MINISTRY OF HEALTH

NEGARA BRUNEI DARUSSALAM

GUIDELINE ON HEALTHCARE WASTE MANAGEMENT

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1.0 GLOSSARY

Antineoplastic
Inhibiting or preventing the development of neoplasm.

Antisepsis
Prevention of infection by inhibiting the growth of infectious agents.

Capacity
The quantity of solid waste that can be processed in a given time under certain specified conditions, usually expressed in terms of mass per 24 hours.

Characterisation
The determination of the physical and chemical (for radioactive waste) and radiological properties of waste, or of other features, to establish the need for further adjustment, treatment, conditioning or suitability for further handling, processing, storage or disposal.

Conditioning
Operations that produce a package suitable for handling, transportation, storage, and/or disposal.

Container
Vessel in which waste is placed for handling, transportation, storage, and/ or eventual disposal. The waste container is a component of the waste package.

Cytostatic
Causing suppression of growth and multiplication of cells.

Cytotoxic
Possessing a specific destructive action on certain cells; used in particular when referring to the lysis (disintegration or dissolution) of cells brought about by immune phenomena and to antineoplastic drugs that selectively kill dividing cells.

Decontamination
Reduction of microbiological contamination to a safe level.

Disinfectant
Chemical agent that is able to reduce the viability of micro-organisms.

Disinfection
Treatment aimed at reducing the number of vegetative micro-organisms to safe or relatively safe levels.

Disposal
Intentional burial, deposit, discharge, dumping, placing, or release of any waste material into or on any air, land or water.

In the context of radioactive waste management, disposal means the emplacement of waste in an approved, specified facility (e.g. near surface or geological repository) of the approved direct discharge of effluents into the environment. Disposal is undertaken without the intention of retrieval.

Flue gas (or exhaust gas)
Gases and suspended particles emitted from an industrial stack or chimney.

Furnace
The chamber of the incinerator into which the refuse is discharged for subsequent ignition and burning.

Genotoxic
Descriptive of a substance that is capable of interacting directly with genetic material, causing DNA damage that can be assayed. The term may refer to carcinogenic, mutagenic or teratogenic substances.

Groundwater
The water contained in porous underground strata as a result of infiltration from the surface.

Half-life of a radionuclide
Half-life of a radionuclide is the time required for the activity of the radioactive sample to decay to one-half of its original value.

Handling
The functions associated with the movement of solid waste materials, excluding storage, processing, and ultimate disposal.

Hazard
Intrinsic potential property or ability (e.g. of any agent, equipment, material, or process) to cause harm.
Note: Harm is an injury or damage to the health of people and/ or to the environment.

Incineration
The controlled burning of solid, liquid, or gaseous combustible waste to produce gases and residues containing little or no combustible material.

Ionisation
Ionisation is the process whereby an atom or molecule gains or loses an electron and becomes an ion. Ionising radiation has sufficient energy to be able to ionise atoms and molecules and therefore produce ions.

Ionising Radiation
Ionising radiation consists of gamma rays, x-rays, alpha and beta particles, and other heavy ions which have sufficient energy to cause ionisation in materials through which they interact.

Leachate
Liquid from a landfill containing substances that were present in the waste, either as liquids or as solids, which were dissolved by water passing through the waste.

Micro-organism
Any microbiological entity, cellular or non-cellular, capable of replication or of transferring genetic material.

Monitoring
The measurement of a concentration or other parameter (radiation of radionuclide concentration in the context of radioactive waste management) for purposes of assessment or control of environmental quality or exposure, and the interpretation of such measurements. Monitoring can be continuous or non-continuous.

Municipal waste
General waste for collection by municipalities, generated mainly by households, commercial activities, and street-sweeping.

Pathogens
Disease-causing organisms.

Prion
A poorly characterised slow infectious agent. Prions are believed to be the cause of a number of neurodegenerative diseases, e.g. Creutzfeldt-Jakob disease.

Pyrolysis
The decomposition of organic material by heat in the absence, or with a limited supply, of oxygen.

Radiation Activity
The expectation value of the number of nuclear transformations occurring in a given quantity of material per unit time (per second). The SI unit of activity is Becquerel (Bq).

Radiation Protection Officer
Radiation Protection Officer (RPO) is an individual competent in radiation protection matters relevant for a given type of practice who is designated by the Authority to oversee the implementation of appropriate radiation protection regulations, measures and procedures. The RPO shall be responsible for the day to day management and supervision of the use of the source of radiation.

Radiation Protection Supervisor
Radiation Protection Supervisor (RPS) is an employee appointed by the radiation employer and approved by the Authority to ensure that all operations within his area of responsibility are conducted according to the established rules and procedures.

Radiation Over-exposure
With respect to Radiation Protection, an over-exposure means a person who has received an unexpected (non-routine) level of ionising radiation exposure above a permitted level (dose limit). The over-exposure may result in breach of regulations, and in severe cases, adverse health effects or even death.

Radionuclide
A radionuclide is a type of nuclide which is radioactive and will undergo spontaneous radioactive decay.

Radioactive Decay
Radioactive decay describes the process whereby radioactive substances decay spontaneously with the release of energy in the form of electromagnetic radiation or particulate radiation. The rate of radioactive decay will depend on the half-life.

Recycling
A term embracing the recovery and re-use of scrap or waste material for manufacturing or other purposes.

Residence time
The time that elapses between the entry of a substance into a furnace and the exit of burn-out residue from the furnace.

Residue
The material remaining after combustion of waste such as ash or slag or materials extracted from a liquid or gas stream.

Risk
Probability that a hazard will cause harm, and the severity of that harm.

Sanitary landfilling
An engineered method of disposing of solid waste on land in a manner that protects the environment, e.g. by spreading the waste in thin layers, compacting it to the smallest practical volume and covering it with soil by the end of each working day, constructing barriers to infiltration, and evacuating the gases produced.

Scavenging
The manual sorting of solid waste at landfills and removal of usable material.

Segregation
The systematic separation of solid waste into designated categories.

Sewage
A community's water supply after it has been fouled by various uses. Its source may be a combination of liquid or water-carried waste from domestic, municipal, and industrial premises, together with groundwater, surface water, and storm water.

Sewerage
A system for the collection and transportation of sewage, including conduits, pipes, and pumping stations.

Sludge
The accumulated solids that separate from liquids such as water or wastewater during processing, or deposits on the bottom of streams or other bodies of water.

Sterilisation
A reduction in micro-organisms of more than 10^6 (more than 99.9999% of the microorganisms are killed), achieved by physical, chemical, or mechanical methods or by irradiation.

Storage
The placement of waste in a suitable location or facility where isolation, environmental and health protection, and human control (e.g. monitoring for radioactivity, limitation of access) are provided. This is done with the intention that the waste will be subsequently retrieved for treatment and conditioning and/ or disposal (or clearance of radioactive waste).

Treatment
Any method, technique or process for altering the biological, chemical or physical characteristics of waste to reduce the hazards it presents, and to facilitate or reduce the costs of disposal. The basic treatment objectives include volume reduction, disinfection, neutralisation, or other change of composition to reduce hazards, including removal of radionuclides from radioactive waste.

Waste form
Waste in its solid physical and chemical form after treatment and/ or conditioning before packaging; the waste form is a component of the waste package.

Waste generator
Any person, organisation or facility engaged in activities that generate waste.

Waste management
All the activities, administrative and operational, involved in the handling, treatment, conditioning, storage, and disposal of waste (including transportation).

Waste package
The product of waste conditioning, which includes the waste form, waste container(s), and any internal barriers (e.g. absorbing materials or liners), prepared

in accordance with requirements for handling, transportation, storage, and/ or disposal.

2.0 INTRODUCTION

This document aims to provide guidance on effective management of healthcare waste. It provides recommendations on safe, efficient, sustainable, affordable and acceptable methods of disposal of wastes generated from healthcare activities in Brunei Darussalam.

The guideline outlines recommendations for all healthcare waste generated to be handled and disposed of safely in accordance with the World Health Organization (WHO) recommendations and other international guidelines on healthcare waste management. It will therefore help to manage and control the disposal of healthcare waste and prevent the risk of potential harmful exposures.

This guideline will also provide waste handlers with recommendations on proper handling and disposal of healthcare waste, thus ensuring their health and safety as well as that of the general public.

A committee comprising staff from various departments of the Ministry of Health contributed to the development of this document and concluded that the contents are suitable for use in all healthcare facilities in Brunei Darussalam.

3.0 DEFINITION OF HEALTHCARE WASTE

Healthcare waste includes all wastes generated within healthcare establishments, research facilities and laboratories related to clinical procedures and activities. In addition, it includes wastes generated from minor sources such as those produced in the course of healthcare undertaken at home such as dialysis or insulin injections.

Majority of healthcare waste can be considered as non-hazardous comparable to domestic waste but a proportion is regarded as hazardous and may create a variety of environmental and health risks.

Wastes are considered hazardous if any quantity or form of the wastes contain toxic substances such as biological, chemical or physical agents which may be harmful to human, animals, food crops, water systems or other elements of the environment.

According to the WHO, hazardous healthcare waste can be categorised into the following:

- Infectious waste
- Pathological waste
- Sharps waste
- Pharmaceutical waste, including cytotoxic/ genotoxic waste
- Chemical waste
- Waste with high content of heavy metals
- Pressurised waste containers; and
- Radioactive waste

Each category can be further subcategorised based on the methods of handling and disposal.

3.1 Infectious Waste

Infectious waste is material suspected to contain pathogens (bacteria, viruses, parasites or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts. It includes:

3.1.1 Waste contaminated with blood or other body fluids

This includes free-flowing blood, blood components and other body fluids; dressings, bandages, swabs, gloves, masks, gowns, drapes and other materials contaminated with blood or other body fluids; and waste that has been in contact with patients' blood undergoing haemodialysis.

3.1.2 Cultures and stocks of infectious agents from laboratory work.

Waste from autopsies, animal bodies, and other waste items that have been inoculated, infected, or in contact with highly infectious agents are highly infectious.

Discarded instruments or materials that have been in contact with persons infected with highly infectious agents are also to be considered infectious wastes.

3.1.3 Patients' waste

This includes excreta, dressings from infected or surgical wounds, and clothes and linens heavily soiled with human blood or other body fluids.

3.2 Pathological Waste

Pathological waste can be considered as a subcategory of infectious waste. It consists of recognisable human body parts, tissues including teeth, organs and human foetuses, blood and body fluids of human origin.

3.3 Sharps Waste

Sharps are items that can cause cuts or puncture wounds including needles, hypodermic needles, scalpels and other blades, knives, infusion sets, saws, broken glass and pipettes that may or may not be infected. It also includes used local anaesthetic cartridges, orthodontic wires, bands and brackets, burs, endodontic files and reamers, used matrix band and any sharp clinical items used in dentistry.

3.4 Pharmaceutical Waste, including Cytotoxic/ Genotoxic Waste

Pharmaceutical waste includes expired, unused, spilt and contaminated pharmaceutical products, drugs, vaccines, sera and pharmaceutical raw materials that are no longer required. It also includes discarded items that are heavily contaminated during the handling of pharmaceuticals such as bottles or boxes with residues, gloves, masks and drug vials. Pharmaceutical waste can either be hazardous or non-hazardous.

Cytotoxic/ genotoxic waste is highly hazardous and may have mutagenic (capable of inducing a genetic mutation), teratogenic (capable of causing defects in an embryo or foetus) or carcinogenic (cancer-causing) properties. It raises serious safety problems, and may include certain cytostatic drugs, vomits, urine or feces from patients treated with these drugs, contaminated materials used in the preparation and administration of such drugs such as syringes, gauzes, tissue, needles, vials, packaging materials, certain carcinogenic chemicals and radioactive substances that are used for medical purposes.

3.5 Chemical Waste

Chemical waste consists of discarded solid, liquid, and gaseous chemicals, e.g. from diagnostic and experimental work, and from cleaning, housekeeping, and disinfecting procedures.

Chemical waste is considered hazardous if it has at least one of the following properties:

- Toxic
- Corrosive (e.g. acids of pH <2 and bases of pH >12)
- Flammable
- Reactive (explosive, water-reactive, shock-sensitive)
- Oxidising

Non-hazardous chemical waste consists of chemicals with none of the above properties, such as sugars, amino acids, and certain organic and inorganic salts.

Hazardous chemical waste may be segregated into the following types:

Chemical Waste	Example
Halogenated solvents	Chloroform, Methylene chloride, Perchloroethylene, Refrigerants, Trichloroethylene
Non-Halogenated solvents	Acetone, Acetonitrile, Ethanol, Ethyl acetate, Formaldehyde, Isopropanol, Methanol, Toluene, Xylene
Halogenated disinfectants	Calcium hypochlorite, Chlorine dioxide, Iodine solutions, Iophors, Sodium dichloroisocyanate, Sodium hypochlorite (bleach)
Aldehydes	Formaldehyde, Glutaraldehyde, Ortho-pthalaldehyde
Alcohols	Ethanol, Isopropanol, Phenols
Other disinfectants	Hydrogen peroxide, Peroxyacetic acid, Quarternary amines
Metals	Arsenic, Cadmium, Chromium, Lead, Mercury, Silver
Acids	Acetic, Chromic, Hydrochloric, Nitric, Sulfuric
Bases	Ammonium hydroxide, Potassium hydroxide, Sodium hydroxide
Oxidisers	Bleach, Hydrogen peroxide, Potassium dichromate, Potassium permanganate
Reducers	Sodium bisulfite, Sodium sulfite
Miscellaneous	Anesthetic gases, Asbestos, Ethylene oxide, Herbicides, Paints, Pesticides, Waste oils

Table 1. Chemical waste from healthcare activities

Waste from materials with high content of heavy metals represent a subcategory of hazardous chemical waste and are usually highly toxic. They can be subcategorised into the following:

3.5.1 Mercury waste

These are generated usually from broken and outdated or unused clinical equipment such as blood pressure gauges and thermometers. It can also be found in amalgam. Mercury is a silvery-white liquid that readily vapourises and remains in the atmosphere for up to a year. It is highly toxic and very hazardous. It is harmful if

absorbed through the skin and may be fatal if inhaled. Whenever possible, spilled drops of mercury should be recovered.

Amalgam waste from dental procedures includes scrap amalgam from excess mix leftover, extracted teeth containing amalgam fillings, carving scrap collected at chairside during filling procedure, amalgam captured by chairside traps, filters and screens, and used empty amalgam capsules. Amalgam, if accidentally incinerated will vapourise and pollute the air. Likewise with the lead foils that form part of the intra-oral x-ray film packets, they too can cause poisoning of the air, when accidentally incinerated. Adverse health effects from mercury exposure includes tremors, impaired hearing and vision, paralysis, insomnia, emotional instability, developmental deficits during foetal development, and attention deficit and developmental delays during childhood.

3.5.2 Cadmium Waste

Cadmium waste is usually generated from discarded batteries.

3.5.3 Lead Waste

Lead waste includes lead generated from instruments used in x-ray, dental and some diagnostic equipment. In dentistry, the lead waste comes in the form of lead foils in pre-packed dental x-ray films and broken lead shields.

3.5.4 Silver Waste

Silver is a toxic heavy metal used in applications such as bactericides, in nanotechnology and in radiographic processing solutions. It is also found in exposed and processed x-ray films. Potential effects of silver are as follows:

- Large doses of silver can turn a person's skin permanently grey;
- Possibility of bacteria developing resistance to the metal and subsequently developing resistance to antibiotics.

3.5.5 Pressurised Waste Containers

Gases used in healthcare such as anaesthetic gases, ethylene oxide, oxygen and compressed air are often stored in portable pressurised cylinders or tanks, cartridges and aerosol cans. Many of these are reusable. However, certain types (notably aerosol cans) are single use and require disposal. Whether inert or not, they are potentially harmful because these pressurised containers may explode if incinerated or accidentally punctured.

Due to the different methods of handling and disposal recommended, this category of waste can be subcategorised as:

- Cylinders, tanks and cartridges
- Aerosol cans

3.6 Radioactive Waste

Radioactive waste is hazardous to living things and must be managed according to prescribed procedures in order to protect human health and the environment. Radioactive waste contains radioactive material and are generated from application of radionuclides in various fields e.g. healthcare, research and industry.

Radionuclides used in healthcare are in either unsealed (open) or sealed sources. Unsealed or open sources are radioactive materials in the liquid form which are administered directly to patients. Sealed sources are radioactive materials contained or encapsulated in strong, unbreakable or impervious objects, such as pins, seeds or needles. Radioactive waste arises in healthcare facilities as a result of diagnostic, therapeutic or research use of unsealed sources.

Radioactive waste can be in solid, liquid or gaseous state and this will determine the method for its disposal. The waste produced by healthcare activities involving radionuclides, and related activities such as equipment maintenance, storage etc, can be classified as follows:

- Sealed
- Spent radionuclide generators
- Excreta from patients treated or tested with unsealed radionuclides
- Residues from shipments of radioactive material and unwanted solutions of radionuclides intended for diagnostic or therapeutic use or calibration
- Low-level liquid waste e.g. from washing apparatus
- Liquids immiscible with water, such as liquid scintillation-counting residues and contaminated pump oil
- Low-level solid waste e.g. paper, glassware, syringes, vials
- Waste from spills and from decontamination of radioactive spills
- Unwanted radioactive gases for diagnostic or therapeutic use or calibration

Most radionuclides used in healthcare activities have short half-lives i.e. they lose their activity relatively quickly (6 hours to 60 days), and this usually results in low-level radioactive waste (<1MBq). Certain specialised therapeutic procedures use radionuclides with longer half-lives; these are usually in the form of small objects such as ‘seeds’ placed on or in the body and may be reused on other patients after sterilisation. Common radionuclides used in therapeutic and imaging investigation activities are Cobalt (^{60}Co), Technetium (^{99m}Tc), Iodine (^{131}I) and Iridium (^{192}Ir). Waste from sealed sources may have a relatively high radioactivity, but is generated in low volumes. Sealed sources are generally returned to the supplier and should not enter the waste stream.

3.6.1 X-ray Developer and Fixer Solutions

X-ray developer and fixer solutions are used in imaging departments to process radiographic films. The fixer solution usually contains 5-10% hydroquinone, 15% potassium hydroxide and less than 1% silver. Used X-ray fixer is hazardous as it has

high silver contents and hence must be disposed of appropriately and should not be allowed to get into the sewerage system as they contain silver compounds which are very toxic and can pollute the aquatic ecosystem.

The unused developer contains a toxic substance called hydroquinone, thus unused developer cannot be disposed of as wastewater. Used developer is non-hazardous because hydroquinone is used up in the developing process, and is therefore safe to be disposed to the sanitary sewer. However, the used developer should not be mixed with fixer solutions, otherwise the mixture will most likely become hazardous as these solutions contain substances which are corrosive, harmful and may be carcinogenic to humans.

3.6.2 Methyl Methacrylate Monomer Primer or Polymer (Dental Resins)

This is used in the making of dentures, temporary crowns, orthodontic appliances and special trays for dental impressions.

3.6.3 Unwanted Irradiating Apparatus

Any obsolete or faulty irradiating equipment not required by a department.

3.7 Non-hazardous General Waste

Non-hazardous or general waste is waste that has not been in contact with infectious agents, hazardous chemicals or radioactive substances, and does not pose a sharps hazard.

More than half of all non-hazardous waste from healthcare facilities is potentially recyclable such as paper, cardboard, plastics, metal and glass. The rest are potentially reusable and this may include used furniture, bedframes, carpets, curtains and dishware, as well as computer equipment, printer cartridges and photocopying toners. Compostable waste includes flowers, food waste from kitchen services and plant waste from ground maintenance.

4.0 LEGISLATIVE, REGULATORY AND POLICY ASPECTS

4.1 International Legislative and Regulatory Principles

International agreement has been reached on a number of underlying principles that govern public health and safe management of hazardous waste. One of these is the Basel Convention, of which Brunei Darussalam is a member. This Convention concerns trans-boundary movements of hazardous waste and is also applicable to healthcare waste, except for radioactive waste which is regulated separately under the International Atomic Energy Agency (IAEA) under the United Nations Agency. Under the Basel Convention, the accepted principle is that the only legitimate trans-boundary shipments of hazardous waste are exported from countries that lack the facilities or expertise to dispose of safely certain wastes to other countries that have both facilities and expertise.

Other principles governing public health and safe management of hazardous waste include:

- The 'Polluter Pays' Principle - all producers of waste are legally and financially responsible for the safe and environmentally sound disposal of the waste that they produce.
- The 'Precautionary' Principle - 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 measures to protect health and safety should be designed accordingly.
- The 'Duty of Care' Principle - any person handling or managing hazardous substances or related equipment is ethically responsible for using the utmost care in that task.
- The 'Proximity' Principle - treatment and disposal of hazardous waste take place at the closest possible location to its source in order to minimise the risks involved in its transport.

4.2. National Legal Provisions

The Environmental Protection and Management Order 2016, which is under the purview of the Department of Environment, Parks and Recreation (Ministry of Development), provides for the protection and management of the environment and other related purposes. However, there are no specific provisions pertaining to healthcare waste management in this legal framework.

The Department of Environment, Recreation and Parks (Ministry of Development) also acts as the Country Focal Point for the Basel Convention.

4.3 Policy Document and Technical Guidelines

The Government of Brunei Darussalam is fully committed to the concept of sustainable development as central to socio-economic development. Eight strategies, including environment strategy, have been identified in the Tenth National Development Plan Year 2012-2017 to ensure that all aspects of development can be implemented in an organised and effective manner. Relevant government agencies are responsible in enforcing protection efforts of the environment in a fair and efficient manner for rainforest, food, wildlife, air, water, climate and ocean.

One of the government agencies responsible is the Department of Environment, Parks and Recreation at the Ministry of Development, which has issued national environmental acts and guidelines such as Environmental Protection and Management Order 2016, Pollution Control Guidelines for the Industrial Development in Brunei Darussalam 2003, and Recycle 123 Handbook. Although these guidelines are mainly targeted for industrial premises concerned with industrial development, they also serve as useful references for the healthcare sector as the healthcare sector produces certain wastes that can be included under the categories of waste listed in the guidelines with their improper/ uncontrolled/ unmonitored discharge affecting the environment in the long term.

5.0 HAZARDS OF HEALTHCARE WASTE

5.1 Types of Hazards

Exposure to hazardous healthcare waste can result in disease or injury. The hazardous nature may be due to one or more of the following characteristics:

- Contains infectious agents
- It is cytotoxic/ genotoxic
- It is radioactive
- Contains toxic/ hazardous chemicals or pharmaceuticals
- Contains sharps

5.2 Persons at Risk

All individuals exposed to hazardous healthcare waste are potentially at risk, including those within healthcare establishments that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management.

The main groups at risk are the following:

- Medical doctors, dentists, nurses, healthcare auxiliaries, and hospital maintenance personnel
- Patients in healthcare establishments; or receiving home care
- Personnel in organisations providing support services such as launderettes, incinerators, waste disposal sites, and transportation
- Personnel involved in the healthcare waste handling
- Patients and personnel involved in primary healthcare such as health clinics
- Visitors to healthcare establishments
- General public

In general, there is lack of awareness of health hazards associated with hazardous healthcare waste. There are also sociological problems, such as foreign workers with language limitations or workers who may be illiterate or ignorant. It is important that they are made aware of the risks and be trained in the precautionary measures and disposal procedures.

5.3 Hazards from Infectious Waste and Sharps

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

- Through a puncture, abrasion, or cut in the skin
- Through the mucous membrane
- By inhalation
- By ingestion

There is particular concern about blood borne infection with human immunodeficiency virus (HIV) and Hepatitis B and C, due to inappropriate disposal of healthcare waste. These viruses are generally transmitted through injuries from sharps such as syringe needles contaminated with human blood.

Concentrated cultures of pathogens and contaminated sharps, particularly hypodermic needles, are probably the waste items that represent the most acute potential hazards to health.

Sharps may not only cause cuts and punctures but also infect these wounds if they are contaminated with pathogens. Because of this double risk – of injury and disease transmission – sharps are considered as a very hazardous waste.

5.4 Hazards from Chemical and Pharmaceutical Waste

Many of the chemicals and pharmaceuticals used in healthcare are hazardous. Chemical wastes may cause intoxication, either by acute or chronic exposure, or physical injuries – the most common being chemical burns. Intoxication can result from absorption of a chemical or pharmaceutical agent through the skin or the mucous membranes, or from inhalation or ingestion. Injuries to the skin, the eyes or the mucous membranes of the airways can occur by contact with flammable, corrosive or reactive chemicals (e.g. formaldehyde and other volatile substances).

The hazardous properties most relevant to wastes from healthcare are as follows:

• *Toxic*. Most chemicals are toxic at some level of exposure. Fumes, dusts and vapour from toxic materials can be especially harmful because they can be inhaled and therefore pass quickly from the lungs into the bloodstream, permitting rapid circulation throughout the body.

• *Corrosive*. Strong acids and alkali bases can corrode completely through other substances, including clothing. If splashed on the skin or eyes, they can cause serious chemical burns and permanent injury. Some of these also break down into poisonous gases, which further increase their hazardousness.

• *Explosive*. Some materials can explode when exposed to heat or flame, notably flammable liquids when ignited in confined spaces, and the uncontrolled release of compressed gases.

• *Flammable*. Compounds with this property catch fire easily, burn rapidly, spread quickly and give off intense heat. Many materials used and stored in medical areas, laboratories and maintenance workshops are flammable, including solvents, fuels and lubricants.

• *Chemically reactive*. These materials should be used with extreme caution and stored in special containers. Some can burn when exposed to air or water, some when mixed with other substances. It is important to note that reactive materials do not have to be near heat or flames to burn. They may burn spontaneously in the presence of air and also give off vapors that may be harmful if inhaled.

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

5.5 Hazards from Genotoxic Waste

Exposure to cytotoxic/ genotoxic substances in healthcare may occur during the preparation of or treatment with particular drugs or chemicals. The main pathways of exposure are inhalation of dust or aerosols, absorption through the skin, ingestion of food accidentally contaminated with cytotoxic and cytostatic drugs, chemicals, or waste. Exposure may also occur through contact with body fluids and secretions of patients undergoing chemotherapy.

Many cytotoxic drugs are extreme irritants and have harmful local effects after direct contact with skin or eyes. They may also cause dizziness, nausea, headache or dermatitis.

5.6 Hazards from Radioactive Waste

Radioactive waste emits ionising radiation which cannot be detected by any of the senses. The ionising radiations of interest in medicine includes x-rays, gamma (ɣ) rays, and α- & β- particles. X-rays are produced from x-ray tubes and only emitted when generating x-ray equipment is switched on. Radiation from radionuclides can never be switched off, and can only be avoided by shielding the material and allowing the radionuclides to undergo spontaneous disintegration i.e. radioactive decay.

The extent of radiation hazards caused by radioactive waste depends on the type and extent of exposure. It usually causes no immediate effects unless an affected individual receives a very high dose of radiation. Radioactive waste, such as certain pharmaceutical waste, is cytotoxic***/*** genotoxic and can affect genetic material.

The hazards from radioactive wastes could be due to direct exposure, inhalation, and ingestion or via cuts or abrasions in the skin. Exposure to radiation can manifest as symptoms such as headache, dizziness, vomiting and diarrhoea. In extreme cases e.g. handling of a highly radioactive source, it may cause severe burns, amputation of body parts and even death. Poorly managed radiation waste may get into the ecosystem and the food chain. This can indirectly affect anyone who consumes the contaminated items unknowingly.

5.7 Survival of Pathogenic Micro-Organisms in the Environment

Hepatitis B virus is very persistent in dry air and can survive for several weeks on a surface; it is also resistant to brief exposure to boiling water. It can survive exposure to some antiseptics and to 70% ethanol, and remains viable for up to 10 hours at 60^{o}C. An infective dose of Hepatitis B and C can survive for up to one week in a blood droplet trapped inside a hypodermic needle.

By contrast, HIV is much less resistant. It survives for no more than 15 minutes when exposed to 70% ethanol and only 3-7 days at ambient temperature. It is inactivated at 56^{o}C.

Vectors such as rats, flies and cockroaches, which feed or breed on organic waste, are well known passive carriers of microbial pathogens; their population may increase dramatically where there is mismanagement of waste both within and outside healthcare establishments.

6.0 HEALTHCARE WASTE MINIMISATION, RE-USE AND RECYCLING

6.1 Waste Minimisation

This refers to activities specifically designed to reduce hazardous and toxic wastes as they affect land disposal as well as contribute to air and water pollution.

Actions should be taken both before waste is generated (also called 'source reduction') - through efficient purchasing policies and good stock management (which are effective ways of reducing purchasing, storage and elimination costs) - and after, by recycling or re-using non-hazardous materials.

Significant reduction of the waste generated in healthcare establishments, laboratories and research facilities may be encouraged by implementing certain policies and practices, including the following:

Source Reduction

- Introduce measures such as purchasing restrictions to ensure the selection of methods or supplies which are less wasteful or generate less hazardous waste
- Use of physical rather than chemical cleaning methods, e.g. steam disinfection instead of chemical disinfection
- Preventing wastage of consumables

Recyclable Products

- Use of materials that may be recycled, either on-site or off-site.

Good Management and Control Practices

- Particularly applicable in the purchase and use of chemicals, pharmaceuticals and radioactive materials
- Centralise purchasing of hazardous chemicals, pharmaceuticals, radioactive materials and irradiating apparatus
- Monitoring of chemicals, pharmaceuticals, radioactive materials and radioactive materials within the healthcare establishment, from receipt to disposal of hazardous waste by relevant authorities
- Use of the oldest batch of the product first
- Material reuse such as autoclave
- Reduced/ more efficient consumer use of materials

Stock Management of Chemical and Pharmaceutical Products

- Frequent ordering of relatively small quantities rather than large amounts at one time particularly for unstable products
- Use of the oldest batch of a product first
- Use of all contents in each container

- Checking the expiry date of all products at the time of delivery

Waste Segregation

- Careful segregation of waste into different categories helps to minimise the costs of treatment and disposal of infectious waste, and minimise quantity of hazardous waste.
- Registered suppliers of chemicals, pharmaceuticals and radioactive materials should be responsible partners in waste minimisation programmes. Measures such as placing orders with suppliers who can provide rapid delivery of small orders, accept the return of unopened stock and offer off-site waste management facilities of hazardous waste should be considered.

6.2 Re-use and Recycling

6.2.1 Re-use

Medical and other equipment used in a healthcare establishment may be re-used provided that it is designed for the purpose and will withstand the sterilisation process. Plastic syringes, hypodermic needles, scalpel blades and catheters should not be thermally or chemically sterilised; they should be discarded.

Table 2 shows examples of sterilisation methods for reusable items recommended by WHO. Specific recommendations for the various application areas such as Infection Control Unit, Dentistry and hospital laboratory can be found in Annex 1.

Method of Sterilisation	Mode Involved
Thermal Sterilisation	*Dry Sterilisation:* Exposure to 160°C for 120 minutes or to 170°C for 60 minutes in an oven.
	Wet Sterilisation: Exposure to saturated steam at 121°C for 30 minutes at 20 psi pressure in an autoclave.
Chemical Sterilisation	*Ethylene oxide:* Exposure to an atmosphere saturated with ethylene oxide for 3-8 hours at 50-60°C in a reactor tank. (See Note for precautions).
	Glutaraldehyde: Exposure to glutaraldehyde solution for 30 minutes. This process is safer for the operators than the use of ethylene oxide but is microbiologically less efficient. Instead of Glutaraldehyde, less toxic disinfectant such as Ortho-phthaldehyde (OPA) can be used.
	Hydrogen peroxide:

Method of Sterilisation	Mode Involved
	• A 7.5% solution can produce high-level disinfection in 30 minutes at 20 °C. Alternatively, equipment exists that can generate a hydrogen peroxide plasma from a 58% hydrogen peroxide solution. The equipment has a 45-minute process time. Hydrogen peroxide can also be used in combination with peracetic acid.
	Peracetic acid: • Can produce sterilisation in 12 minutes at 50–55°C, with instruments ready to be used in 30 minutes. Peracetic acid can also be used in combination with hydrogen peroxide.
	OPA (Ortho-phthaldehyde): • High-level disinfection in 12 minutes at 20°C. This is a less toxic disinfectant and currently recommended to be used in place of Glutaraldehyde.
	Hypochlorous acid/ hypochlorite: • 400–450 ppm active free chlorine, contact conditions established by simulated use testing with endoscopes.

Table 2. Examples of sterilisation methods for reusable items

NOTE:

Ethylene oxide is a very hazardous chemical agent. Sterilisation using this chemical should be undertaken by highly trained and adequately protected technical personnel.

Certain types of containers may be re-used provided that they are properly washed and disinfected. For example, containers that once held detergent or other liquids may be re-used as containers for sharps waste provided that they are puncture-proof, and correctly and clearly marked on all sides.

6.3 Minimisation and Safe Recycling of Certain Healthcare Waste

6.3.1 Chemicals and Pharmaceuticals

Careful and comprehensive management of storage will substantially reduce the quantities of chemical and/ or pharmaceutical waste produced by healthcare establishments.

Proper management of chemical or pharmaceutical waste storage should be supervised by the chief pharmacist (or the equivalent) at the healthcare establishment.

6.3.2 Pressurised Waste Containers

Aerosol cans containing chemicals and/ or pharmaceutical substances are generally not recyclable and therefore should be emptied before disposal and may be disposed at landfills with general wastes. Undamaged pressurised gas cylinders that can be refilled should be returned to their original supplier. Pressurised containers must never be incinerated as they may explode, causing injury to workers and/ or damage to equipment.

6.3.3 Heavy Metals

Silver can be reclaimed from used radiographic fixer solution by two main methods: electrolytic recovery or metallic replacement.

Lead foils can be recycled by selling them back to the supplier.

Metallic mercury is a valuable product. In case of spillages, e.g. from a broken thermometer, thermostat, or specialised apparatus from laboratories, mercury waste should never be disposed with infectious waste stream, as they are volatile in an incinerator, and without an appropriate scrubber will pollute the atmosphere. It is possible to collect mercury by using mercury spillage kits, with absorbent material or a sponge that collects mercury. This can then be stored in jars before recycling. In dentistry, excess amalgam containing mercury is collected in glass jars under water for recycling. Mercury waste must be collected separately from other wastes and disposed at an appropriate landfill.

Cadmium found in batteries should never be disposed with infectious waste stream, as they are volatile in an incinerator, and without an appropriate scrubber will pollute the atmosphere.

6.3.4 Radioactive Items

Recycling and re-use of radioactive materials should be considered as an alternative to disposal, depending on circumstances and approval. Possibilities for recycling includes:

- Re-use of sealed source
- Decontamination and re-use of equipment and protective clothing; and
- Re-use of dilute waste stream (for rinsing and washing of waste tanks that contained highly radioactive liquid waste)

High activity and long-life radionuclides designed as pins, needles, tubes, capsules, or seeds used for radiotherapy may be recovered after use, washed and sterilised to be re-used for other patients, with the approval of an Oncologist and Medical Physicist or Health Physicist.

7.0 SEGREGATION, STORAGE AND TRANSPORTATION OF HEALTHCARE WASTE

7.1 Segregation System

The correct method of segregation of healthcare waste is the responsibility of the person who produces the waste item. The healthcare facility management is responsible for making sure that there is appropriate segregation, proper transportation and storage system, and that all staff adhere to the correct procedures.

Segregation should be carried out by the producer of the waste as close as possible to its place of generation, which means segregation should take place in a medical area, at a bedside, in an operating theatre or laboratory by nurses, physicians and technicians. If classification of a waste item is uncertain, as a precaution it should be placed inside a container used for hazardous healthcare waste.

The hazardous waste portion is commonly separated into two parts: used sharps and potentially infectious items. For the latter, the largest components are typically tubing, bandages, disposable medical items, swabs and tissues. Further types of containers can be used for other categories of wastes, such as chemical and pharmaceutical wastes, or to separate out pathological waste, where it is to be handled and disposed differently from the other portions of the waste flow.

7.1.1 Waste containers, colour codes and labels

There must be a system of colour coding for waste containers which will enable healthcare workers to place waste items into the correct container, and to maintain segregation of the wastes during transport, storage, treatment and disposal. Colour coding also provides a visual indication of the potential risk posed by the waste in a particular container. The WHO scheme is available and can be used as a guide. (Table 3)

Healthcare facilities throughout Brunei Darussalam are currently using a 2-colour coding waste segregation system i.e. yellow biohazard waste bags (500µm thickness minimum) for clinical waste and black waste bag (250 µm thickness minimum) for domestic wastes. A yellow coloured sharps container is used for disposal of sharps e.g. needles, scalpel, blades etc.

Type of waste	Colour of container and markings	Type of container
Highly infectious waste	Yellow, marked '*HIGHLY INFECTIOUS'* with biohazard symbol	Strong, leak-proof plastic bag, or container capable of being autoclaved
Other infectious waste, pathological and anatomical waste	Yellow with biohazard symbol	Leak-proof plastic bag or container
Sharps	Yellow, marked '*SHARPS*', with biohazard symbol	Puncture-proof container
Chemical and pharmaceutical waste	Brown, labelled with appropriate hazard symbol	Plastic bag or rigid container
Radioactive waste	Labelled with radiation symbol	Lead box
General healthcare waste	Black	Plastic

Table 3. Scheme of waste segregation as per WHO recommendations.

7.1.2 Management of waste containers

Labelling of waste containers is essential to identify the source, record the type and quantity of waste produced in each area, as well as allows issues with waste segregation to be traced back to the producing area. Labels need to be attached to each filled container with the details of the area, date and time of closure of the container, and the name of the person filling out the label. The international hazard symbol must be placed on each waste container. Several symbols are relevant to the different kinds of hazardous waste produced in a healthcare facility, and these are reproduced in Figure 1. Comparison of common hazardous waste symbols are shown in Annex 9.

Biohazard symbol

Old radiation symbol

New radiation symbol

Figure 1. Biohazard and radiation hazard symbols.

7.2 Beyond Basic Segregation

7.2.1 Non-hazardous waste

Food wastes can be collected from medical areas and returned directly to the kitchens. Kitchen wastes can be composted or, where regulations allow, sterilised and used for animal feed. Non-hazardous biodegradable wastes (e.g. flowers) may be disposed with domestic wastes.

7.2.2 Hazardous waste

Highly infectious wastes, such as diagnostic laboratory samples and waste from infectious patients especially in isolation units, should be collected separately and autoclaved at the point of generation. Once disinfected, the waste should leave the medical area in an infectious healthcare waste container.

Anatomical waste, particularly recognisable body parts or foetal material, should be handled according to prevailing religious and cultural preferences (most commonly, authorised burial or cremation). Sharps waste (needle and syringe combination) should be placed directly into a sharps container.

Chemical and pharmaceutical wastes should be segregated and collected by subcategories: mercury, batteries, cadmium-containing wastes, photochemical, stains and laboratory reagents, cytotoxic drugs and other pharmaceuticals. All should be clearly labelled with the type of waste and the name of the major chemicals, with any necessary hazard labels attached e.g. corrosive, flammable, explosive or toxic chemicals. Liquid chemical wastes should never be mixed or disposed down the drain, but should be stored in strong leak-proof containers.

Spilled mercury

- Where mercury thermometers and sphygmomanometers are still in use, medical staff should be supplied with a spill kit and given training on how to use it.
- Any spillages larger than a thermometer should be dealt with in consultation with the local health and safety authority.

- Brushes and vacuum cleaners should never be used for spilled mercury. Mercury can be cleaned up easily from wood, linoleum, tile and similar smooth surfaces. It cannot be completely removed from carpets, curtains, upholstery or other absorbent materials. The affected portion should be isolated and disposed of appropriately.

Unused pharmaceuticals

- Should be sent to the pharmacy for return to the manufacturer.
- Pharmaceuticals should be kept in their original packaging to aid identification and prevent reaction between incompatible chemicals.
- Spilt and contaminated chemicals and pharmaceuticals should not be returned to the pharmacy but should go directly from the point of production to a waste store and must be kept dry.

Radioactive wastes may be stored in secure, radiation-proof repositories (leak-proof, lead-lined and clearly labelled with the name of the radionuclide and date of deposition) where it should be left to decay naturally.

7.3 Waste Containers: Specifications and Siting

Waste containers can come in many shapes and sizes and be made from different materials. They should be sturdy and leak-proof, and lined with a sturdy plastic bag (except for sharps containers). The recommended thickness of bags for infectious waste is 70µm (ISO 7765 2004).

Plastics used for either containers or bags should be chlorine-free. Not all plastic bags can withstand temperatures of 121°C, and some can melt during an autoclave process.

Containers should have well-fitting lids, either removable by hand or preferably operated by a foot pedal. Both the container and the bag should be of the correct colour for the waste they are intended to receive, and labelled clearly. Mixing colours, such as having yellow bags in black bins, should be avoided as it will increase the potential for confusion and poor segregation.

Since sharps can cause injuries that leave people vulnerable to infection, both contaminated and uncontaminated sharps should be collected in a puncture-proof and impermeable container that is difficult to break open after closure. (Figure 2)

The appropriate waste receptacle (bags, bins, sharps boxes) should be available to staff in each waste-producing area in a healthcare facility. Posters showing the type of waste that should be disposed of in each container should be posted on walls to guide staff and reinforce good habits.

Figure 2. Cardboard safety boxes

Staff should be encouraged to think of waste disposal as part of a patient's treatment, therefore all aspects of the care process should be completed at the bedside or treatment room. If intervention at the bedside is required, a waste container should be taken to the bed including a sharps bins. A mobile trolley with infectious waste and sharps containers should be used in all clinical areas.

When segregating hazardous and non-hazardous healthcare wastes, waste containers should be located close together, wherever possible. Containers for infectious waste should not be placed in public areas because patients and visitors may use the containers and come into contact with potentially infectious waste items. As most staff will dispose of gloves and aprons after treating patients, static bins should be located as close as possible to sinks and washing facilities.

If there is a known communicable infection (e.g. Methicillin-Resistant *Staphylococcus Aureus*, tuberculosis or leprosy), all wastes used in and around the patient should be classed as an infection risk and placed in the yellow infectious waste container. Waste from each patient should be treated according to their known infection status.

A waste audit data can be used to indicate the type, size and number of containers needed in each area. It should be used to estimate disposal capacity requirements and the amount of recyclables generated. Both are essential for good waste management and cost control. It can also be used to track the entire waste stream through to final disposal.

7.4 Collection within the Healthcare Facility

Collection should be daily for most wastes, and collection times should be fixed and appropriate to the quantity of waste produced in each area of the healthcare facility.

General waste should not be collected at the same time or in the same trolley as infectious or other hazardous wastes.

Waste bags and sharps containers should be filled to no more than three quarters full. Once this level is reached, they should be sealed and ready for collection. Plastic bags should never be stapled but may be tied or sealed with a plastic tag or string. Replacement bags or containers should be available at each waste collection location so that filled ones can be replaced immediately.

Waste bags and containers should be labelled with the date, type of waste and point of generation to allow them to be tracked through to disposal. Wherever possible, weight should also be routinely recorded.

In a medical area where the morning routine begins with changing of dressings, infectious waste should be collected mid-morning to prevent soiled bandages remaining in the medical area for longer than necessary. Visitors arriving later in the day will bring with them an increase in general waste, such as newspapers and food wrappings, therefore, the optimum time for general and recyclable waste collection would be after visitors have left.

In contrast to a general medical area, operating theatres will typically generate a high proportion of potentially infectious waste. Several collections will need to be done to fit in with the schedule of operations. Maternal and child health clinics may generate primarily sharps waste from injections, which will need to be collected at the end of each working day.

7.5 Interim Storage in Medical Departments

Where possible, hazardous waste generated in medical areas should be stored in utility rooms which are designated for cleaning equipment, dirty linen and waste.

7.6 Onsite Transport of Waste

7.6.1 General requirements

Onsite transport should take place during less busy times whenever possible. Set routes should be used to prevent exposure to staff and patients and to minimise the passage of loaded carts through patient care and other clean areas. The internal transport of waste should use separate floors, stairways or elevators as far as possible. Regular transport routes and collection times should be fixed and reliable. Transport staff should wear adequate personal protective equipment, gloves, strong and closed shoes, overalls and masks.

Hazardous and non-hazardous wastes should always be transported separately. In general, there are three categories for transport of wastes:

• Waste transportation trolleys for general waste should be painted black, only be used for non-hazardous waste types and clearly labelled ‘General waste’ or ‘Non-hazardous waste’.

• Infectious waste can be transported with used sharps waste. Infectious waste should not be transported with other hazardous waste, to prevent the possible spread of infectious agents. Trolleys should be coloured in the appropriate colour code for infectious waste (yellow) and should be labelled ‘Infectious waste’.

• Other hazardous wastes, such as chemical and pharmaceutical wastes, should be transported separately in boxes to central storage sites.

The use of waste chutes in healthcare facilities is not recommended, because they can increase the risk of transmitting airborne infections.

7.6.2 Transport trolleys

Healthcare waste can be bulky and heavy, and should be transported using wheeled trolleys or carts that are not used for any other purpose (Figure 3). To avoid injuries and infection transmission, trolleys and carts should:

- be easy to load and unload
- have no sharp edges that could damage waste bags or containers during loading and unloading
- be easy to clean and, if enclosed, fitted with a drainage hole and plug
- be labelled and dedicated to a particular waste type
- be easy to push and pull
- not be too high (to avoid restricting the view of staff transporting waste)
- be secured with a lock (for hazardous waste)
- be appropriately sized according to the volumes of waste generated at a healthcare facility

Wastes, especially hazardous waste, should never be transported by hand due to risk of accident or injury from infectious material or incorrectly disposed sharps that may protrude from a container.

Spare trolleys should be available in case of breakdowns and maintenance. The vehicles should be cleaned and disinfected daily. All waste bag seals should be in place and intact at the end of transportation.

Figure 3. A selection of onsite transportation trolleys

7.6.3 Routing

Separate hazardous and non-hazardous routes should be planned and used. Collection points and specific route of wastes should be planned and mapped. In general, a waste route should follow the principle 'from clean to dirty'. Collection should start from the most hygienically sensitive medical areas (e.g. intensive care, dialysis, theatres) and follow a fixed route around other medical areas and interim storage locations.

A routing plan would be influenced by:

- waste volume and number of waste bags or containers
- type of waste
- capacity of the waste storage within medical areas and at interim storage areas
- capacity of the transportation trolleys
- transport distances and journey times between the collection points

7.7 Central Storage in Healthcare Facilities

Central storage areas are places within a healthcare facility where different types of wastes should be brought for safe retention until it is treated or collected for transport offsite. (Figure 4)

General recommendations for storage facilities for healthcare waste are to:

- have an impermeable, hard-standing floor with good drainage (away from water courses), and the floor should be easy to clean and disinfect
- separate infectious wastes from other hazardous wastes
- have a water supply for cleaning purposes
- have easy access for staff who are in charge of handling wastes
- be lockable to prevent access by unauthorised persons
- have easy access for waste-collection vehicles
- have protection from the sun
- be inaccessible to animals, insects and birds
- have good lighting and at least passive ventilation
- not be situated in the proximity of fresh food stores and food preparation areas
- have a supply of cleaning equipment, protective clothing and waste bin bags or containers located conveniently close to the storage area
- have a washing basin with running tap water and soap that is readily available for staff
- be cleaned regularly (at least once per week)
- have spillage containment equipment
- be appropriate to the volumes of waste generated from each healthcare facility

7.7.1 General requirements

A storage location for healthcare waste should be designated inside the healthcare facility. The area must be totally enclosed and separate from supply rooms or food preparation areas. Loading docks, space for compactors and balers for cardboard, staging areas for sharps boxes, recycling containers and secure storage should be provided.

Storage facilities should be labelled in accordance with the hazard level of the stored wastes. Figures 4 and 5 show commonly used signs indicating the hazard posed by different types of wastes. In general, there are six different kinds of waste storage areas:

1) Non-hazardous or general waste
2) Hazardous waste
3) Infectious and sharps waste
4) Chemical waste
5) Pharmaceutical waste
6) Radioactive waste

No entry for unauthorised in all persons storage areas

Biohazard signage for and infectious sharps wastes

Toxic hazard signage for chemical and hazardous pharmaceutical wastes

Figure 4. Examples of signage outside the storage facility

No eating or drinking

No smoking

Figure 5. Examples of signage inside the storage facility

Hazardous waste storage

Further specifications should be considered for the storage of hazardous waste, in addition to the above general requirements.

Infectious waste storage

The storage room must be identified as an infectious waste area by using the biohazard sign. Floors and walls should be sealed or tiled to allow for easy disinfection. The storage room should be connected to a special sewage system for infectious hospital waste water. Compacting of untreated infectious waste or waste with a high content of blood or other body fluids destined for off-site disposal (for which there is a risk of spillage) is not permitted. Sharps can be stored, but other infectious wastes should be kept cool or refrigerated at a temperature preferably no higher than 3 °C to 8 °C if stored for more than a week. Unless a refrigerated storage room is available, storage times for infectious wastes (e.g. the time gap between generation and treatment) should not exceed 24 hours.

Pathological waste storage

Pathological waste and the growth of pathogens it may contain are considered as biologically active waste, and gas formation during storage should be expected. To minimise these possibilities, the storage places should have the same conditions as those for infectious and sharps wastes.

In some instances, body parts are passed to the family for ritual procedures or are buried in designated places. They should be placed in sealed bags to reduce risk of infection transmission before release to the public. Figure 6 shows an example of a label for a pathological waste storage room.

Figure 6. Label for a pathological waste storage room

Pharmaceutical waste storage

Pharmaceutical waste should be segregated from other wastes. Various waste streams are listed below:

- Pharmaceutical waste with non-hazardous characteristics that can be stored in a non-hazardous storage area:
  - ampoules with non-hazardous content (e.g. vitamins)
  - fluids with non-hazardous contents such as vitamins, salts (sodium chloride), amino salts
  - solids or semi-solids such as tablets, capsules, granules, powders for injection, mixtures, creams, lotions, gels and suppositories
  - aerosol cans including propellant-driven sprays and inhalers

- Hazardous waste that should be stored in accordance with their chemical characteristics (e.g. genotoxic drugs) or specific requirements for disposal (e.g. controlled drugs or antibiotics):
  - controlled drugs (should be stored under government supervision)
  - disinfectants and antiseptics
  - anti-infective drugs (e.g. antibiotics)
  - genotoxic drugs (genotoxic waste)
  - ampoules containing antibiotics

Genotoxic waste is highly toxic and should be identified and stored carefully away from other healthcare waste in a designated secure location. It can be stored in the same manner as toxic chemical waste, although some cytotoxic waste may also carry risk of infection.

Chemical waste storage

Hazardous chemical waste storage place should be an enclosed area and separated from other waste storage areas. (Figure 7)

When storing liquid chemicals, the storage should be equipped with a liquid- and chemical-proof sump. If no sump is present, catch-containers to collect leaked liquids should be placed under the storage containers. Spillage kits, protective equipment and first aid equipment (e.g. eye showers) should be available in the storage area. The storage area itself should have adequate lighting and good ventilation to prevent the accumulation of toxic fumes.

To ensure the safe storage of chemical wastes, the following separate storage zones should be available to prevent dangerous chemical reactions:

- explosive waste
- corrosive acid waste
- corrosive alkali waste (bases)
- toxic waste
- flammable waste
- oxidative waste
- halogenated solvents (containing chlorine, bromine, iodine or fluorine)
- non-halogenated solvents

Liquid and solid wastes should be stored separately.

Storage area for explosive or highly flammable materials must be suitably ventilated above and below, with a bonded floor constructed of materials suitable to withstand explosion or leakage.

Storage of chemicals in different safety compartments

Storage of liquid chemical wastes in chemical-resistant plastic containers

Safety cabinet for flammable substances

Inside a safety cabinet for flammable substances

Figure 7. Examples of storage places for chemical wastes

Radioactive waste storage

Radioactive waste should be stored in containers that prevent dispersion of radiation, and stored behind lead shielding. Waste that is to be stored during radioactive decay should be labelled with the type of radionuclide, date, period of time before full decay and details of required storage conditions.

The decay storage time for radioactive waste differs from other waste storage, because the main target will be to store the waste until the radioactivity is substantially reduced to background level and the waste can be safely disposed of as normal waste. A minimum storage time of 10 half-life times for radioisotopes in wastes with a half-life of less than 90 days is a common practice.

Infectious radioactive waste should be decontaminated before disposal. Sharp objects such as needles, Pasteur pipettes and broken glass should be placed into a sharps container. Liquids associated with solid materials, such as assay tube contents, should be decanted or removed by decay time. All radioactive labelling should be removed on any items to be disposed of.

Radioactive waste with a half-life of more than 90 days must be collected and taken to a national disposal site by its specialist contractor.

7.7.2 Layout of waste storage areas

A 'waste yard', where all the relevant waste management activities are brought together, should be available. To segregate certain tasks, it is best to set up multi-functional buildings (waste storage areas), including a fenced storage area for general waste (A), a room for infectious waste (B), a treatment room (C), a fenced area with an ash or sharps pit (D), a container cleaning room (E), and a clean office with lockers and toilets (F). (Figure 8)

A sample design of a storage room for chemical wastes is presented in Figures 8 and 9.

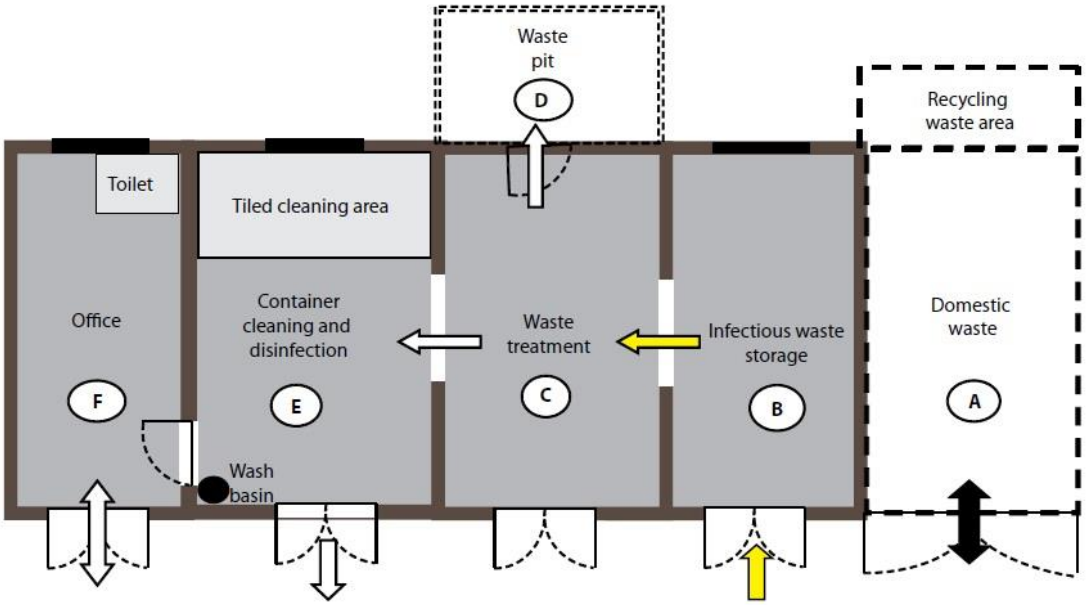

Figure 8. Sample of waste storage area

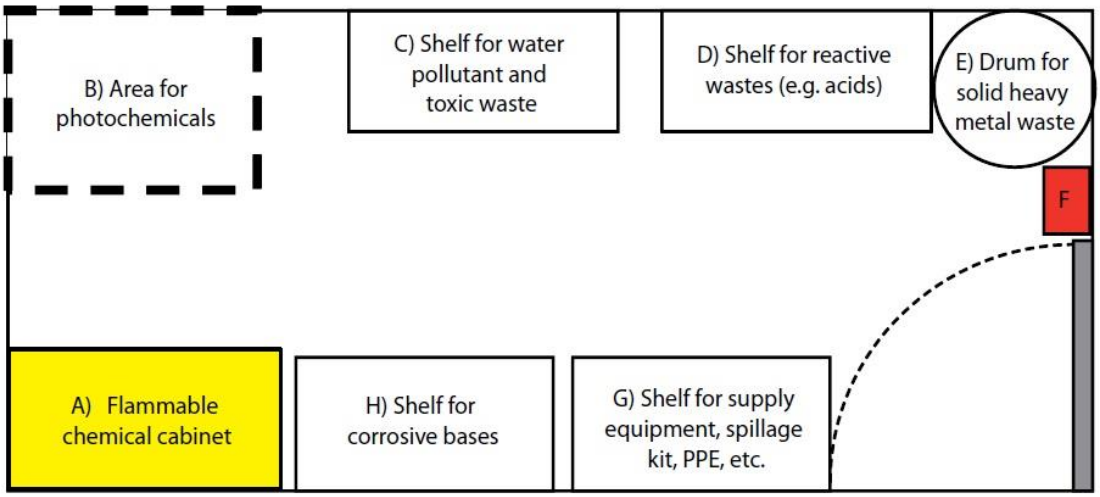

Figure 9. Sample outline of chemical storage room

7.7.3 Documentation of operation of storage areas

Keeping clear records of wastes stored and their treatment and disposal dates must be done, and the following forms of additional documentation are recommended:

- A written spill contingency plan (Annex12)
- A weekly store inspection protocol
- Protocols for using, repairing and replacing emergency equipment
- Training system and documentation (names of trained staff, job descriptions, form of training, date of training, date for refresher or revalidation training)
- Hazardous waste storage documentation
- Collection of relevant safety data sheets

7.8 Offsite Transport of Waste

Transporting hazardous healthcare waste should comply with relevant regulations, and with international agreements if wastes are shipped across an international frontier for treatment (Secretariat of the Basel Convention, 1992).

7.8.1 Logistic staff

Drivers of vehicles carrying hazardous healthcare waste should have appropriate training about risks and handling of hazardous waste. Training on the following issues should be included:

- Relevant legal regulations
- Waste classifications and risks
- Safe handling of hazardous waste
- Labelling and documentation
- Emergency and spillage procedures

In addition, drivers should be declared medically fit to drive vehicles.

In case of accidents, contact numbers or details of emergency services and other essential departments should be available in the driver's vehicle.

7.8.2 Vehicle requirements

Any vehicle used to transport healthcare waste should fulfill several design criteria:

- The body of the vehicle should be of a suitable size commensurate with the design of the vehicle
- There should be a bulkhead between the driver's cabin and the vehicle body, which is designed to retain the load if the vehicle is involved in a collision
- There should be a suitable system for securing the load during transport
- Empty plastic bags, suitable protective clothing, cleaning equipment, tools and disinfectant, special kits for dealing with liquid spillages, should be carried in a separate compartment in the vehicle

- The internal finish of the vehicle should allow it to be steam-cleaned and internal angles should be rounded to eliminate sharp edges to permit more thorough cleaning and prevent damage to waste containers
- The vehicle should be marked with the name and address of the waste carrier
- An international hazard sign should be displayed on the vehicle and containers, as well as an emergency telephone number
- The driver should be provided with details of the waste being carried

An example of a specially designed vehicle used for transporting healthcare waste is shown in Figure 10. Vehicles or containers used for transporting healthcare waste should not be used for transporting any other materials. Vehicles should be kept locked at all times, except when loading and unloading, and kept properly maintained. Open-topped skips or containers are unsuitable because they fail to isolate wastes from the general public during transportation, and should not be used for healthcare waste.

Figure 10. Example of a vehicle used for transporting healthcare waste

7.8.3 Labelling of the transport vehicle

The transport vehicle should be labelled according to the type of waste that is being transported. The label that is displayed should follow the United Nations classification of waste. Some examples are shown in Annex 10.

No specific vehicle labelling is required if less than 333 kg (i.e. 'gross dangerous goods charge') of infectious waste (UN 3291) is transported, although labelling is recommended. Vehicles transporting more than 333 kg gross weight must be provided with warning plates, as represented in Annex 10.

A warning plate should:

- be not less than 250 mm by 250 mm, with a line of the same colour as the symbol running 12.5 mm inside the edge and parallel with it
- correspond to the label required for the dangerous goods in question with respect to colour and symbol
- display the numbers prescribed for the dangerous goods on the corresponding label, in digits not less than 25 mm high

7.8.4 Cleaning of container and vehicle

Vehicles and transporting containers used for the transportation of waste should be cleaned and disinfected daily after use. Mechanical cleaning, combined with soaps and detergents, which act as solubility promoting agents, can be used. Cleaning and disinfection have to be carried out in a standardised manner or by automated means that will guarantee an adequate level of cleanliness. A standard operating procedure for cleaning should be prepared and explained to cleaning staff. In addition, a schedule for preventive maintenance should be set up for all equipment and vehicles used in the transportation process.

7.8.5 Transport documentation

Before sending hazardous healthcare wastes offsite, transport documentation (commonly called a 'consignment note' or 'waste tracking note') should be prepared and carried by the driver.

The consignment note for a vehicle carrying hazardous healthcare waste should include the following information in case of accidents or official inspection:

- Waste classification
- Waste sources
- Pick-up date management of wastes from healthcare activities
- Destination
- Driver name
- Number of containers or volume
- Receipt of load received from responsible person at pick-up areas

This information allows quick and effective counter measures to be taken in the event of an accident or incident. Weight of wastes is useful for commercial treatment and disposal operators who bill healthcare facilities for their waste services.

On completion of a journey, the transporter should complete a consignment note and return it to the waste producer. A typical consignment note for carriage and disposal of hazardous waste and routing of the copies to a waste producer, waste disposer and regulator is shown in Annex 11.

There should be four copies of the signed consignment note: one for the generator, one for the transport entity, one for the treatment entity, and one for the relevant regulatory authority.

Driver documents

Drivers operating trucks with dangerous waste require special knowledge about risks and handling. For that reason, the driver should undergo appropriate training and preferably obtain a certificate indicating their competency to transport hazardous wastes.

UN 3291 CLINICAL WASTE, UNSPECIFIED, NOS or (BIO) MEDICAL WASTE, NOS or REGULATED MEDICAL WASTE, NOS

ADR Class 6.2 Packing group II

1. Characteristics
   - Hazardous to skin, eyes and air passages
   - Biohazard – Infectious to humans and/ or animals. Serious risk of contamination of soil and water.

2. Personal protection
   - Protection suit
   - Gloves, mask and goggles
   - Closed shoes

3. Intervention actions

3.1 General
   - Keep upwind. Put on personal protective equipment before entering danger area.
   - Minimise number of personnel in risk area.
   - People and animals who may be contaminated should be kept isolated pending medical/veterinary examination.

3.2 Spillage
   - Stop leaks if possible
   - Contain spillage by any means available
   - Absorb liquid in sand or earth or any other suitable material
   - If substance has entered a water course or sewer, inform the responsible authority.

3.3 Fire (involving the substance)
   - Let breached containers burn. Prevent the fire spreading with water spray.
   - Minimise use of extinguishing media and contain run-off
   - Remove undamaged containers away from heat radiation

4. First aid
   - First aid kit should be readily available

8.0 TREATMENT AND DISPOSAL METHODS FOR HEALTHCARE WASTE

There are many different types of treatment and disposal methods of healthcare waste but the main aim is to limit public health and environmental impacts by:

- Transforming the waste into non-hazardous residues by treatment
- Containing the waste or its residues to avoid human exposure
- Containing the waste or its residues to avoid dispersion into the environment

There are five basic processes for the treatment of hazardous components in healthcare waste, in particular, sharps, infectious and pathological wastes: thermal, chemical, irradiation, biological and mechanical. There are various treatment and disposal methods for all the healthcare waste categories as recommended in the World Health Organization (WHO) Guidelines on the Safe Management of Waste from Healthcare Activities (2013 Edition).

The recommended treatment and disposal options for healthcare waste include the following:

- Incineration
- Chemical Disinfection
- Wet and Dry Thermal Treatment
- Microwave Irradiation
- Land Disposal
- Inertization

The final choice of treatment system of waste should be made carefully, and should take into consideration various factors depending on the local resources and conditions.

8.1 Incineration

Incineration is a high-temperature dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and results in a very significant reduction of waste volume and weight.

Incineration has been widely used as the disposal method for most hazardous healthcare waste particularly those that cannot be recycled, re-used, or disposed in a landfill site.

8.1.1 Required waste characteristics

Incineration of waste is affordable and feasible only if the “heating” (or “calorific”) value of the waste reaches at least 2000 kcal/kg (8370 kJ/kg). While the value for hospital wastes containing high levels of plastics can exceed 4000 kcal/kg (16 740 kJ/kg), some healthcare waste may contain a high proportion of wet waste and have much lower calorific values.

The characteristics that make waste suitable and unsuitable for incineration are as outlined in Table 4.

Wastes Characteristics for Incineration	**Wastes Unsuitable for Incineration**
Heating value above 2000 kcal/kg (8370 kJ/kg); Calorific values within the regulatory and design requirements (e.g. the desired residence time, system operating temperature and excess air levels); Content of combustible matter above 60%; Content of non-combustible solids below 5%; Content of non-combustible fines below 20%; Moisture content below 30%.	Pressurised gas containers; Large amounts of reactive chemical waste; Silver salts and photographic or radiographic wastes; Halogenated materials such as polyvinyl chloride (PVC) plastics (waste and packaging of waste should not contain PVC material); Wastes containing mercury, cadmium and other heavy metals, such as broken thermometers, used batteries and lead-lined wooden panels; Sealed ampoules or vials that may implode during the combustion process; Radioactive materials; Pharmaceuticals thermally stable in conditions below 1200 °C (e.g. 5-fluorouracil).

Table 4. Waste characteristics suitable and unsuitable for incineration

8.1.2 Rules and recommendations on the disposal of healthcare waste by incineration

- When healthcare waste is delivered to the incineration site, the packaging should be checked to ensure it is undamaged

- Healthcare waste should not be packed in cylindrical containers to prevent rolling on the grids where they are placed for combustion
- Facilities should be available at the incineration site for the cleaning and disinfection of transportation equipment, including vehicles
- Healthcare waste should be loaded directly into the furnace
- Use of automatic loading device for bags and containers of healthcare waste, rather than manual loading, would protect the safety of workers
- Healthcare waste should not be stored at the incineration site for more than 24 hours; longer storage would require cooling facilities to prevent the growth of certain pathogens and the development of odours
- The combustion efficiency should be checked. It should be at least 97% during incineration of healthcare waste
- Healthcare waste should be introduced into the furnace only when the normal condition of combustion has been established - never during start-up or shutdown of the combustion process
- The process should be designed to prevent contamination of ashes or wastewater by the healthcare waste
- Air pollutants of incinerator emission should be monitored regularly

8.2 Chemical Disinfection

8.2.1 Simple chemical disinfection processes

Chemical disinfection is now being used for the treatment of healthcare waste. Chemicals are added to the waste to kill or inactivate the pathogens. This treatment usually results in disinfection (incomplete elimination of pathogens) rather than sterilisation (complete elimination of pathogens).

Chemical disinfection is most suitable for treating liquid waste such as blood, urine, stools or hospital sewage. Solid waste including microbiological cultures, sharps, etc. may also be disinfected chemically, with the following limitations:

- Shredding and/ or milling of waste is usually necessary before disinfection, however, the shredder is liable to frequent mechanical failure or breakdown
- Powerful disinfectants are required, which are themselves hazardous and should only be used by well-trained and adequately protected personnel
- Disinfection efficiency depends on operational conditions
- Only the surface of intact solid waste will be disinfected

Human body parts should not normally be disinfected chemically (see section 8.5 for disposal method).

8.2.2 Operational Considerations

The speed and efficiency of chemical disinfection will depend on operational conditions including:

- Type of chemical used
- Amount of chemical used
- Contact time between disinfectant and waste
- Extent of contact between disinfectant and waste
- Operating temperature, humidity, pH, etc.

8.2.3 Shredding of waste before disinfection

Shredding of solid healthcare waste before disinfection is essential for the following reasons:

- To increase the extent of contact between waste and disinfectant by increasing the surface area and eliminating any enclosed spaces;
- To reduce the volume of waste.

Water is normally added during shredding to prevent excessive warming and facilitate subsequent contact with the disinfectant. Shredding of waste before disinfection with subsequent compacting can reduce the original waste volume by 60-90%.

8.2.4 Types of chemical disinfectants

The types of chemicals used for disinfection of healthcare waste are mostly aldehydes, chlorine compounds, ammonium salts, and phenolic compounds such as formaldehyde, ethylene oxide, glutaraldehyde, sodium hypochlorite and chlorine dioxide. The characteristics of these disinfectants are outlined in Annex 5.

The use of ethylene oxide is no longer recommended for waste treatment because of the significant hazards related to its handling.

Powerful disinfectants are often hazardous and toxic, and many are harmful to skin and mucous membranes. Users should therefore be aware of their physiological effects and wear protective clothes, including gloves and protective eye glasses or goggles. Disinfectants are also aggressive to certain building materials and should be handled and stored according to manufacturers' instructions.

8.3 Wet and Dry Thermal Treatment

There are two methods of thermal treatment:

- Wet thermal treatment including use of autoclaves (hydroclaves)
- Dry thermal treatment using a self-contained screw-feed unit

8.3.1 Wet thermal treatment

Wet thermal treatment or steam disinfection is based on exposure of shredded infectious waste to high temperatures, high pressure steam, and is similar to the autoclave sterilisation process. It inactivates most type of micro-organisms if temperature and contact time are sufficient; a minimum temperature of 121^{o}C is required.

The wet thermal process requires that waste be shredded before treatment; for sharps, milling or crushing is recommended to increase disinfection efficiency. The process is inappropriate for the treatment of anatomical waste; and will not efficiently treat chemical or pharmaceutical waste.

Once disinfected, waste can join the municipal waste collection and disposal mechanism.

The effectiveness of a wet thermal disinfection technique should be routinely checked using the *Bacillus subtilis* or *Bacillus stearothermophilus* test strips.

8.3.2 Dry thermal treatment

In dry-heat processes, heat is applied without adding steam or water. Instead, the waste is heated by conduction, natural or forced convection, or thermal radiation. In forced convection heating, air heated by resistance heaters or natural gas is circulated around the waste in the chamber.

The principal steps of the process include the following:

- Waste is shredded to particles about 25mm in diameter
- Waste enters the auger, which is heated to a temperature of 110-140^{o}C by oil circulating through its central shaft
- Waste rotates through the auger for about 20 minutes, after which the residues are compacted

The waste is reduced by 80% in volume and by 20-35% in weight. This process is suitable for treating infectious waste and sharps, but it should not be used to process pathological, cytotoxic, or radioactive waste. And this is not a suitable method to treat infectious plastic healthcare waste.

8.4 Microwave Treatment

A large-scale, semi-continuous microwave unit is capable of treating about 250 kg/hour (3000 tonnes per year).

The types of waste commonly treated in microwave systems are identical to those treated in autoclaves: cultures and stocks, sharps, materials contaminated with

blood and body fluids, isolation and surgery waste, laboratory waste (excluding chemical waste) and soft waste (e.g. gauze, bandages, gowns and bedding) from patient care. Volatile and semi volatile organic compounds, chemotherapeutic waste, mercury, other hazardous chemical waste and radiological waste should not be treated in a microwave.

8.5 Land Disposal

The residue of clinical waste following incineration is disposed into authorised landfills in Brunei Darussalam.

Different methods adopted for landfills are:

- Open dumps
- Sanitary landfills
- Encapsulation
- Safe burial in hospital premises
- Land disposal of residues

8.5.1 Municipal disposal site

Untreated **healthcare waste should never be deposited on or around open dumps**.

8.5.1.1 Open dumps

Untreated **healthcare waste should never be deposited on or around open dumps**.

8.5.1.2 Sanitary landfills

These landfills are designed to have at least four advantages over open dumps:

- Geological isolation of waste from the environment
- Appropriate engineering preparations before the site is ready to accept Waste
- Staff are present on site to control operations
- Organised deposit and daily coverage of waste

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

Before healthcare waste is sent for disposal, it is prudent to inspect landfill sites to ensure that there is sensible control of waste deposition.

The safety of waste burial depends critically on rational operational practices. The bottom of the pit should be at least 1.5 m higher than the groundwater level.

It is important to note that this type of waste disposal is practical only for relatively limited periods (1-2 years), and for relatively small quantities of waste (5-10 tonnes in total). Where these conditions are exceeded, other option, probably involving disposal at a municipal solid waste landfill, will need to be chosen.

8.5.1.3 Land disposal of residues

Hazardous waste that have become non-risk waste after being treated either by chemical disinfection or incineration may be finally disposed of in landfill sites.

8.6 Special Recommendation on Treatment and Disposal of Specific Waste Categories

8.6.1 Sharps

There are several methods other than incineration that can be used to dispose sharps, which generally entail the following steps:

- Using onsite mechanical needle cutters or electric needle destroyers
- Shredding the treated plastic parts
- Burying the metal pieces in sharps pits
- Re-melting the plastics for recycling.

Alternatively, the sharps waste can be autoclaved, shredded and encapsulated in cement blocks that can later become useful items such as hospital benches.

8.6.2 Anatomical waste, pathological waste, placenta waste and contaminated animal carcasses

The treatment of anatomical, pathological, and placenta and foetal remains wastes may be bound by sociocultural, religious and aesthetic norms and practices. Two traditional options have been:

- (burial) in cemeteries or special burial sites
- (burial) in cemeteries or special burial sites incinerators

8.6.3 Pharmaceutical Waste

Several options exist for small quantities of pharmaceutical waste:

- Return of expired pharmaceuticals to the donor or manufacturer
- Encapsulation and burial in a sanitary landfill
- Chemical decomposition in accordance with the manufacturer's guidance if

chemical expertise and materials are available
- Water and discharge into a sewer for moderate quantities of relatively mild liquid or semi-liquid pharmaceuticals, such as solutions containing vitamins, cough syrups, intravenous solutions and eye drops

Antibiotics or cytotoxic drugs should not be discharged into municipal sewers or watercourses.

For large quantities of pharmaceutical waste, the options available include:

- Encapsulation and burial in a sanitary landfill
- Incineration in kilns equipped with pollution-control devices designed for industrial waste and that operate at high temperatures
- Dilution and sewer discharge for relatively harmless liquids such as intravenous fluids (salts, amino acids, glucose)

8.6.4 Cytotoxic Waste

Cytotoxic waste is highly hazardous and should never be landfilled or discharged into the sewerage system. Disposal options include:

- Return to the original supplier
- Incineration at high temperatures
- Chemical degradation in accordance with manufacturers instruction

Full destruction of all cytotoxic substances may require incineration temperatures up to 1200ºC and a minimum gas residence time of two seconds in the second chamber. The incinerator should be equipped with gas-cleaning equipment. Incineration at lower temperatures may release hazardous cytotoxic vapours into the atmosphere.

Incineration in most municipal incinerators, in single-chamber incinerators or by open-air burning, is inappropriate for the disposal of cytotoxic waste.

8.6.5 Chemical Waste

Minimisation

Waste minimisation is the best way to improve the management of chemical waste. There are several options which include:

- Substituting highly toxic and environmentally persistent cleaners and solvents with less toxic and environmentally friendly chemicals
- Using minimum concentrations where possible
- Ensuring good inventory control (i.e. “just-in-time” purchasing)
- Designing storage areas well
- Integrating pest management

- Keeping disinfecting trays covered to prevent loss by evaporation
- Developing spill prevention and clean-up procedures
- Recovering solvents using fractional distillation

Pre-treatment and Recovery Methods
If practical and economically feasible, it is recommended for all chemical wastes to be recovered, re-used, or disposed of in-house. For some chemical waste types, pre-treatment and recovery methods are available prior to disposal.

Recovery and re-use
Considerations should be given to distillation for the recovery of large volumes of solvents. Other recovery methods include precipitation or crystallisation.

Dilution
Many laboratory chemical wastes can be diluted to an extent to allow disposal to the sewer system:

- Strong acids and bases should be diluted to pH 3-11
- Water soluble flammable solvents can be diluted to render them non-flammable
- Small amounts of various heavy metal compounds may be diluted to an extent that does not pose hazard to sewer system

However, dilution is not recommended for toxic substances exhibiting characteristics of accumulation, persistence, or degradation to more toxic substances.

Neutralisation
Strong acids and bases can carefully be neutralised to pH 3-11 to render them less hazardous for disposal.

Oxidation
Compounds such as sulphides, cyanides, aldehydes, mercaptans, and phenolics can be oxidized to less toxic and less odoriferous compounds.

Reduction
Oxidisers, peroxides, various organic chemicals and heavy metals solutions can be reduced to less toxic substances. Aqueous wastes containing hexavalent chromium may be reduced to trivalent using reducing agents such as bisulphate and ferrous sulphate. Mercury, lead, and silver may be removed from aqueous streams by the process of reduction/ precipitation. Organo-lead compounds can be removed by similar processes.

The resulting concentrated metal wastes can be containerised and disposed of at an authorised hazardous waste management facility, or subjected to recovery at a treatment facility.

Controlled Reactions/ Processes
Other methods for reducing the hazardous properties of waste will involve processes specific to particular wastes generated by the laboratory. Examples include evaporation, filtration, ion exchange, carbon adsorption, solvent extraction, hydrolysis, ozonolysis, and electrolysis.

8.6.6 Disposal Methods
The following measures are suggested:

- Hazardous chemical wastes of different composition should be stored separately to avoid unwanted chemical reactions
- Hazardous chemical wastes should not be discharged into sewerage systems
- Large amounts of chemical wastes should not be buried, as they may leak from their containers, overwhelm the natural attenuation process provided by the surrounding waste and soils, and contaminate water sources
- Large amounts of chemical disinfectants should not be encapsulated, as they are corrosive to concrete and sometimes produce flammable gases

An option for disposing of hazardous chemicals is to return them to the original supplier, who should be equipped to deal with them safely. Where such an arrangement is envisaged, appropriate provisions should be included in the original purchase contract for the chemicals. Preferably, these wastes should be treated by a specialist contractor with the expertise and facilities to dispose safely of hazardous waste. Use of certain products for non-medical purposes may also be considered; for example, use of outdated disinfectants to clean toilets is often acceptable.

Wastes containing mercury or cadmium should not be burned or incinerated. Cadmium and Mercury volatilise at relatively low temperature and can cause atmospheric pollution.

Mercury- or cadmium-containing wastes can be sent to facilities that specialise in the recovery of heavy metals. It may also be possible to send back the wastes to the suppliers of the original equipment, with a view to re-processing or for final disposal. Exporting wastes to countries with expertise and facilities for its adequate treatment should also be considered, but only within the rules laid down by the Basel Convention.

If none of the above options are feasible, the wastes would have to go to a disposal or storage site designed for hazardous industrial waste.

Containerisation
This method should be used only in the disposal of inert laboratory solid wastes. Each laboratory department should have a procedure for handling solid wastes which includes classification, segregation, and collection. Materials disposed of in this manner must be suitable for sanitary landfill and of no threat to the personnel handling the waste.

Disposal to the Sewer System

Many laboratory chemicals, with or without pre-treatment, are amendable when disposed to the sewer system. Highly toxic, malodorous, or lachrymatory chemicals should not be disposed of down the drain. Laboratory drains are usually interconnected, and a substance that goes down one sink may arise as vapour from another. Additionally, co-mingling of wastes from different sources in the sewer system may present as definite hazards, e.g. sulphide poured down one drain may come into contact with an acid poured down another. Some simple reactions, such as ammonia plus iodine or silver nitrate plus ethanol, may produce explosions.

Incineration, Solvent Recovery

Waste solvents free of solids and corrosive or reactive substances should be collected, segregated, and containerized. Segregation into at least two groups may be necessary as some incineration or solvent recovery sites cannot handle chlorinated solvents.

Lab Pack

Small containers of hazardous wastes (liquids and solids) in over-packed drums can be disposed of in secure or specially permitted landfills. The chemicals are to be segregated and packaged according to the following classification: poisons, oxidizers, flammables, corrosive-acids, and corrosive-alkalis. However, some chemicals of similar classification may react, e.g. concentrated solutions of nitric acid mixed with acetic acid can cause spontaneous explosion.

Vermiculite or another inert and compatible material should be placed around the original waste containers to avoid breakage and to act as an absorbent should any leakage or breakage occur. The chemicals are to be equally distributed within the drum with not less than an equal volume of vermiculite. The drums must be completely filled and properly sealed.

Solidification

An alternative to lab pack involves solidification of compatible liquid chemical wastes with vermiculite or a suitable solidification agent such as diatomaceous earth or clay.

Waste Exchange

Specific wastes, especially if produced in large quantities, may be useful in waste exchange, where a laboratory's unused chemicals or wastes may be another laboratory's reagent, possibly with only minor pre-treatment methods.

8.6.7 Summary of Recommended Pre-treatment and Disposal Methods for Laboratory Chemical Wastes

A summary of pre-treatment and disposal methods for laboratory chemicals by waste type is given in Table 5. Safety Data Sheets should be available for all laboratory chemicals. Wherever practical and economical, recovery and re-use is the preferred method for the management of chemical wastes.

Waste Type	Pre-treatment Method	Disposal Method
Non-hazardous	Not applicable	Containerisation
Weak aqueous acid and weak aqueous alkaline solutions (<10% weight) and related compounds	i) Dilution ii) Neutralization	i) Sewer ii) Solidification
Concentrated aqueous acid and concentrated aqueous alkaline solutions and related compounds	i) Dilution ii) Neutralization	i) Sewer ii) Lab pack iii) Solidification
Non-halogenated organic solvents and related compounds, e.g. xylene, phenol-based disinfecting solutions	Not applicable	i) Incineration ii) Lab pack iii) Solidification
Halogenated organic solvents and related compounds, e.g. chloroform, and perchlorethylene	Not applicable	i) Incineration ii) Lab pack iii) Solidification
Organic acids and bases, e.g. acetic acid	Neutralization	i) Sewer ii) Incineration iii) Lab pack
Inorganic and organic oxidizers, peroxides, e.g. potassium dichromate	i) Dilution ii) Reduction	i) Sewer ii) Lab pack
Toxic heavy metals	i) Dilution ii) Reduction	i) Sewer ii) Lab pack iii) Solidification
Toxic poisons, herbicides, pesticides, and carcinogens, e.g. Polycyclic Aromatic Hydrocarbons (PAHs), diaminobenzidine	i) Dilution ii) Reduction	i) Sewer ii) Lab pack iii) Solidification
Aqueous solutions of reducing agents and related compounds, e.g. stannous chloride, sodium bisulphate	i) Dilution ii) Oxidation	i) Sewer ii) Lab pack iii) Solidification
Water-reactive substances, e.g. white phosphorus, phosphide	As special waste, see*	As special waste, see*
Cyanide, sulphide, and ammonia bearing wastes	i) Dilution ii) Oxidation	i) Sewer ii) Lab pack
Explosive materials, e.g. potassium chlorate	As special waste, see *	As special waste, see*

Waste Type	Pre-treatment Method	Disposal Method
Asbestos or asbestos bearing wastes	As special waste, see **	As special waste, see**
Polychlorinated biphenyls (PCBs)	As special waste, see ***	As special waste, see ***

Table 5. Summary of Pre-treatment and Disposal Methods

NOTE:

* Police and Fire & Rescue (HAZMAT) Departments should be contacted for disposal of especially dangerous wastes, in most cases explosives. Examples include metallic sodium, picric acid, metal azides, organic azides, and organic peroxides.

** Asbestos or asbestos bearing wastes must be wet, and sealed inside a leak-tight container while wet. The containers must bear a warning label stating: "Caution, contains asbestos – avoid opening or breathing container – breathing asbestos is hazardous to your health". Disposal is permitted only in authorised landfills.

*** PCBs in concentrations of less than 50 ppm can be disposed of in a municipal landfill or co-mingled with compatible organic wastes destined for incineration. PCBs in concentrations of 50 to 500 ppm should be designated as "PCB contaminated waste", and those above 500 ppm should be designated as "PCB waste". Disposal of these wastes require detoxification, or management at a facility approved for the disposal (incineration or landfilling) of PCBs.

8.7 Special Recommendation on Treatment and Disposal of Radioactive Waste

In the presence or suspicion of radioactive wastes, Radiation Safety and Quality Unit (RSQU) should be contacted for consultation to define the activity levels and half-lives of the radionuclides present.

A radioactive waste management plan includes a waste minimisation programme such as source reduction, extended storage for decay of radioactivity and substitution with a non-radioactive alternative.

Possible disposal methods for low-level radioactive wastes are as follows:

- Decay in storage i.e. safe storage of waste until its radiation levels are indistinguishable from background radiation
- Return to supplier
- Long-term storage at an authorised radioactive waste disposal site

Radionuclides are not to be released to the environment unless:

- The radioactivity levels are confirmed to be below clearance levels; or
- The radioactivity of liquid or gaseous effluents is within limits set by a regulatory authority

Disposal of sealed sources, long-life radionuclides and spent sources (e.g. x-ray equipment) are as follows:

- Return to the producer or supplier of their original form. Healthcare facilities planning to import a sealed source with radioactivity greater than 100MBq should require the supplier to accept the source back after expiration of its useful life time and within a year after notification is made.
- Stored in approved long-term storage facility

Prior to disposal, the waste should first be "conditioned" to make it suitable for handling, transportation and storage.

Types Of Radioactive Waste	Recommended Disposal Method
Sealed and other sources of radioactive waste	Return to supplier or manufacturer
Spent radionuclide generators	Decay – delay – incinerate – landfill or return to supplier
Excreta from patients treated with unsealed radioactive materials	Holding tanks – sewerage system
Unwanted solutions for diagnosis or therapeutic use or calibration	Store – incinerate – landfill
Low level waste from washing	Sewerage
Liquids immiscible with water	Incinerate
Low level waste for example paper, syringes	Incinerate – landfill
Waste from spill and from decontamination	Decay – delay – incinerate – landfill
Unwanted radioactive gases for diagnostic or therapeutic purposes, or calibration	Environment, away from settlements (inform authority prior to discharge)

Table 6. Recommended disposal method for different types of radioactive wastes

9.0 OCCUPATIONAL HEALTH AND SAFETY PRACTICES FOR HEALTHCARE PERSONNEL AND WASTE HANDLERS

9.1 Occupational Health and Safety Hazards of Healthcare Personnel and Waste Handlers

Healthcare workers can be exposed to biological agents (bacteria, virus, fungi) due to direct contact of contaminated waste materials. In addition, they may acquire infections from inhalation of contaminated air. In particular, waste handlers or collectors may be exposed to the following occupational health and safety hazards at work:

- Physical: heat from incineration process, radiation from radioactive waste materials
- Chemical: heavy metals (mercury, cadmium, lead, arsenic), gases & fumes (dioxin, sulphur dioxide, nitrogen dioxide, PCB), cytotoxic chemicals, pharmaceuticals
- Biological: HIV, Hepatitis A, Hepatitis B, Hepatitis C, Ebola, Tetanus, fungal infections, and other bacterial, viral or parasitic infections
- Ergonomic: lifting of heavy loads, awkward working postures
- Mechanical: injuries due to sharps, broken glass pieces and machinery, strains, sprains
- Safety: fire, electricity, explosion

Blood borne virus	Risk of transmission of infection
Hepatitis B	18-30%
Hepatitis C	1.8% - 3%
HIV	0.3%

Table 7. Risk of transmission of infection following occupational exposure

9.2 Principles

Healthcare waste management policies or plans should include provision for the continuous monitoring of workers' health and safety to ensure that correct handling, storage, transport treatment, and disposal procedures are being followed. Essential occupational health and safety measures include the following:

- Proper selection of workers in particular waste handlers, as certain disease conditions may be deemed unfit for such work duties e.g. asthma, kidney disease, immune-compromised persons
- Proper and appropriate training of workers e.g. health and safety induction/ orientation

- Hazard communication e.g. identifying labels, warning signs
- Provision of equipment and clothing for personal protection
- Provision of first aid facilities, in particular for waste workers e.g. first aid box, first aid training
- Spill management system
- Emergency response plan
- Reporting of accidents, dangerous occurrences and any work-related illness to relevant authorities
- An effective occupational health programme that includes immunisation, post-exposure prophylactic treatment and medical surveillance

Training in health and safety should be carried out to ensure that workers are aware of and understand the potential risks associated with healthcare wastes, the benefits of immunisation against potential diseases (Hepatitis A and B, Typhoid, Tetanus etc) and the importance of appropriate use of personal protection equipment.

9.3 Hierarchy of Controls

Methods to control occupational hazards have traditionally been discussed in terms of hierarchy and presented in order of priority for their effectiveness in preventing exposure to the hazard or preventing injury resulting from exposure to the hazard. Table 8 shows an example on how to apply the hierarchy of controls framework to blood borne pathogen hazards.

1. **Elimination of hazard**
   Complete removal of a hazard from the work area. Elimination is the method preferred in controlling hazards and should be selected whenever possible.

   Examples include removing sharps and needles and eliminating all unnecessary injections. Jet injectors may substitute syringes and needles. All unnecessary sharps, such as towel clips, should also be eliminated, and needleless systems should be used.

2. **Engineering controls**
   Controls that isolate or remove a hazard from a workplace.

   Examples include sharps disposal containers and needles that retract, sheathe or blunt immediately after use (also known as safer needle devices or sharps with engineered injury-prevention features).

3. **Administrative controls**
   Policies to limit exposure to a hazard e.g. universal precautions.

   Examples include allocation of resources demonstrating a commitment to staff safety, an infection control committee, an exposure control plan, replacement of all unsafe devices, and consistent training on the use of safe devices.

4. **Work practice controls**
   Controls that reduce exposure to occupational hazards through the behaviour of workers.

   Examples include no needle recapping, placing sharps containers at eye level and at arm's reach, emptying sharps containers before they are full, and arranging for the safe handling and disposal of sharps devices before beginning a procedure.

5. **Personal protective equipment (PPE)**
   Barriers and filters between the worker and the hazard.

   Examples include eye goggles, gloves, masks and gowns.

Table 8. Controls framework

Workers at risk include healthcare providers, hospital cleaners, maintenance workers, operators of waste treatment equipment and all operators involved in waste handling and disposal within and outside healthcare establishments.

9.4 Workers' Protection

The production, segregation, transportation, treatment and disposal of healthcare wastes involve the handling of potentially hazardous materials. Protection against personal injury is therefore essential for all workers who are at risk. The individuals responsible for management of healthcare wastes should ensure that all risks are identified and that suitable protection from those at risk is provided.

A comprehensive risk assessment of all activities involved in healthcare waste management, carried out during preparation of a waste management plan, will allow the identification of necessary protection measures. These measures should be designed to prevent exposure within safe limits. Once the assessment is completed, personnel should receive suitable training.

9.4.1 Protective clothing

The type of protective clothing used will depend to an extent upon the risk associated with the healthcare waste, but the following should be made available to all personnel who collect or handle healthcare waste:

- Helmets, with or without visors - depending on the activity
- Face masks - depending on the activity
- Eye protectors (safety goggles) - depending on the activity
- Overalls (coveralls) – obligatory
- Industrial aprons – obligatory
- Leg protectors and/ or industrial boots – obligatory
- Disposable gloves (for medical staff) or heavy duty/ cut resistance gloves (for waste workers) – obligatory

Industrial 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 needles or other sharp items have been placed in plastic bags, such items may pierce thin walled or weak plastic containers. If it is likely that healthcare waste bags will come into contact with workers' legs during handling, leg protectors may also need to be worn.

Operators of manually loaded incinerators should wear protective face visors and helmets. During ash and slag removal and other operations that create dust, dust masks should be provided for operators.

9.4.2 Personal hygiene

Basic personal hygiene is important for reducing the risks from handling healthcare wastes. Convenient washing facilities (with warm water and soap) including showers should be available for personnel involved in the task especially at storage and incineration facilities. For radioactive waste contamination, excessive scrubbing is to be avoided.

9.4.3 Immunisation

Viral hepatitis B infection has been reported among healthcare personnel and waste handlers, and immunisation against the disease is therefore recommended. In addition, immunisation against tetanus, hepatitis A, and typhoid is also recommended for all personnel handling wastes.

9.4.4 Medical surveillance

All healthcare personnel and waste handlers must be subject to pre-placement medical examination and those who are unfit to handle waste, in particular waste workers, to be exempted from handling hazardous healthcare waste. In addition, they must undergo periodic health assessment in order to determine any ill health effects due to exposure of such hazardous healthcare waste.

9.4.5 Management Practices

Management practices contribute to a reduction in risk for personnel who handle healthcare waste and these are summarised as follows:

- *Waste segregation*: Careful separation of different types of waste into different and distinct containers or bags 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 authorised individuals only, protects against infestation by insects and rodents, and prevents contamination of surrounding areas
- *Appropriate transportation*: Reduces risk of workers being exposed to waste

9.4.6 Special precautions for clearing up spillages of potentially hazardous substances

Dealing with spillages

Spillages require clean-up of the area contaminated by the spilt waste. For spillages of highly infectious material, it is important to determine the type of infectious agent because immediate evacuation of the area may be necessary in some cases. In general, the most hazardous spillages occur in laboratories rather than in medical care departments.

Procedures for dealing with spillages should specify safe handling operations and appropriate protective clothing. An example of such a procedure is provided in Table 9. Appropriate equipment for collecting waste and new containers should be available, as should means for disinfection. Table 10 provides a typical list of required items.

In case of skin and eye contact with hazardous substances, there should be immediate decontamination. An exposed person should be removed from the area of the incident for decontamination, generally with copious amounts of water. Special

attention should be paid to the eyes and any open wounds. In case of eye contact with corrosive chemicals, the eyes should be irrigated continuously with clean water for 10–30 minutes; the entire face should be washed in a basin, with the eyes being continuously opened and closed.

- **Evacuate** the contaminated area.
- **Decontaminate** the eyes and skin of exposed personnel immediately.
- **Inform** the designated person (usually the waste management officer or infection control officer), who should coordinate the necessary actions.
- Determine the **nature** of the spill.
- **Evacuate** all the people not involved in cleaning up if the spillage involves a particularly hazardous substance.
- Provide **first aid** and medical care to injured individuals.
- **Secure** the area to prevent exposure of additional individuals.
- Provide adequate **protective clothing** to personnel involved in cleaning up.
- **Limit** the spread of the spill.
- **Neutralise or disinfect** the spilled or contaminated material, if indicated.
- **Collect** all spilled and contaminated materials. **Sharps should never be picked up by hand**; brushes and pans or other suitable tools should be used. Spilled material and disposable contaminated items used for cleaning should be placed in the appropriate waste bags or containers.
- **Decontaminate or disinfect** the area, wiping up with absorbent cloth. The cloth (or other absorbent material) should never be turned during this process, because this will spread the contamination. The decontamination should be carried out by working from the least to the most contaminated part, with a change of cloth at each stage. Dry cloths should be used in the case of liquid spillage. For spillages of solids, cloth impregnated with water (acidic, basic or neutral, as appropriate) should be used.
- **Rinse** the area, and wipe dry with absorbent cloth.
- **Decontaminate or disinfect** any tools that were used.
- **Remove** protective clothing and decontaminate or disinfect it, if necessary.
- **Seek medical attention** if exposure to hazardous material has occurred during the operation.
- **Report** the incident and document the response.

Table 9. General procedures for dealing with spillages

Action	Tools or items
Approaching the spillage	Protective equipment (to secure the area)
Containing the spillage	Absorbent material (e.g. absorbent paper, towels, gauze pads)
Neutralising or disinfecting the spillage (if necessary)	For infectious material: disinfectant For acids: sodium carbonate, calcium carbonate or other bases For bases: citric acid powder or other acids For cytotoxic material: special chemical degradation substances
Collecting the spillage	For liquids: absorbent paper, gauze pads, wood shavings, calcium bentonite, diatomaceous earth For solids: forceps, broom, dustpan or shovel For mercury: mercury sponge or vacuum pump
Organising containment for disposal	Plastic bag (red, yellow, or brown, as appropriate), sharps container
Decontaminating or disinfecting the area	For infectious material: disinfectant For hazardous chemicals: suitable solvent or water
Documenting the spillage	Reporting of incident to the superior

Table 10. List of items for spillage cleaning

9.4.7 Response to Injury and Exposure

A programme of response has been established that prescribes the actions to be taken in the event of exposure to a hazardous substance or injury (see Annex 6 for flowchart of reporting accident at work). All staff who handle healthcare waste should be trained to deal with injuries and exposures. The programme includes 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, usually Supervisor who may in turn report to the Infection Control Nurse
- Retention, if possible, of the item involved in the incident; details of its source for identification of possible infection
- Additional medical attention in an Emergency Department, as soon as possible (if necessary)
- Medical surveillance
- Blood or other tests if indicated
- Recording of the incident (place, date, time, nature of incident/ accident, staff involved)

- Reporting of the incident with above details to Occupational Health using the prescribed Accident at Work reporting form
- Investigation of the incident, and identification and implementation of remedial action to prevent similar incidents in the future

In case of needle stick injury, bleeding of the wound should be encouraged and the area should be washed under clean running water. The remaining elements of the accident response plan should then be followed.

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

9.5 Cytotoxic Safety

The senior pharmacist of the healthcare establishment should be designated to ensure safe use of cytotoxic drugs. It is recommended to appoint a fulltime Genotoxic Safety Officer (GSO) to supervise the safe management of cytotoxic waste. The following key measures are essential in minimising exposure:

- Written procedures that specify safe working methods for each process
- Safety data sheets, based on the supplier's specifications, to provide information on potential hazards
- Established procedure for emergency response in case of spillage or other occupational accident
- Appropriate education and training for all personnel involved in the handling of cytotoxic drugs

Specific guidelines on safe handling of cytotoxic waste should be established for the protection of personnel. These guidelines 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 outdated drugs to suppliers
- Safe storage separately from other healthcare waste
- Provisions for the disposal of contaminated material, for the decontamination of re-usable 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 incontinent patients

Specific procedures to follow in case of spillages of, or contamination by, mutagenic and carcinogenic products should be followed and strictly adhered to.

Minimal protective measures for all waste workers who handle cytotoxic waste should include protective clothing, gloves, goggles and masks.

9.6 Radiation Safety

An officer should be appointed by the healthcare facility, who is approved by the Radiation Safety and Quality Unit (RSQU), to undertake the responsibility as the Radiation Safety Officer (RSO) in the area concerned. One of the tasks is to ensure that radiation waste is managed properly.

The following are required to reduce the risk of radiation exposure:

- Ensure that the healthcare facility where radiation material or irradiating apparatus are used is registered with the Radiation Safety and Quality Unit (RSQU)
- A written radiation safety manual should be available in the healthcare establishment
- Establish a contingency plan in case of radiation over-exposure
- Provide appropriate training for all personnel who are involved in the handling of radioactive materials and waste

The following are some of the information required by the appropriate authority in order for the applicant to be registered to use radioactive materials:

- A radiation organisation structure
- Site design inclusive of storage availability
- Written procedures that specify the safe working methods for the area undertaken
- Procedures on emergency response and radiation accident
- Procedures on radiation waste disposal

9.6.1 Radiation Over-exposure of Personnel

The following measures should be taken in the event of over-exposure:

- Immediately report to the Radiation Protection Officer for further direction, who will notify Radiation Safety and Quality Unit (RSQU) within 24 hours with a brief written report. In his or her absence, the Radiation Protection Supervisor shall take over his/ her responsibilities
- Retain the item involved in the incident, and identify the level of radiation exposure
- Keep the waste shielded if possible
- Provide medical attention if required

- Medical surveillance
- Special blood test for the suspected radiation-exposed individual
- Provide full incident report to the Radiation Safety and Quality Unit within 30 days
- Radiation Safety and Quality Unit makes an investigation of the incident and provides corrective action to prevent a similar incident from happening in the near future

10.0 HOSPITAL FACILITY HYGIENE AND INFECTION CONTROL

10.1 Introduction

Management of healthcare waste is an integral part of hospital hygiene and infection control. Healthcare waste can be considered as a reservoir of pathogenic micro-organisms, which if someone is exposed could give rise to an avoidable infection. If waste is inadequately managed, these micro-organisms can be transmitted by direct contact, by inhalation or by a variety of animal vectors (e.g. flies, rodents, roaches), which could come into contact with waste.

This chapter outlines the basic principles of prevention and control of infections that may be acquired in healthcare facilities. It does not address other aspects of hospital hygiene and infection control and safety, such as bloodstream and urinary tract infections. It is stressed that other environmental health considerations, such as adequate water supply and sanitation facilities for patients, visitors and healthcare staff, are of prime importance in minimising the transmission of infections.

10.2 Chain of Infection

A basic infection control principle is to be aware of the chain of infection and identify the most effective points to prevent potential disease transmission. Transmission of infectious diseases in a healthcare facility requires at least six elements: an infectious agent, a reservoir, a portal of exit, a means of transmission, a portal of entry, and a susceptible host. Numerous actions, some of which are described in this chapter, can be taken to break the links in this chain of events.

10.3 Epidemiology of Nosocomial Infections

Nosocomial infections (also known as hospital acquired infections, hospital associated infections, and hospital infections) are infections that are not present in the patient at the time of admission to a healthcare facility but develop during the course of the patient's stay.

Nosocomial infections occur as a result of medical procedures performed on patients that lead to infections from a patient's own (endogenous) flora or as a result of exposure to items contaminated with infectious agents.

10.4 Transition from Exposure to Infection

Whether an infection will develop after an exposure to micro-organisms depends upon the interaction between the micro-organisms and the host.

The most important determinants of infection are the nature and number of the infectious agents. Micro-organisms range from the completely innocuous to the extremely pathogenic; the former will never cause an infection even in immune compromised individuals, while the latter will cause an infection in virtually every case of exposure. A classification of conventional, conditional and opportunistic pathogens is given in Table 11.

When only a few organisms are present, an infection will not necessarily develop. However, when a critical number is exceeded, it is very likely that an infection will become established thus signifies the proper and adequate management of healthcare wastes.

Classification of pathogenic organisms	Example
Conventional pathogens Cause disease in healthy individuals in the absence of specific immunity	Methicillin-resistant Staphylococcus aureus, Streptococcus pyogenes (beta strep group A), Salmonella spp., Shigella spp., Vancomycin-resistant Enterococcus, Corynebacterium diphtheriae, Mycobacterium tuberculosis, Bordetella pertussis, Hepatitis A and B viruses, Rubella virus, Rotaviruses, Human Immunodeficiency Virus (HIV)
Conditional pathogens Cause disease, other than trivial local infections, only in persons with reduced resistance to infection (including newborn infants) or when implanted directly into tissue or a normally sterile body area	Streptococcus agalactiae, Enterococcus spp., Clostridium tetani, Escherichia coli, Klebsiella spp., Serratia marcescens, Acinetobacter baumanii, Pseudomonas aeruginosa, Candida spp
Opportunistic pathogens Cause generalised disease, but only in patients with profoundly diminished resistance to infection	Atypical mycobacteria, Nocardia asteroides, Pneumocystis carinii

Table 11. Classification of pathogenic organisms

10.5 Sources of Infection

In a healthcare facility, sources of infectious agents may be the personnel, the patients or the inanimate environment.

The hospital environment can be contaminated with pathogens. *Salmonella spp*. or *Shigella spp., Escherichia coli O157:H7* or other pathogens may be present in the food and cause an outbreak, just as they can in a community outside the hospital.

Waterborne infections may develop if the water distribution system breaks down. In more sophisticated facilities, the water cooling system of air-conditioning equipment may become contaminated with *Legionella pneumophilia*, causing Legionnaires' disease in susceptible patients. Pharmaceuticals may become contaminated during production or preparation; an outbreak of infection by *Pseudomonas aeruginosa*, *Burkholderia cepacia* or *Serratia marcescens* may occur as a consequence.

The source of most hospital epidemics is infected patients i.e. patients infected with pathogenic micro-organisms. These micro-organisms are often released into the environment in very high numbers, depending on the disease, exceeding the minimal infective dose, and exposing other patients, who subsequently develop hospital acquired infections.

10.6 Routes of Transmission

In healthcare settings, the main modes of transmission from a source to a new host are:

- Contact transmission
- Droplet transmission
- Airborne transmission
- Bloodborne transmission
- Vector transmission

10.7 Prevention of Nosocomial Infections

Two basic principles govern the main control measures to prevent the spread of nosocomial infections in healthcare facilities:

- Separate an identified source of infection from other patients and medical areas
- Eliminate all obvious routes of transmission

The separation of the source has to be interpreted in a broad sense. It includes the isolation of infected patients and implementing aseptic conditions by introducing measures intended to act as a barrier between infected or potentially contaminated tissue and the environment, including other patients and medical staff.

10.7.1 Ways to improve infection control

Eliminate wasteful practices that just increase costs:

Avoid:

- Routine swabbing of healthcare environment to monitor standard of cleanliness
- Routine fumigation of isolation rooms with formaldehyde
- Routine use of disinfectants for environment cleaning, e.g. floors and walls
- Inappropriate use of PPE in intensive care units, neonatal units and operating theatres
- Use of overshoes, dust-attracting mats in the operating theatres, and intensive care and neonatal units
- Unnecessary intramuscular and intravenous injections
- Unnecessary insertion of invasive devices e.g. IV lines, urinary catheters, nasogastric tubes
- Inappropriate use of antibiotics for prophylaxis and treatment
- Improper segregation and disposal of clinical waste

Use good, no-cost infection control practices

- Use aseptic technique for all sterile procedures
- Remove invasive devices when no longer needed
- Isolate patients with communicable diseases or a multidrug resistant organism on admission
- Avoid unnecessary vaginal examination of women in labour
- Minimise the number of people in operating theatres
- Place mechanically ventilated patients in a semi-recumbent position

Use good, low-cost infection control practices

- Provide education and practical training in standard infection control e.g. hand hygiene, aseptic technique, appropriate use of PPE, use and disposal of sharps
- Provide handwashing material throughout a healthcare facility e.g. soap and alcoholic hand disinfectants
- Use single-use disposable sterile needles and syringes
- Use sterile items for invasive procedures
- Avoid sharing multi dose vials and containers between patients
- Ensure equipment is thoroughly decontaminated between patients
- Provide Hepatitis B immunisation to healthcare workers
- Develop a post-exposure management plan for healthcare workers
- Dispose of sharps in robust containers

11.0 HEALTHCARE WASTE MANAGEMENT IN EMERGENCIES

It is recommended that each healthcare facility or institution should form their own healthcare waste management

11.1 Guiding Principles

The collection, management and disposal of wastes resulting from emergencies such as natural disasters and conflicts, by their nature may overwhelm waste management programmes. In such situations, all forms of wastes including hazardous healthcare wastes remain uncollected and untreated. Measures, therefore, need to be taken to remove wastes as soon as possible after an emergency in order to reduce the potential for disease transmission.

The first step in the management of healthcare waste in emergencies is to carry out a rapid initial assessment. This will address emergency responders e.g. a coordinated response from aid and local bodies, thus bringing together whatever resources may be available to reduce public health risks.

The management of wastes generated by emergency medical care activities can vary during the three phases of the disaster management cycle, namely initial assessment, immediate response and recovery phase.

11.2 Phases for Safe Management of Healthcare Waste in Emergencies

11.2.1 Phase One: Rapid initial assessment

Rapid assessment immediately following a disaster or other emergency are designed to be swift and to inform responders about critical and immediate needs.

11.2.2 Phase Two: Emergency phase

The purpose of healthcare waste management in an emergency is to avoid wastes from being scattered indiscriminately around medical buildings and their grounds, and reduce the likelihood of secondary infections.

Healthcare waste generated by emergency medical care activities in tents, field hospitals, mobile hospitals and ambulances should be segregated accordingly to avoid sharps injuries. Sharps wastes should be stored safely in puncture-proof and leak-proof containers.

All non-sharps wastes should be collected in medical areas in rigid containers, such as plastic buckets with a cover, to prevent waste items from being exposed to disease transmission by contact by hand, airborne particles and flying insects. Containers and covers should be washed and disinfected with 1% chlorine solution.

The following preventive measures can be implemented during an emergency response phase to reduce public and occupational health risks:

- All healthcare staff and waste handlers should be vaccinated at least against Tetanus, Hepatitis A, Hepatitis B and Typhoid
- Encourage hand hygiene (washing, preferably followed by disinfection)
- Use heavy-duty rubber gloves for handling healthcare waste
- Raise the awareness of staff about simple post exposure prophylaxis in the event of an occupational injury e.g. needle-stick injury
- Contain and promptly clean up spillages of infectious materials and disinfect with chlorine reagent (1% solution) quickly to avoid pathogen transmission
- Disinfect body fluids with chlorine reagent (1% solution) before their discharge
- Conduct onsite awareness-raising activities (whenever possible) to remind healthcare staff about occupational exposures and the safe practices for managing healthcare waste

11.2.3 Phase Three: Recovery phase

Key points to address during a recovery phase:

- Existing procedures and practices of healthcare waste management
- Responsibility for the management of healthcare waste
- Presence of an infection control committee to oversee improvement and training
- Dedicated equipment for storage, collection and on-site and off-site transportation of healthcare waste
- Availability of on-site and off-site healthcare waste treatment facilities
- Availability of on-site and off-site disposal facilities
- Level of healthcare staff awareness about the risks associated with healthcare waste
- Staff health protection (e.g. protective clothing, vaccination)

11.3 Contingency Planning and Emergency Preparedness

Healthcare waste management should be included in contingency plans for the health sector.

At healthcare facility level, contingency plans on healthcare waste management during emergency situations should address the following:

- What standards will be used to guide a response?
- What are the current capacities of the agencies or organisations to respond?
- What initial assessment arrangements are needed?
- What actions will be taken as an immediate response to the situation?
- Who does what and when? Who is coordinating and leading?
- What resources would be needed?

- How will information flow between the various levels (local and national)?
- Have specific preparedness actions be agreed on and practised?

Contingency planning needs to be seen as a continuing process that is regularly reviewed and updated to ensure that all partners are familiar with their various roles, responsibilities and actions to be undertaken.

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ANNEX 1

RECOMMENDATION ON STERILISATION METHOD FOR RE-USABLE ITEMS

Disciplines	Method of Sterilisation	Steps Involved
Dentistry Hospital Infection Control Hospital Laboratories	Thermal Sterilisation	*Wet Sterilisation*: Exposure to saturated steam at 121˚ C for 15 minutes in an autoclave at 15 lbs per sq. in. or 134˚ C for 3 minutes in an autoclave at 32 lbs per sq. in.
Hospital Infection Control	Chemical Sterilisation	*Ethylene oxide*: Exposure to an atmosphere saturated with ethylene oxide for 60 minutes at 20˚ C in a reactor tank or ETO sterilisers.
Dentistry Hospital Infection Control Hospital Laboratories	Chemical Sterilisation	*Glutaraldehyde*: Exposure to glutaraldehyde solution (e.g. Cidex 2%) for 20-30 minutes and 1 hour following a known myobacterial infection (this will kill most bacteria, spores and viruses). It is recommended for heat-sensitive equipment.
Hospital Infection Control	Chemical Sterilisation	*Plasma Sterilisation (Sterrad):* Exposure to hydrogen peroxide within its chambers at a temperature of 42˚C to 50˚ C for 75 minutes.

ANNEX 2

SORTING, PACKING AND DISPOSAL GUIDELINES FOR DIFFERENT CATEGORIES OF WASTE

Type of waste	Type of containers/ colour of containers and markings	Sorting guidelines	Recommended method of disposal	Comments on disposal
Pathological and Infectious Waste Includes dental wastes such as teeth and oral soft tissues	Yellow Plastic Bag with Marking: '*BIOHAZARD WASTE*'	Teeth and any soft tissues from the oral cavities may be loosely covered in cotton gauze to absorb any remaining blood or saliva	Incineration	Ideally, incineration is the best method. However, in Brunei, this type of waste may be sent to special landfills for burial of anatomical body parts. Teeth with amalgam fillings and infectious anatomical waste must be disinfected before being sent to the special landfills for safe burial.
Pathological and Infectious Waste Includes blood, saliva or other body fluids and any materials used and contaminated by these fluids				Old or excess carved amalgam contaminated with blood or saliva should be disposed of under waste with high content of heavy metal. They should be washed clean of body fluids.

Chemical Waste Includes disinfectant, used radiographic developer solution, methyl methacrylate	Yellow chemical resistant container Marking: '*CHEMICAL WASTE*' * Identity of each chemical to be specified	Store separately based on the different waste type	Incineration/ Export under the Basel Convention **OR** Return to supplier **OR** Encapsulation depending on type	See Table 5 for further details on pretreatment and method of disposal. Disinfectants and used radiographic developer can be diluted and pass into drains connected to sewage treatment plant. Unused expired developer solution may be returned to supplier via export under Basel, neutralized or diluted. Methacrylate solid is incinerated in open containers or otherwise encapsulated and sent to special landfills for chemical waste if available.
Solids and Semi-solids; Pharmaceutical Waste Tablets, Capsules, Ointments, Creams, Suppositories, Granules, Gels, Pharmaceutical Raw Materials. Does not include Cytotoxics Psychotropics and Narcotics.	Plastic Waste Bag/ Rigid Paper Carton Colour – Brown Marking: *'PHARMACEUTICAL WASTE - SOLIDS AND SEMI-SOLIDS*'	These items should be removed from their outer packaging but remain in their inner packaging e.g. tablets and capsules should not be removed from their blisters pack, from the bottles or the tubes. Powders, creams etc should remain in the container or tube.	High Temperature Incineration * If less than 1% of total daily waste, can be disposed of directly in landfill	Prior to incineration, tablets and capsules must be removed from their original containers. The latter should be disposed of as general waste. For antibiotic powder, they may be diluted with water, left for two weeks and then disposed of to the sewers. For large amount, disposal should be staggered over a period of time.

Liquid Pharmaceutical Solutions, Suspensions, Syrups, Mixtures, Lotions, Infusions, Enemas, Eye, Ear and Nose Drops, Pharmaceutical Raw Materials. Does not include Disinfectant, Psychotropics and Narcotics, Cytotoxics and Cytostatics.	Plastic Waste Bag/ Rigid Paper Carton Colour – Brown Marking: *'PHARMACEUTICAL WASTE – LIQUIDS'*	These items should be removed from their outer packaging but remain in their inner packaging.	Sewers This method is recommended for biodegradable organic materials with no or low toxicity. Other alternatives are incineration or encapsulation.	For large quantity of waste, disposal should be staggered over a period of time. The containers should be disposed of as general waste. For liquid anti-infectives, they may be diluted with water, left for two weeks and then disposed of to the sewers.
Liquid Pharmaceutical (Injectables) Including vaccines and blood products. Does not include Psychotropics and Narcotics, Cytotoxics and Cytostatics.	Rigid Plastic Container and then to be placed in Rigid Paper Carton/ Plastic Waste Bag Colour – Yellow Marking: *'PHARMACEUTICAL WASTE – INJECTABLES'*	These items should be removed from their outer packaging but remain in their inner packaging. For anti-infective drugs and biological products, they may be packed separately from other liquid injectables as their disposal have to be handled differently.	Sewers or Encapsulation For anti-infective drugs, encapsulation or inertization is recommended	Open the vials/ ampoules, syringe out the liquid and dispose the liquid down the sewers. The empty ampoules and broken glass are to be disposed of as sharps. Unbroken vials to be discarded as normal waste. For safety reasons, biological products should be denatured first before dispose of into sewers. Anti-infective drugs should be diluted with water, left for two weeks before discharge of into sewers.

Psychotropics and Narcotics (Controlled Drugs)	Packed in original container and kept in a rigid paper carton Marking: *'PHARMACEUTICAL WASTE – CD'*	A complete list stating the name, strength and dosage form of the drug, quantity and expiry date. For government institutions under the Ministry Of Health, the Psychotropics and Narcotics are to be packed separately.	To be referred to the Pharmacy Enforcement Section	Psychotropics from government institutions are to be returned to the pharmacy section in the respective hospitals in each district. The disposal will be carried out according to the dosage form of the drugs and under the strict supervision of an appointed pharmacist.
Pressurised Containers Cylinders, Tanks, Cartridges and Aerosol Canisters such as inhalers, accuhalers. Includes Kavo Oil, Fixed Adhesive used in dentistry.	Firm paper carton boxes or plastic waste bag Colour – Black Marking: According to the content of the containers. Not necessary for aerosol canisters as they are mixed with normal waste.	For cylinders and tanks retained in their original form. For aerosol canisters such as metered dose inhalers, the canister should be removed from the inhaler device and mixed with normal waste.	For undamaged cylinder and tanks - Recycle and refill. Alternatively return to supplier. For damaged containers and cartridges - Landfill	Must not be incinerated as explosion may harm operator and cause damage to the incinerator. For non-pressurised canisters such as rotahalers, they can be disposed of as for aerosol canisters. Used or expired glass cartridges should be disposed of as sharps.
Waste with High Content of Heavy Metal Mercury, Lead (e.g. lead foils and shields) and Silver (e.g. recovered from radiographic fixer solution)	Leak-proof containers Marking: '*HAZARDOUS WASTE – HEAVY METAL'* To specify the name of the heavy metal.	Each type to be packed separately. *Mercury*: This includes excess amalgam in mixing pot, excess amalgam carving during filling procedures, amalgam caught in chair side traps, filters and screens as well as old amalgam fillings.	Encapsulated and landfilled. Alternatively, export under Basel Convention for recycling and recovery.	Pre-capsulated amalgam capsules must be re-capped and sent with general waste to landfills for burial. Extracted teeth with amalgam fillings must be disinfected before being sent to special landfills. Lead foils and shields and fixer solution can be sent to manufacturers for recycling via export under the Basel Convention.

ANNEX 3

LIST OF COMMONLY USED CYTOTOXIC DRUGS IN THE HOSPITAL

Name of cytotoxic drug	Minimum incineration temperature
Aclarubicin	1000˚C
Amsacrine	>260˚C
Bleomycin	1000˚C
Carboplatin	1000˚C
Carmustine	1000˚C
Chlormethine (Mustine)	800˚C
Cisplatin	280˚C
Cyclophosphamide	900˚C
Cytarabine	1000˚C
Dacarbazine	500˚C
Dactinomycin	1000˚C
Daunorubicin	800˚C
Doxorubicin	>700˚C
Epirubicin	700˚C
Etoposide	1000˚C
5-Flurouracil	1200˚C
Idarubicin	700˚C
Ifosfamide	1000˚C
Mephalan	500˚C
Methotrexate	1000˚C
Mithramycin	1000˚C
Mitomycin	1000˚C
Mitoxantrone	800˚C
Plicamycin	1000˚C
Thiotepa	800˚C
Vincristine	1000˚C
Vindesine	1000˚C

ANNEX 4

CHARACTERISTICS OF DIFFERENT TYPES OF INCINERATORS

Characteristics	Pyrolytic	Rotary kilns	Single-chamber
Adequate for the following waste categories	1. Infectious waste (including sharps) and pathological waste. 2. Pharmaceutical and chemical residues.	1. Infectious waste (including sharps) and pathological waste. 2. All chemical and pharmaceutical wastes, including cytotoxic waste.	1. Infectious waste (including sharps) and pathological waste. Pathogens are eliminated if the incinerator is correctly operated. Ashes should contain <3% burnt matter. 2. General healthcare waste (similar to domestic refuse) may be incinerated particularly if the low heating value exceeds 4000 kcal/kg (16740 kJ/kg)
Inadequate for the following waste	1. Non-risk healthcare waste similar to urban waste 2. Genotoxic waste 3. Radioactive waste	1. Non-risk healthcare waste 2. Radioactive waste	1. Pharmaceutical and chemical residues. Exhaust gases may contain toxic substances, such as dioxins. 2. Genotoxic waste 3. Inorganic compounds and thermally resistant waste
Incineration temperature	800-900 ° C	1200-1600 ° C	300-400 ° C
Incinerator capacity	Ranges from 200kg/day to 10 tonnes/day	Ranges from 0.5 to 3 tonnes/hr	100-200 kg/day
Exhaust-gas capacity	Needed for larger facilities	Likely to be needed, as the incineration of chemical waste produces exhaust gases and ashes that may be loaded with toxic chemicals.	Not practical; therefore, installation of this type of incinerator is not recommended where air pollution is already a problem.
Additional remarks	The equipment is relatively expensive to purchase, operate and maintain. Well-trained personnel are required.	Equipment and operation costs are high, as is energy consumption. Waste and incineration by-products are highly corrosive, and the refractory lining of the kiln often has to be repaired or replaced. Well-trained personnel are required.	This is an incineration option that meets minimum requirement. This type of incinerator is employed only if a pyrolytic incinerator cannot be afforded.

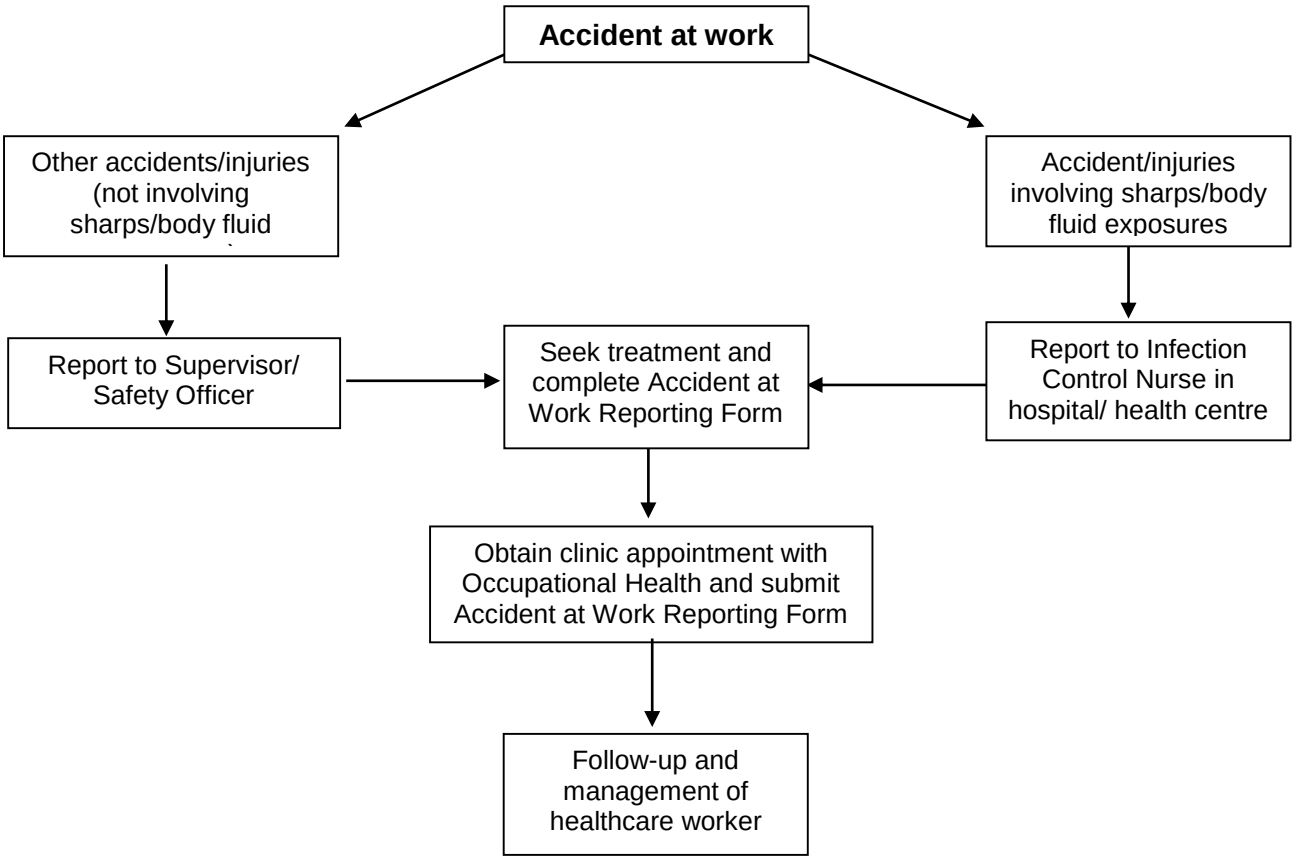
ANNEX 5

CHARACTERISTICS OF DIFFERENT TYPES OF CHEMICAL DISINFECTANTS (Corrosiveness and Fire Precaution)

Disinfectants	Corrosiveness	Comments
Glutaraldehyde ($CHO-(CH_2)_3-CHO$)	Aqueous solutions of glutaraldehyde are corrosive to most metals; usually stored in stainless steel containers, steel containers lined with phenolic resins, or reinforced polyethylene containers, in well-ventilated, leakage-proof rooms.	Glutaraldehyde is suitable for use as a chemical disinfectant only in solutions in which a high level of chemical safety can be maintained. Glutaraldehyde waste should never be discharged in sewers; it may be neutralised through careful addition of ammonia or sodium bisulfite; it may also be incinerated after mixing it with a flammable solvent.
Sodium hypochlorite (NaOCl)	Aqueous solutions are corrosive to metals; usually stored in plastic containers in well ventilated, dark, and leakage-proof rooms; should be stored separately from acids.	Sodium hypochlorite may be widely used because of relatively mild health hazards. Unused solution should be reduced with sodium bisulfite or sodium thiosulfate and neutralised with acids before discharge with sewers. Large quantities of concentrated solutions should be treated as hazardous chemical waste.
Chlorine dioxide (ClO_2)	Containers of chlorine dioxide should be stored in well-ventilated and leakage-proof rooms.	-

ANNEX 6

FLOWCHART FOR ACCIDENT AT WORK REPORTING FOR HEALTHCARE WORKERS



ANNEX 7

THE ICRP (INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION) RECOMMENDATION ON DOSE LIMITS

Table 1. Recommended Dose Limit for Radiation Worker

Application	Dose Limit per Year (mSv)
Effective Dose (Whole Body)	20[1]
Equivalent Dose in:	
the lens of the eye	150
the skin[2]	500
the hands and feet	500

Table 2. Recommended Dose Limit for Members of the Public

Application	Dose Limit per Year (mSv)
Effective Dose (Whole Body)	1
Equivalent Dose in:	
the lens of the eye	15
the skin[3]	50

Note:

a. Once pregnancy has been declared, the equivalent dose limit to the surface of the woman's abdomen shall be 2 mSv for the remainder of the pregnancy, and the intake of radionuclide shall be limited to 1/20th of the ALI (Annual Limits of Intake).
b. Dose limits do not include medical or natural background radiation.

[1] The limit on effective dose (whole body) is 20 mSv per year, averaged over a defined period of 5 years and with the further provision that the effective dose shall not exceed 50 mSv in any single year.
[2] The limit of 500 mSv for skin is averaged over areas of not more than 1cm^2 regardless of the area exposed.
[3] The limit of 50 mSv for skin (public) is averaged over areas of not more than 1cm^2 regardless of the area exposed.

ANNEX 8

RADIONUCLIDES USED IN HEALTHCARE FACILITIES

Radionuclide[b]	Emission	Format	Half-life	Application
^{3}H	β	Unsealed	12.3 years	Research
^{14}C	β	Unsealed	5730 years	Research
^{32}P	β	Unsealed	14.3 days	Diagnosis; therapy
^{51}Cr	γ	Unsealed	27.8 days	*In-vitro* diagnosis
^{57}Co	β	Unsealed	271 days	*In-vitro* diagnosis
^{60}Co	β	Sealed	5.3 years	Diagnosis; therapy; research
^{59}Fe	β	Unsealed	45 days	*In-vitro* diagnosis
^{67}Ga	γ	Unsealed	78 hours	Diagnostic imaging
^{75}Se	γ	Unsealed	119 days	Diagnostic imaging
^{85}Kr	β	Unsealed	10.7 years	Diagnostic imaging; research
^{99m}Tc	γ	Unsealed	6 hours	Diagnostic imaging
^{123}I	γ	Unsealed	13.1 hours	Diagnostic uptake; therapy
^{125}I	γ	Unsealed	60 days	Diagnostic uptake; therapy
^{131}I	β	Unsealed	8 days	Therapy
^{133}Xe	β	Unsealed	5.3 days	Diagnostic imaging
^{137}Cs	β	Sealed	30 years	Therapy; research
^{192}Ir	β	Sealed (ribbons)	74 days	Therapy
^{198}Au	β	Sealed (seeds)	2.3 days	Therapy
^{222}Rd	α	Sealed (seeds)	3.8 days	Therapy
^{226}Ra	α	Sealed	1600 years	Therapy

[a] Adapted from WHO (1985).

[b] ^{3}H and ^{14}C used for research purposes account for the largest amount of radioactive health-care waste.

ANNEX 9

COMPARISON OF COMMON HAZARDOUS WASTE SYMBOLS

Corrosive (C)

These substances attack and destroy living tissues, including the eyes and skin.

Highly flammable (F)

These substances easily catch fire (flash point: 21–55 °C). Never store flammable substances together with explosive ones.

Toxic (T)

These substances can cause death. They may have their effects when swallowed or breathed in, or when absorbed through the skin.

Harmful (Xn)

These substances are similar to toxic substances but are less dangerous.

Explosive (E)

An explosive is a compound or mixture susceptible to a rapid chemical reaction, decomposition or combustion, with the rapid generation of heat and gases with a combined volume much larger than the original substance.

Irritant (I)

These substances can cause reddening or blistering of skin.

Extremely flammable (F+)

Liquid substances and preparations that have an extremely low flash point (<21 °C) and therefore catch fire very easily.

Very toxic (T+)

Substances and preparations that, in very low quantities, cause death or acute or chronic damage to health when inhaled, swallowed or absorbed via the skin.

Oxidising (O)

These substances provide oxygen, which allows other materials to burn more fiercely.

Dangerous for environment (N)

Substances that, were they to enter into the environment, would present or might present an immediate or delayed danger for one or more components of the environment.

No direct equivalent; use harmful or irritant symbol as appropriate

Specific organ toxicity

These substances may cause:

- damage to organ or organs after single or repeated exposure
- respiratory sensitization
- allergy or asthma or breathing difficulties if inhaled.

Annex 10

SELECTED UNITED NATIONS PACKAGING SYMBOLS

UN Class	Name	Description of symbol	Symbol
3.1	Flammable Liquids	Black symbol: flame Background: red Class “3” in bottom corner	
5.1	Oxidising Substances	Black symbol: flame over circle Background: yellow Class “5.1” in bottom corner	
6.1	Toxic Substances Black	Black symbol: skull and crossbones Background: white Class “6” in bottom corner	
6.2	Infectious Substances	Black symbol: three crescents superimposed on a circle Background: white Class “6” in bottom corner	
7A	Radioactive Material Category I - White	Black symbol: trefoil Background: white Class “7” in bottom corner	
7B	Radioactive Material Category II – Yellow	Black symbol: trefoil Background: white Class “7” in bottom corner	
7C	Radioactive Material Category III – Yellow	Black symbol: trefoil Background: yellow Class “7” in bottom corner	
8	Corrosive Substances Category I – White	Black symbol: liquids spilling from two glass vessels and attacking a hand and a metal Background: upper half white, lower half black with white border Class “8” in bottom corner	
9	Miscellaneous Dangerous Substances Category I - White	Black symbol: seven vertical stripes in upper half Background: white, lower half black with white border Class “9” underlined in bottom corner	

ANNEX 11

Sample of consignment note for carriage and disposal of infectious waste

Consignment note

Date of collection: (*dd,mmm,yyyy)*

_____

Consignor (generator) – name and address

_____

Waste carrier – name and address

_____

Date of receipt: (*dd,mmm,yyyy)*

_____

Consignee (treatment site) – name and address

_____

Waste Description

UN No. and Type of Packaging	Proper shipping name	Gross weight (kg)

I hereby declare that the contents of the consignment are fully and accurately described above all respects in proper condition according to applicable international and national governmental regulations. I declare that all of the applicable requirements have been met.

_____	_____	_____
Signature Consignor (Generator)	Signature Waste Carrier (Transport)	Signature Consignee (Treatment Site)

ANNEX 12

GENERAL PROCEDURES IN CASE OF SPILLAGES

Healthcare waste spill management

Improper management of healthcare waste spills may lead to disastrous consequences. Each facility must have a healthcare waste spill response plan and procedures.

General procedures in case of spillages

The actions listed below provide an example of typical measures that could/ should be taken in case of accidental spillages of healthcare waste:

1. **Evacuate and cordon** the affected area of spillage
2. **Decontaminate** the eyes and skin of exposed personnel immediately
3. Provide **first aid** and medical care to injured individuals
4. **Inform** the designated person (usually the waste management officer or infection control officer) whose role is to coordinate the necessary actions
5. Determine the **nature** of the spill
6. **Evacuate** all individuals not involved in cleaning up if the spillage involves a particularly hazardous substance
7. **Secure** the area to prevent exposure of additional individuals
8. Provide adequate **protective clothing** to personnel involved in cleaning up
9. **Limit** the spread of the spill
10. **Neutralise or disinfect** the spilled or contaminated material if indicated
11. **Collect** all spilled and contaminated material. **Sharps should never be picked up by hand;** brushes and pans or other suitable tools should be used. Spilled materials and disposable contaminated items used for cleaning should be placed in the appropriate waste bag or container.
12. **Decontaminate or disinfect** the area, wiping up with absorbent cloth. The cloth (or other absorbent material) should never be turned during this process, because this will spread the contamination. The decontamination should be carried out by working from the least to the most contaminated part, with a change of cloth at each stage. Dry cloths should be used in the case of liquid spillage; for spillages of solids, cloth impregnated with water (acidic, basic, or neutral as appropriate) should be used.
13. **Rinse** the area, and wipe dry with absorbent cloths
14. **Decontaminate or disinfect** any tools that were used
15. **Remove** protective clothing and decontaminate or disinfect it if necessary
16. **Seek medical attention** if exposure to hazardous material has occurred during the operation
17. **Report** the incident to the relevant authorities and document the response

Spill kit

A spill kit is a collection of items to be used in the immediate response and cleanup of spills, leaks or other discharges of hazardous wastes e.g. chemical spills. Spill kits should be maintained in close proximity to areas where chemicals are used, stored or disposed to enable

prompt response and cleanup of spills. All employees should be familiar with the location and contents of all spill kits and the procedures to be followed in the event of a chemical spill.

Contents of Spill Kit

A typical spill kit contains the following equipment and materials:

- Personal protective equipment (PPE) e.g. heavy duty gloves made of nitrile or neoprene, chemical resistant safety glasses, disposable lab coat or apron, and disposable boot covers.
- Equipment and materials to clean up spills. The following items are recommended for spill kits:
  - A container to hold spill cleanup debris. This could be a five gallon pail with sealable lid or thick plastic bags. For larger spills, 55 gallon drums and drum-over packs should be used.
  - Granular absorbents, absorbent pads and boom, as appropriate.
  - Plastic dust pan and broom for sweeping up granular absorbents. For flammable materials, ensure that the dust pan is spark free.
  - Labels (e.g. hazardous waste stickers) to properly mark containers of spill cleanup debris.
  - Forceps, tongs, or other tools to pick up contaminated debris or broken glass

Spill management procedure

Action	Tools or items
Approaching the spillage	Protective equipment to secure the area
Containing the spillage	Absorbent material (e.g. absorbent paper, towels, gauze pads, granular absorbent)
Neutralising or disinfecting the spillage (if necessary)	For infectious material: disinfectant (bleaching power-used in powder form or in solution of varying dilution 1:1 to 1:100 depending on the nature of the spilled material) For acids: sodium carbonate, calcium carbonate or other base For bases: citric acid powder or other acid For cytotoxic material: special chemical degradation substances
Collecting the spillage	For liquids: absorbent paper, gauze pads, wood shavings, calcium bentonite, diatomaceous earth For solids: forceps, broom, dustpan or shovel For mercury: mercury absorbent powered, mercury sponge or vacuum pump
Organising containment for disposal	Plastic bag (red, yellow, or brown, as appropriate), sharps container
Decontaminating or disinfecting the area	For infectious material: disinfectant For hazardous chemicals: suitable solvent or water
Documenting the spillage	Report the incident to Supervisor

Management of spills of radioactive materials

Minor Radioactive Waste Spill

- Alert people in the area of the spill
- Notify Radiation Safety Office (RSO)
- Wear personal protective equipment (PPE) including safety goggles, gloves, shoe covers, long sleeve lab coat
- Cover liquid spills with absorbent paper towels
- Carefully fold the absorbent paper with clean side out and place into a plastic bag for disposal in radioactive waste container. Also place contaminated gloves and other disposable materials into the plastic bag.
- Monitor the area, hands, clothing and shoes for contamination with an appropriate survey meter or wipe sampling procedures
- Repeat cleanup until contamination is no longer detected

Major Radioactive Spill

- Attend to the injured or contaminated persons and remove them from exposure
- Alert people to vacate the area
- Have potentially contaminated personnel stay in one area until they have been checked for the presence of contamination
- Notify Radiation Protection Officer (RPO)
- If possible, the spill should be shielded, but only if it can be done without further contamination or significant exposure
- Close doors and prevent entrance into the area
- Contaminated clothing should be removed and stored for further evaluation by the RPO