WASTE REDUCTION AND RECYCLING SOLUTIONS FOR HOSPITALS 1

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Definitions. Terminology

- The term "**healthcare waste**" is used by European Union (EU) and World Health Organisation (WHO) while "**medical waste**" is used in many countries, such as the US, South Korea, and China. In Japan is used the term "**infectious waste**" [1].

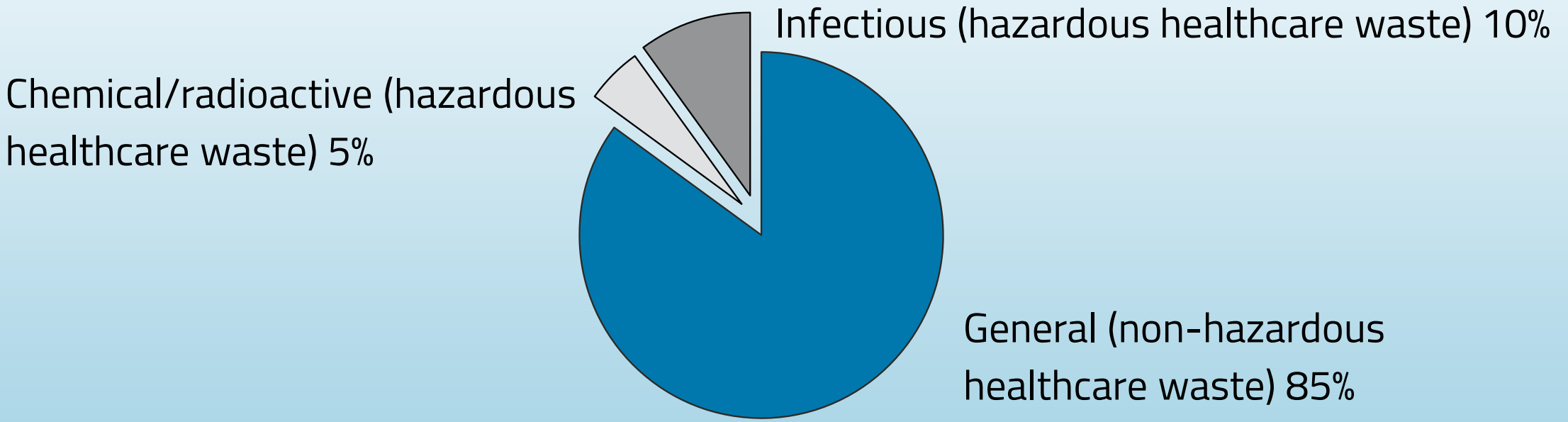
- According to World Health Organisation (WHO) [2] "The term **healthcare waste** includes all the waste generated within healthcare facilities, research centres and laboratories related to medical procedures. In addition, it includes the same types of waste originating from minor and scattered sources, including waste produced in the course of healthcare undertaken in the home (e.g. home dialysis, self-administration of insulin, recuperative care).

Definitions. Terminology

- Between 75% and 90% of the waste produced by healthcare providers is comparable to domestic waste and usually called "**non-hazardous**" or "general healthcare waste". It comes mostly from the administrative, kitchen and housekeeping functions at healthcare facilities and may also include packaging waste and waste generated during maintenance of healthcare buildings.

- The remaining 10–25% of healthcare waste is regarded as "**hazardous**" and may pose a variety of environmental and health risks.

Definitions. Terminology



Typical waste compositions in healthcare facilities [2]

Definitions. Terminology

- According to United States Environmental Protection Agency (EPA) [3] "**Medical waste** is a subset of wastes generated at healthcare facilities, such as hospitals, physicians' offices, dental practices, blood banks, and veterinary hospitals/clinics, as well as medical research facilities and laboratories. Generally, medical waste is healthcare waste that that may be contaminated by **blood, body fluids or other potentially infectious materials** and is often referred to as regulated medical waste".

- In Japan [4], "**infectious wastes** are defined as the infectious waste materials generated in medical institutions as a result of medical care or research which contain **pathogens that have the potential to transmit infectious diseases**".

Classification

Category	EU/code*	WHO	USA
Terminology	Healthcare waste	Healthcare waste	Medical Waste
Sharps	Sharps Code 18 01 01	Sharps	Contaminated sharps/Unused sharps
Body parts and organic including blood bags and blood preserves	Body parts and organs including blood bags and blood preserves Code 18 01 02	Pathological	Bulk human blood/Pathological wastes
Waste whose collection and disposal is subject to special requirements to prevent infections	Human and Animal Infectious Code 18 01 03	Infectious	Isolation/Cultures and stocks of infectious agents and associated biologicals/animal wastes

Classification

Category	EU/code*	WHO	USA
Terminology	Healthcare waste	Healthcare waste	Medical Waste
Waste whose collection and disposal are not subject to special requirements to prevent infection (e.g., dressings, plaster casts, linen, disposable clothing, diapers contaminated with blood, etc.)	Infectious Code 18 01 04	Infectious	-
Chemicals consisting of or containing dangerous substances	Chemical Code 18 01 06	Chemical	-
Chemicals other than those mentioned in 18 01 06	Chemical/ Unused hazardous medicines Code 18 01 07	Chemical	Small volumes of chemical hazardous waste

Classification

Category	EU/code*	WHO	USA
Terminology	Healthcare waste	Healthcare waste	Medical Waste
Cytotoxic and cytostatic medicines	Unused hazardous medicines Code 18 01 08	Cytotoxic	Antineoplastic drug
Chemicals other than those mentioned in 18 01 08	Unused non-hazardous medicines Code 18 01 09	Pharmaceutical	Small volumes of chemical hazardous waste
Amalgam waste from dental care	Amalgam waste from dental care Code 18 01 10	Amalgam waste from dental care	-

Classification

Category	EU/code*	WHO	USA
Terminology	Healthcare waste	Healthcare waste	Medical Waste
Radioactive waste		Waste containing radioactive substances (from radiotherapy or laboratory research, sealed sources)	
Non-hazardous or general healthcare waste		Waste that does not pose any particular biological, chemical, radioactive or physical hazard	

Codes according to [Commission Decision of 18 December 2014 amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European Parliament and of the Council]

Classification

Sharps waste

Sharps are items that could **cause cuts or puncture wounds**, including needles, hypodermic needles, scalpels and other blades, knives, infusion sets, saws, broken glass and pipettes. Whether or not they are infected, such items are usually considered **highly hazardous healthcare waste** and should be treated as if they were potentially infected.

Pathological waste

Pathological waste could be considered a subcategory of infectious waste, but is often classified separately – especially when special methods of handling, treatment and disposal are used. Pathological waste consists of **tissues, organs, body parts, blood, body fluids and other waste from surgery and autopsies on patients with infectious diseases**. It also includes **human fetuses and infected animal carcasses**.

Recognizable human or animal body parts are sometimes called **anatomical waste**. Pathological waste may include healthy **body parts that have been removed during a medical procedure or produced during medical research**.

Classification

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.

This category includes:

- waste contaminated with blood or other body fluids,
- cultures and stocks of infectious agents from laboratory work,
- waste from infected patients in isolation wards.

Classification

Pharmaceutical waste

Pharmaceutical waste includes **expired, unused, spilt and contaminated pharmaceutical products**, prescribed and proprietary drugs, vaccines and sera that are **no longer required**, and, due to their chemical or biological nature, need to be disposed of carefully.

The category also includes **discarded items heavily contaminated during the handling of pharmaceuticals**, such as bottles, vials and boxes containing pharmaceutical residues, gloves, masks and connecting tubing.

Classification

Genotoxic waste

Genotoxic waste is **highly hazardous** and may have **mutagenic** (capable of inducing a genetic mutation), **teratogenic** (capable of causing defects in an embryo or fetus) or **carcinogenic** (cancer-causing) properties.

The disposal of genotoxic waste raises serious safety problems, both inside hospitals and after disposal, and should be given special attention.

Genotoxic waste may include certain cytostatic drugs vomit, urine or faeces from patients treated with cytostatic drugs, chemicals and radioactive material.

Genotoxic means toxic to the deoxyribonucleic acid (DNA).

Classification

Cytotoxic and cytostatic waste

Cytotoxic means **toxic to the cell**; cytostatic means suppressing the growth and multiplication of the cell; antineoplastic means inhibiting the development of abnormal tissue growth; and chemotherapeutic means the use of chemicals for treatment, including cancer therapy.

Cytotoxic (chemotherapeutic or antineoplastic) drugs, the principal substances in this category, have the ability to **kill or stop the growth of certain living cells** and are used in chemotherapy of cancer. They play an important role in the therapy of various neoplastic conditions, but are also finding wider application as immunosuppressive agents in organ transplantation and in treating various diseases with an immunological basis.

Cytotoxic drugs are most often used in specialized departments, such as **oncology and radiotherapy units**, whose main role is cancer treatment. Their use in other hospital departments and outside the hospital in clinics and elsewhere is also increasing.

Classification

Cytotoxic and cytostatic waste

Cytostatic drugs can be categorized as follows:

- alkylating agents: cause alkylation of DNA nucleotides, which leads to cross-linking and miscoding of the genetic stock;
- antimetabolites: inhibit the biosynthesis of nucleic acids in the cell;
- mitotic inhibitors: prevent cell replication.

Classification

Cytotoxic and cytostatic waste

Cytotoxic wastes are generated from several sources and can include the following:

- contaminated materials from drug preparation and administration, such as syringes, needles, gauzes, vials, packaging;
- outdated drugs, excess (leftover) solutions, drugs returned from the wards;
- urine, faeces and vomit from patients, which may contain potentially hazardous amounts of the administered cytostatic drugs or of their metabolites, and which should be considered genotoxic for at least 48 hours and sometimes up to 1 week after drug administration.

Classification

Chemical waste

Chemical waste consists of **discarded solid, liquid and gaseous chemicals**; for example, from diagnostic and experimental work and from cleaning and disinfecting procedures.

Chemical waste from health care is **considered to be hazardous** if it has at least one of the following properties:

- toxic (harmful),
- corrosive (e.g. acids of pH <2 and bases of pH >12),
- flammable,
- reactive (explosive, water reactive, shock sensitive),
- oxidizing.

Classification

Chemical waste	Examples
Halogenated solvents	Chloroform, methylene chloride, perchloroethylene, refrigerants, trichloroethylene
Non-halogenated solvents	Acetone, acetonitrile, ethanol, ethyl acetate, formaldehyde, isopropanol, methanol, toluene, xylenes
Halogenated disinfectants	Calcium hypochlorite, chlorine dioxide, iodine solutions, iodophors, sodium dichloroisocyanurate, sodium hypochlorite (bleach)
Aldehydes	Formaldehyde, glutaraldehydes, ortho-phthalaldehyde
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
Oxidizers	Bleach, hydrogen peroxide, potassium dichromate, potassium permanganate
Reducers	Sodium bisulfite, sodium sulfite
Miscellaneous	Anaesthetic gases, asbestos, ethylene oxide, herbicides, paints, pesticides, waste oils

Classification

Radioactive waste

Radioactive wastes are materials **contaminated with radionuclides**.

They are produced as result of procedures such as in **vitro analysis of body tissue** and fluid, **in vivo organ imaging and tumour localization**, and various investigative and therapeutic practices.

Radionuclides used in health care are in either **unsealed** (or open) sources or **sealed sources**.

Unsealed sources are usually liquids that are applied directly, while sealed sources are radioactive substances contained in parts of equipment or encapsulated in unbreakable or impervious objects, such as pins, “seeds” or needles.

Classification

Radioactive waste

The waste produced by healthcare and research activities involving radionuclides and related equipment maintenance and storage can be classified as follows:

- sealed sources;
- spent radionuclide generators;
- low-level solid waste (e.g. absorbent paper, swabs, glassware, syringes, vials);
- residues from shipments of radioactive material and unwanted solutions of radionuclides intended for diagnostic or therapeutic use;
- liquid immiscible with water, such as liquid scintillation counting;
- residues used in radioimmunoassay, and contaminated pump oil;
- waste from spills and from decontamination of radioactive spills;
- excreta from patients treated or tested with unsealed radionuclides;
- low-level liquid waste (e.g. from washing apparatus);
- gases and exhausts from stores and fume cupboards.

Classification

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**.

A significant proportion (**about 85%**) of all waste from healthcare facilities is non-hazardous waste and is usually similar in characteristics to municipal solid waste. More than half of all non-hazardous waste from hospitals is paper, cardboard and plastics, while the rest comprises discarded food, metal, glass, textiles, plastics and wood.

In many places, community or regulatory requirements encourage **materials recycling**. In the past, all or most non-hazardous and municipal waste was discarded in dumps or landfills or burnt in municipal incinerators.

Greater awareness of the environmental impacts of waste and the recognition that most of the non-hazardous waste from healthcare facilities is potentially recyclable or compostable have changed the approaches to managing general waste.

Classification

Non-hazardous general waste

Common recyclable materials from healthcare facilities are:

- corrugated cardboard boxes,
- newspapers and magazines,
- polyethylene terephthalate (PET or PETE) (e.g. plastic water bottles, soft-drink bottles)
- polystyrene packaging,
- wood (e.g. shipping pallets),
- paper (e.g. white office paper, computer printer paper, coloured ledger paper),
- metals (e.g. aluminium beverage cans and containers, food tin cans, other metal containers),
- high-density polyethylene (HDPE) (e.g. plastic milk containers, containers for food, plastic bottles for saline solutions or sterile irrigation fluids),
- clear, coloured or mixed glass,
- construction and demolition debris.

International regulations

International regulations:

- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (UNEP, 1992).
- Bamako Convention (1991).
- Stockholm Convention on Persistent Organic Pollutants (UNEP, 2004).
- Agenda 21 (plan of action for the 21st century adopted by 173 heads of State at the Earth Summit held in Rio in 1992).
- WHO and UNEP initiatives concerning mercury and Decision VIII/33 of the Conference of the Parties to the Basel Convention on mercury wastes.

International regulations

European regulations:

- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives.
- Commission Regulation (EU) No 1357/2014 of 18 December 2014 replacing Annex III to Directive 2008/98/EC of the European Parliament and of the Council on waste and repealing certain Directive.
- Commission Implementing Decision (EU) 2016/2325 of 19 December 2016 on the format of the certificate on the inventory of hazardous materials issued in accordance with Regulation (EU) No 1257/2013 of the European Parliament and of the Council on ship recycling.
- Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants.
- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).
- Commission Decision of 18 December 2014 amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European Parliament and of the Council.

Sources of healthcare waste

The source and quantity of waste generated is influenced by several factors:

- activity level (number of occupied beds, number of patients per day and/or staff number);
- the type or specificity of the health facility (medical clinic, county hospital, etc.);
- medical specialties (e.g. department, operating rooms, office);
- location (rural or urban);
- legislative or political regulations regarding waste classification;
- internal waste management procedures;
- temporal variations (for example during the week versus weekend, seasonal);
- availability of material resources;
- the level of infrastructure development in the country.

Sources of healthcare waste

The major sources of healthcare waste are:

- Hospitals:
  - -University hospital,
  - -General hospital,
  - -District hospital,
- Other healthcare facilities:
  - -Emergency medical care services,
  - -Healthcare centres and dispensaries,
  - -Obstetric and maternity clinics,
  - -Outpatient clinics,
  - -Dialysis centres,
  - -Long-term healthcare establishments and hospices,
  - -Transfusion centres,
  - -Military medical services,
  - -Prison hospitals or clinics.

Sources of healthcare waste

The major sources of healthcare waste are:

- Related laboratories and research centres:
  - -Medical and biomedical laboratories,
  - -Biotechnology laboratories and institutions,
  - -Medical research centres,
- Mortuary and autopsy centres,
- Animal research and testing,
- Blood banks and blood collection services,
- Nursing homes for the elderly.

Sources of healthcare waste

The minor sources of healthcare waste are:

- Small healthcare establishments:
  - -First-aid posts and sick bays,
  - -Physicians' offices,
  - -Dental clinics,
  - -Acupuncturists,
  - -Chiropractors,
- Specialized healthcare establishments and institutions with low waste generation:
  - -Convalescent nursing homes,
  - -Psychiatric hospitals,
  - -Disabled persons' institutions.

Sources of healthcare waste

The minor sources of healthcare waste are:

- Activities involving intravenous or subcutaneous interventions:
  - -Cosmetic ear-piercing and tattoo parlours,
  - -Illicit drug users and needle exchanges,
- Funeral services,
- Ambulance services,
- Home treatment.