures:

- Proper training of workers (no training/no hiring policy should be instituted; immunization at the first day of the work).
- Provision of equipment and clothing for personal protection.
- Establishment of an effective occupational health program that includes immunization, post-exposure prophylaxis (PEP) treatment and continuous medical surveillance.
- Information, Education and Communication (IEC) activities.

Training on health and safety should ensure that workers know and understand the potential risks associated with HCW, value of immunization against viral hepatitis B and the importance of consistent use of personal protection equipment (PPE). Workers at risk include health care providers, hospital cleaners, maintenance workers, operators of waste treatment equipment, and all operators involved in waste handling and disposal within and outside health care establishments.

7.1 Infection Prevention

Everyone who works at, receives care at or visits a HCF is at risk of infections. Thus, infection prevention is the responsibility of everyone. As a result of being at a HCF, staff, clients and visitors may be exposed to infectious diseases that others at the facility have. We can, however, prevent transmission of infections in many cases. The only way to prevent infections is to stop the transmission of micro-organisms that cause infections. The best way to prevent infection is by following standard precautions, which include the following:

- Wash hands.
- Wear PPE such as gloves, eye protection, face-shields, and gowns.
- Follow appropriate respiratory hygiene/cough etiquette.
- Prevent injuries with sharps.
- Correctly process instruments and client-care equipment.
- Maintain correct environmental cleanliness and waste-disposal practices.
- Handle, transport and process used/soiled linens correctly.

7.2 Personal hygiene and hand hygiene

Basic personal hygiene is important for reducing the risks from handling HCW, and convenient washing facilities (with warm water and soap) should be available for personnel involved in the task. As the hands of health care workers are the most frequent vehicle of nosocomial infections; hand hygiene including both hand washing and hand disinfection is the primary preventive measure. An antimicrobial soap will reduce the transient flora, only if the standard procedure for hand washing is applied. Hand washing with non-medicated soap is essential when hands are dirty and should be routine after physical contact with a patient. Killing all transient flora with all contaminants within a short time (few seconds) necessitates hygienic hand disinfection: only alcohol or alcoholic preparations act sufficiently fast. Hands should be disinfected with alcohol when an infected tissue or body fluid is touched without gloves.

7.3 Workers' protection

The generation, segregation, collection, transportation, treatment, and disposal of HCWs involve the handling of potentially hazardous and infectious material. Protection against personal injury is, therefore, essential for all workers who are directly involved in handling potentially hazardous and infectious HCWs. The individuals responsible for management of HCW should ensure that all risks are identified and that suitable protection from those risks is provided. A comprehensive risk assessment of all activities involved in HCWM should be carried out during preparation of the HCWM plan, which will allow the identification of necessary protection measures. These measures should be designed to prevent exposure to hazardous materials or other risks, or at least to keep exposure within safe limits. (WHO, 1999) Suitable training should be provided to the related personnel on this aspect.

7.4 Protective clothing

The type of protective clothing usage will depend to an extent upon the risk associated with the HCW, but the following should be made available to all personnel who are directly involved to collect and handle HCWs:

- Helmets/cap with or without visors: depending on the operation
- Face masks: depending on operation
- Disposable gloves (medical staff) or utility gloves or heavy-duty gloves (waste workers): obligatory
- Eye protectors (safety goggles): depending on operation
- Overalls (coveralls): obligatory
- Aprons: obligatory
- Leg protectors and/or boots: obligatory

Boots and heavy-duty gloves are particularly important for waste workers. The thick soles of the boots offer protection in the storage area, as a precaution from spilled sharps, and where floors are slippery. If segregation is inadequate, needles or other sharp items may have been placed in plastic bags; such items may also pierce thin-walled or weak plastic containers. If it is likely that HCW bags will come into contact with workers' legs during handling, leg protectors may also need to be worn.

7.5 Immunization

Viral hepatitis B infections have been reported among health care personnel and waste handlers, and immunization against the disease is; therefore, recommended. Tetanus immunization is also recommended for all personnel handling waste.

7.6 Injection Safety

Medical professionals and health care workers must be made aware on the injection safety. Injections are most commonly used among health care procedure worldwide. In developing and transitional countries alone, some 16 thousand million injections are administered each year. Most injections, more than 90%, are given for therapeutic purposes while 5 to 10% are given for preventive services, including immunization and family planning. (WHO, Guiding principle to ensure injection safety devices) A safe injection does not harm the recipient, does not expose the health care worker to any avoidable risk and does not result in waste that is dangerous for the community. Unsafe injection practices (reuse of syringes and needles in the absence of sterilization) have to be discouraged. The disposable needle and syringe should be rendered useless after use. The needle from the syringe should be cut/crushed and disposed safely.

7.7 Response to injury and exposure

Health care facility should establish program that prescribes the actions to be taken in the event of injury or exposure to a hazardous substance. All staffs who handle HCW should be trained to deal with injuries and exposures. The program should include the following elements:

- Immediate first-aid measures, such as cleansing of wounds and skin, and irrigation (splashing) of eyes with clean water.
- An immediate report of the incident to a designated responsible person.
- Retention, if possible, of the item involved in the incident; details of its source for identification of possible infection.
- Additional medical attention in an accident and emergency or occupational health department, as soon as possible; such as availability of post-exposure prophylaxis (PEP).
- Medical surveillance
- Blood or other tests if indicated.
- Recording of the incident;
- Investigation of the incident, and identification and implementation of remedial action to prevent similar incidents in the future.

The purpose of incident reporting should not be seen as punitive; active support by managers should encourage prompt and accurate reporting.

7.8 Special precautions for clearing up spillages of potentially hazardous substances

Spillage usually requires clean-up of the only contaminated area. For clearing up spillages of body

fluids or other potentially hazardous substances, particularly if there is any risk of splashing, eye protectors and masks should be worn, in addition to gloves and overalls. Respirators (gas masks) are also needed if an activity is particularly dangerous, for e.g., if it involves toxic dusts, the clearance of incinerator residues, or the cleaning of contaminated equipment. Residues should be recovered as completely as possible using hand tools (e.g. a shovel), and then packed safely. It is especially important to recover spilled droplets of metallic mercury. If a leakage or spillage involves infectious material, the floor should be cleaned and disinfected after most of the waste has been recovered.

7.9 Safe Use of Cytotoxic Drugs and Radioactive Materials

Health care facilities, which use cytotoxic products and radioactive materials, should develop specific guidelines on their safe handling for the protection of personnel and the environment. It is difficult to ensure safe use of cytotoxic and radioactive material, it is recommended that the use of these substances be limited to specialized (e.g., oncological) HCFs, which are better able to implement safety measures. The guidelines handling cytotoxic products should include rules on the following waste handling procedures:

- Separate collection of waste in leak proof bags or containers, and labeling for identification
- Return of date expired drugs to suppliers. Take back policy should be applied for these kinds of materials. Agreement should be signed while purchasing the cytotoxic and radioactive materials and these materials should be collected back by the suppliers after usage.
- Safe storage separately from other HCW
- Provisions for the disposal of contaminated material, for the decontamination of reusable equipment, and for the treatment of spillages.
- Provisions for the treatment of infectious waste contaminated with cytotoxic products, including excreta from patients and disposable linen used for patients.

Hospital staffs should ensure that the families of patients undergoing chemotherapy are aware of the risks and know how they can be minimized or avoided. Minimal protective measures for all waste workers who handle cytotoxic waste should include protective clothing, gloves, goggles and masks.

7.10 Emergency Response in case of spillage

Spillage is the most common type of emergency involving infectious and other hazardous materials. Spills are inadvertent discharges that occur at different place of HCF. Spills include accidental tipping over containers, dropping and breaking of containers. It may also occur during manual transfer, overfilling and leaks in the process. The response process for the spillage includes:

- Contaminated area cleaned and disinfected.
- Exposure of workers is limited as much as possible during the cleaning process.
- Impacts have to be limited on patients, medical, other personnel and environment.
- Spillage of mercury should be properly handled.
- Procedures for dealing with spillage should specify safe handling operation and appropriate protective clothing.
- In case of skin and eye contact with hazardous substance, there should be immediate decontamination and in case of eye contact with corrosive chemicals, the eye should be irrigated

continuously with clean water for 10-30 minutes; the entire face should be in basin with eyes being continuously opened and closed.

7.11 Management practices

Many of the management practices recommended in Chapters 6 contribute to a reduction in risk for personnel who handle health care waste; these are summarized as follows:

- Waste segregation: careful separation of different types of waste into different distinct containers or bags, which defines the risk linked to each waste package.
- Appropriate packaging: prevents spillage of waste and protects workers from contact with waste.
- Waste identification (through distinct packaging and labeling): allows for easy recognition of the class of waste and of its source.
- Appropriate waste storage: limits the access to authorized individuals only, protects against infestation by insects and rodents, and prevents contamination of surrounding areas.
- Appropriate transportation: reduces risks of workers being exposed to.

8. Methods of Health Care Waste Management at Different Levels of Health Care Facilities

According to Solid Waste Management Act 2011, the responsibility for processing and management of hazardous waste, medical waste, chemical waste and industrial waste under the prescribed standards goes to the person or institution that has generated the waste. Thus, the responsibility of management of HCWs of the HCF is the responsibility of chief of a HCF is of the facility itself. This chapter provides the basic guidance for the management of HCWs at different levels of HCF; however, HCFs can plan for the classification, segregation and management of the HCWs based on the local context and environment. The following tables (Table 6 to 13) show the HCWM at different levels of HCFs:

Table 6. Health Care Waste Management at Hospitals

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of HCF, concerned health workers and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial/controlled incineration as per standard operating procedure (SOP).	
	Sharps such as injections, blades	Mutilate/cut the tip of the syringe and the needle with needle and hub cutter, then autoclave and dispose properly. **OR** Wastes are first disinfected with 0.5% chlorine solution and then subjected to deep burial/ encapsulation/septic vault.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Dispose in secured landfill after encapsulation.	

Types and Categories of HCW		Methods of management	Responsibility
	Cytotoxic pharmaceutical waste such as post- expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates etc.	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill with encapsulation	Chief of HCF, concerned health workers and the authorized person
Infectious and highly infectious waste	Infectious wastes such as blood bags, gloves, syringe etc.	Sterilization with autoclave/ steam sterilization and dispose safely. Always mutilate/cut before disposal/ recycling. **OR** Mutilate/cut gloves, syringes, blood bags and then disinfect with 0.5% chlorine solution and dispose it properly (e.g. deep burial).	Chief of HCF, concerned health workers and the authorized person
	Infectious waste such as bandage, cotton etc.	Autoclave and then dispose properly. **OR** These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	
Radioactive waste	Sealed radiation source, liquid and gaseous, material contaminated with radionuclide, such as paper cups, straws, needles syringes, test tubes etc.	Apply return back policy; return the waste to the store and from the store to the supplier; it should be agreed at the purchasing phase. **OR** Radioactive isotope should be collected, packaged, inventoried and securely stored for time period suitable for complete radioactive decay. In case of mixed radioactive and infectious waste, the radioactive component is addressed first and later suitable treatment for the infectious component should be carried out.	
Other hazardous waste	Heavy metal such as mercury .	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	
	Chemical waste (chemicals used in production of biological toxins, chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Table 7. Health Care Waste Management at Primary Health Care Centre

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of primary health care centre, concerned health workers and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial/controlled incineration as per standard operating procedure (SOP).	
	Sharps such as injections, blades	Mutilate/cut the tip of the syringe and the needle with needle and hub cutter, then autoclave and dispose properly. **OR** Wastes are at first disinfected with 0.5% chlorine solution and deep burial/encapsulation/septic vault.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Dispose in secured landfill after encapsulation.	
	Cytotoxic pharmaceutical waste such as post-expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill after encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as blood bags, gloves, syringe	Sterilization with autoclave/ steam sterilization and dispose properly. Mutilate before disposal. **OR** Mutilate/cut gloves, syringes and blood bags and disinfect wastes with 0.5% chlorine solution and dispose it properly.	
	Infectious waste such as bandage, cotton	Autoclave and dispose properly. **OR** These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	

Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	Chief of primary health care centre, concerned health workers and the authorized person
	Chemical waste (chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Table 8. Health Care Waste Management at Health Post

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of Health post, concerned health workers and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial.	
	Sharps such as injections, blades	Mutilate/cut and autoclave then dispose properly. **OR** Wastes are at first disinfected with 0.5% chlorine solution and deep burial/encapsulation/septic vault.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Dispose in secured landfill after encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as gloves, syringe	Sterilization with autoclave/ steam sterilization. Always mutilate/cut before disposal/ recycling. **OR** Mutilate/cut gloves syringes, blood bags and then disinfect with 0.5% chlorine solution and dispose safely.	
	Infectious waste such as bandage, cotton	Autoclave and dispose properly. **OR** These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	

Other hazardous	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	Chief of Health post, concerned health workers and the authorized person
	Chemical waste (chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Table 9. Health Care Waste Management at Sub Health Post

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of Sub-Health post, concerned health workers and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial.	
	Sharps such as injections, blades	Mutilate/cut and autoclave then dispose properly. **OR** Wastes are at first disinfected with 0.5% chlorine solution and deep burial/encapsulation/septic vault.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Dispose in secured landfill or burial pit/ after encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as, gloves, syringe	Sterilization with autoclave/ steam sterilization and dispose safely. Always mutilate/cut before disposal. **OR** Mutilate/cut gloves, syringes, blood bags and disinfect wastes with 0.5% chlorine solution and dispose safely (deep burial).	
	Infectious waste such as bandage, cotton	Autoclave and dispose properly. OR These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	

Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	Chief of Sub-Health post, concerned health workers and the authorized person
	Chemical waste (chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains, after massive dilution with plain water.	

Table 10. Health Care Waste Management at Primary Health Care Out-reach Clinic (PHCORC)/Out-reach Immunization Post/Session

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	These wastes can be put in pit for Composting. (Discuss with the local authority for disposal).	Concerned health workers
	Recyclable (Non-biodegradable)	Recyclable items can be disposed by contacting the local authority. **OR** Bring back to the health care facility for proper disposal.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal. **OR** Bring back to the health care facility and dispose properly.	
HCW requiring special attention	Sharps such as needles	Mutilate/cut and Dispose in safety Box. The box can be carried to the nearby HCFs and dispose (Autoclave and dispose). **OR** These wastes are at first disinfected with 0.5% chlorine solution and deep burial/ encapsulation/septic vault. (Discuss with local authority before disposal whether it is possible in the local area or not.)	
Infectious waste	Wastes such as cotton swabs	It can be carried to the nearby HCFs, autoclave and dispose properly. **OR** First disinfect with 0.5% chlorine solution and safe disposal through deep burial.	

Table 11. Health Care Waste Management at Private/Public Teaching Hospitals and Nursing Homes/Research Institute

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Director, concerned health workers and the authority assigned person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If the waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial/ controlled incineration as per standard operating procedure (SOP).	
	Sharps such as injections, blades	Mutilate/cut the tip of the syringe and the needle with needle and hub cutter, then autoclave and dispose properly. **OR** Wastes are at first disinfected with chlorine solution and deep burial/ encapsulation/septic vault.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Dispose in secured landfill after encapsulation.	
	Cytotoxic pharmaceutical waste such as post-expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill after encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as blood bags, gloves, syringe	Sterilization with autoclave and dispose safely. Always mutilate/ cut before disposal/recycling. **OR** Mutilate/cut gloves, syringe, blood bags and then disinfect with 0.5% chlorine solution and dispose safely.	
	Infectious waste such as bandage, cotton	Autoclave and then dispose properly. **OR** These wastes are first disinfected with 0.5% chorine solution and safe disposal through burial/ sanitary landfill.	

Radioactive waste	Sealed radiation source, liquid and gaseous, material contaminated with radionuclide, such as paper cups, straws, needles syringes, test tubes	Apply return back policy; return the waste to the store and from the store to the supplier; it should be agreed at the purchasing phase. **OR** Radioactive isotope should be collected, packaged, inventoried and securely stored for time period suitable for complete radioactive decay. In the case of mixed radioactive and infectious waste, the radioactive component is addressed first and later suitable treatment for the infectious component should be carried out.	Director, concerned health workers and the authority assigned person
Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	
	Chemical waste (chemicals used in production of biological toxins, chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water.	

Table 12. Health Care Waste Management at Clinic/Pathology lab clinic

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Chief of the clinic and the authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If the waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Human anatomical wastes such as placenta, human tissue	Dispose in placenta pit/safe burial/ controlled incineration as per standard operating procedure (SOP).	
	Sharps such as injections, blades	Mutilate/cut the tip of the syringe and the needle with needle and hub cutter, then autoclave and dispose properly. **OR** Disinfect with 0.5% chlorine solution and dispose safely.	

HCW requiring special attention	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Disposal in secured landfill with encapsulation.	Chief of the clinic/ concerned staffs
	Cytotoxic pharmaceutical waste such as post-expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill with encapsulation.	
Infectious and highly infectious waste	Infectious wastes such as blood bags, gloves, syringe	Autoclave the waste and then dispose properly. Mutilate/cut before disposal. **OR** Mutilate/cut gloves, syringes, blood bags and disinfect with 0.5% chlorine solution and dispose safely (deep burial).	
	Infectious waste such as bandage, cotton	Autoclave the waste and then dispose properly. **OR** Disinfect wastes with 0.5% chlorine solution and dispose safely.	
Radioactive waste	Sealed radiation source, liquid and gaseous, material contaminated with radionuclide, such as paper cups, straws, needles syringes, test tubes	Apply return back policy; return the waste to the store and from the store to the supplier; it should be agreed at the purchasing phase. **OR** Radioactive isotope should be collected, packaged, inventoried and securely stored for time period suitable for complete radioactive decay. In the case of mixed radioactive and infectious waste, the radioactive component is addressed first and later suitable treatment for the infectious component should be carried out.	
Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled and stored in secured place.	
	Chemical waste (chemicals used in production of biological toxins, chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Table 13. Health Care Waste Management at Pharmacy/Medical Stores

Types and Categories of HCW		Methods of management	Responsibility
Non-risk HCW	Bio-degradable (Compostable)	The waste can be composted to produce compost manure and can also be used for production of bio-gas.	Storekeeper and authorized person
	Recyclable (Non-biodegradable)	Recyclable items should be recycled and reused.	
	Other non-risk waste	If waste cannot be composted or recycled, contact the local authority for disposal.	
HCW requiring special attention	Sharps such as injections, blades	In case of used needles and syringes, wastes are first autoclaved and if autoclave is not available, disinfect with 0.5% chlorine solution and dispose safely.	
	Pharmaceutical waste such as waste comprising of date expired, contaminated and discarded medicines	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Disposal in secured landfill after encapsulation	
	Cytotoxic pharmaceutical waste such as post-expiration date cytotoxic pharmaceuticals, discernable liquid residues of cytotoxic concentrates	Apply return back policy; return the waste to the store and from the store to the supplier. **OR** Sanitary landfill with encapsulation.	
Other hazardous waste	Heavy metal such as mercury	Should be collected and stored separately in glass bottle with water and well labeled.	
	Chemical waste (chemicals used in production of biological toxins, chemicals used in disinfection, insecticides)	Chemical treatment and discharge into drains after massive dilution with plain water	

Note:

- **It is recommended to have central treatment facility (CTF) for the treatment and disposal of HCWs based on the public-private partnership (PPP) approach however, where these facilities are not available, HCF shall have to manage their HCWs using the BAT and BEP techniques so as to have 'zero waste concept' as being practiced in different hospitals of Nepal such as Civil Service Hospital and Bir Hospital.**
- **Open burning should not be considered as an option because of the risk it creates for staffs, communities and the environment.**
- **If autoclave is not available in the HCF then disinfect wastes with 0.5% chlorine solution or 1% bleaching powder solution.**
- **Chemical treatment using at least 0.5% chlorine solution for at least 30 minutes. If it is not available then disinfect wastes with 1% bleaching powder solution for at least one hour.**
- **Unusable blood and laboratory reagents should be safely disposed after proper chemical treatment.**

9. Training and Raising Awareness

Promotion of the appropriate handling and disposal of HCW is important for public health and hence every member of the community has the right of information about the potential health hazards. The objectives of public education on HCWs are as follows:

- To prevent exposure to HCW and related health hazards;
- To create awareness and foster responsibility among hospital patients and visitors to HCFs regarding hygiene and HCWM.
- To inform the public about the risks linked to HCW.

In order to develop proper training modules, training need assessment should be carried out at the first. Training need assessment has been defined as the process to establish a clear understanding of who requires what types of training.

9.1 Employees to be trained

All hospital personnel, including senior medical doctors, should be convinced of the need for a comprehensive HCWM plan and the related training. Separate training activities should be designed for the following personnel:

- Hospital managers and administrative staff responsible for implementing regulations on HCWM.
- Medical doctors
- Nurses and Paramedicals Staff
- Cleaners, porters, staff and waste handlers

9.2 Content

Training programs should include:

- Information on, and justification for, all aspects of the health care waste plan
- Information on the role and responsibilities of each hospital staff member in implementing the plan
- Technical instructions, relevant for the target group, on the application of waste management practices.

These should be periodically reviewed and updated. Periodic repetition of courses will provide refreshment training as well as orientation for new employees and for existing employees with new responsibilities; it will also update knowledge in line with policy changes. In general, the training should include the following information:

- Concept of health care waste and basic steps for health care waste management
- Legal provisions, policies and international commitments

- Impact of HCW on health and environment
- Health care waste management
- Management of mercury spill
- Injection safety
- Health and safety
- Health care waste management at different levels of HCF
- Field visit and action plan

9.3 Training responsibility

The administration/management section should be given responsibility for all training related to HCWM. The section should ensure that staffs at all levels of HCFs are aware of the HCWM plan, their own responsibilities and obligations in this regard. The record of all training sessions and the content of training programs should be documented. The content of the training programs should be periodically reviewed and updated as per requirements.

9.4 Training package

The training package can be developed by the national government responsible for the HCWM. The package should be suitable for various types of HCFs, including government, private, teaching and dental hospitals, polyclinics, health centre, health care research institutions and clinical laboratories. It would also be useful for more general educational establishments and for organizations that provide services for HCW disposal. The package should be liberally illustrated with drawings, diagrams, photographs, slides or overhead transparencies. These should reflect the environments in which trainees work and provide examples of measures that have been (or will be) implemented. Where it is likely that waste handlers and other workers are illiterate, all procedures should be carefully represented in diagrams and photographs.

9.5 Selection of participants

The ideal number of participants in a training course is 15-20. Courses should be aimed at all categories of personnel; discussions may be easier and more useful if the group is composed of trainees from various disciplines (e.g. supervisors, medical and nursing staff, laboratory staff, engineers, auxilliary staff) or at least contains one or two medical assistants and nurses. It may also be valuable to include senior administration staff and heads of departments in certain training groups to demonstrate their commitment to the waste management policy and to show the relevance of the policy to all personnel of health care establishments.

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Annex

List of Personnel involved in the preparation of this Guideline.

S.No	Name	Designation	Organization
1	Dr. Tirth Raj Burlakoti	Former Chief Specialist	MoHP
2	Dr. Sheela Verma	Former Chief Specialist	Curative Division/ MoHP
3	Dr. Senendra Raj Upreti	Director General	DoHS
4	Dr. Bal Krishna Subedi	Former Director	PHCRD/ DoHS
5	Dr. Dipendra Raman Singh	Director	NCASC
6	Dr. Bhim Acharya	Director	MD/ DoHS
7	Dr. Guna Raj Lohani	Chief	Curative Division/ MOHP
8	Dr. Baburam Marasini	Director	EDCD/ DoHS
9	Mr. Mahendra Shrestha	Director	NHTC
10	Mr. Shree Krishna Bhatta	Chief	DPHO, Kathmandu
11	Ms. Ishwari Devi Shrestha	Chief Nurse Administrator	MoHP
12	Mr. Chudamani Bhandari	Director	LCD/ DoHS
13	Ms. Shrijana Shrestha	Sr. P.H. A.	MD/DoHS
14	Mr. Ram Sharan Maharjan	Engineer	SWMTSC
15	Ms. Sudha Vaidya	Former Nursing Director	NAMS/Bir Hospital
16	Dr. Govinda Prasad Kharel	Senior Engineer	MoE
17	Mr. Kedar Prajapati	Sr. Divi. Engineer	MoUD
18	Mr. Surendra Subedi	Senior Divisional Chemist	Department of Environment
19	Mr. Babar Gurung	PHO	DPHO, Kathmandu
20	Ms. Usha Deulah	Staff Nurse	Bir Hospital
21	Ms. Smita Shrestha	Staff Nurse	NAMS/Bir Hospital
22	Dr. Madhab Pd Lamsal	Sr. Inte. Med. Officer	Kanti Children Hospital
23	Mr. Dipendra Pokharel	Senior Administrative Officer	SGNHC
24	Mr. Gopal Kumar Gupta	Waste Mgmt Focal Person	CSH
25	Dr. Binaya Sapkota	Chief	Department of Pharmacy/CSH
26	Mr. Dhiraj Mainali	HCWM Assistance Officer	CSH
27	Mr. Nimesh Dhakal	Program Officer	WHO
28	Ms. Prerana Dongol	Program Coordinator	HECAF

29	Mr. Terrence Thompson	Sr. Environmental Health Advisor	WHO
30	Dr. Sudan Raj Panthi	NPO	WHO
31	Dr. J.N.Giri	Immunisation Coordinator	WHO
32	Ms. Deepa Shrestha	Prog. Assistant	WHO
33	Dr. Usha Gautam	Pro. Officer	COMAT
34	Dr. Sumitra Amatya	Executive Director	SWMTSC
35	Mr. Ram charitra Sah	Executive Director	CEPHED
36	Mr. Salil Devkota	Environment Expert	NESS
37	Mr. Dirgha Raj Shrestha	National Programme Manager	IPAS
38	Mr. Manish Thapa	Engineer	CEPHED