

# Safe Healthcare Waste Management: Chemical and Cytotoxic Waste

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# Outline

## Chemical waste:

- Definition and sources
- Hazardous chemical waste
- Safe management of chemical waste (segregation, collection, transport, storage, treatment and disposal)

## Chemotherapeutic/ Cytotoxic waste:

- Definition and sources
- Safe management of cytotoxic waste (segregation, collection, transport, storage, treatment and disposal)

# Chemical waste

Waste containing chemical substances:

- laboratory reagents
- film developer
- disinfectants that are expired or no longer needed
- solvents
- waste with high content of heavy metals, e.g. batteries; broken thermometers and blood-pressure gauges

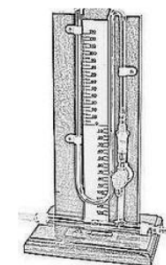
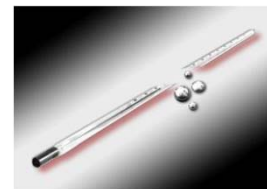
# Hazardous chemical waste

Discarded solid, liquid and gaseous chemicals that are:

- Toxic
- Corrosive
- Flammable
- Reactive – Explosive, water reactive, shock sensitive
- Oxidizing

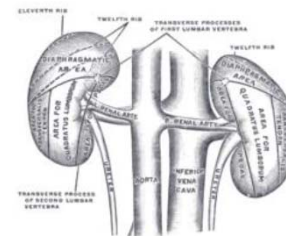
# Examples of chemical waste containing heavy metals

- Mercury
  - Thermometers, sphygmomanometers
  - Cantor tubes, esophageal dilators
  - Mercury switches, fluorescent lamps
  - Dental amalgam
  - Some formulations (e.g., Thimerosal)
- Cadmium
  - Dry cell batteries
- Lead
  - Radiation shielding



# Health impacts of chemical exposure

- Lungs: cancer, asthma, irritation
- Eyes & mucous membranes; irritation, conjunctivitis, blurred vision
- Skin: irritation, rashes & burns
- Nervous system
- Liver and kidneys
- Reproductive system
- Cancers



# Safe management of chemical waste

Segregation

Handling and collection

Storage

Transport

Treatment

Disposal

# Segregation of Chemical Waste

Separate from infectious waste, radioactive waste, and general hazardous waste

Segregate based on compatibility  
Toxic, Corrosive, Flammable, Reactive



# WHO recommended segregation Scheme

Category of waste	Colour of container and markings <sup>a</sup>	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 <sup>b</sup>	Labelled with radiation symbol	Lead box
General health-care waste	Black	Plastic bag

# Labeling of chemical waste

Waste container label should have:

- Name, address, telephone of the generator
- Point of generation (if applicable)
- Start date of accumulation of waste
- Estimated quantity
- Description of contents
- Waste classification
- Hazard symbols
- Precautionary statement
- Emergency contact information

**HAZARDOUS WASTE**

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL.  
IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY  
AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

GENERATOR INFORMATION: \_\_\_\_\_

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_ PHONE \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

EPA / MANIFEST ID NO. \_\_\_\_\_ DOCUMENT NO. \_\_\_\_\_ / \_\_\_\_\_

ACCUMULATION START DATE \_\_\_\_\_ EPA WASTE NO. \_\_\_\_\_

**HAZARDOUS WASTE, SOLID, N.O.S.**

NA3077

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

**HANDLE WITH CARE!**

# International Chemical Waste Symbols

ic



Flammable



rosive



Explosive



dizer



# Handling of chemical waste

PPE should be used when handling hazardous chemicals

Type of PPE required is specific for each chemical

# Handling of chemical waste

appropriate transferring methods must be used  
bonding, grounding, and explosion proof devices  
for flammable waste



spill kit accessible

different spill kits for different hazards

materials in the kit are hazardous after use



secondary containment

# On-Site Transport of Chemical Waste

Use wheeled trolleys, containers, or carts  
designated for chemical waste transport :

Easy to load and unload

No sharp edges

Easy to clean

Leak proof

# Storage of chemical waste

Separate and enclosed area/ room/bldg.

Good ventilation

Easy access to safety shower and eyewash station

Liquid or chemical proof sump (secondary containment in case of leaks)

No mixing of chemical waste (according to manufacturers' specifications)

Incompatible wastes stored separately, e.g. acids & bases

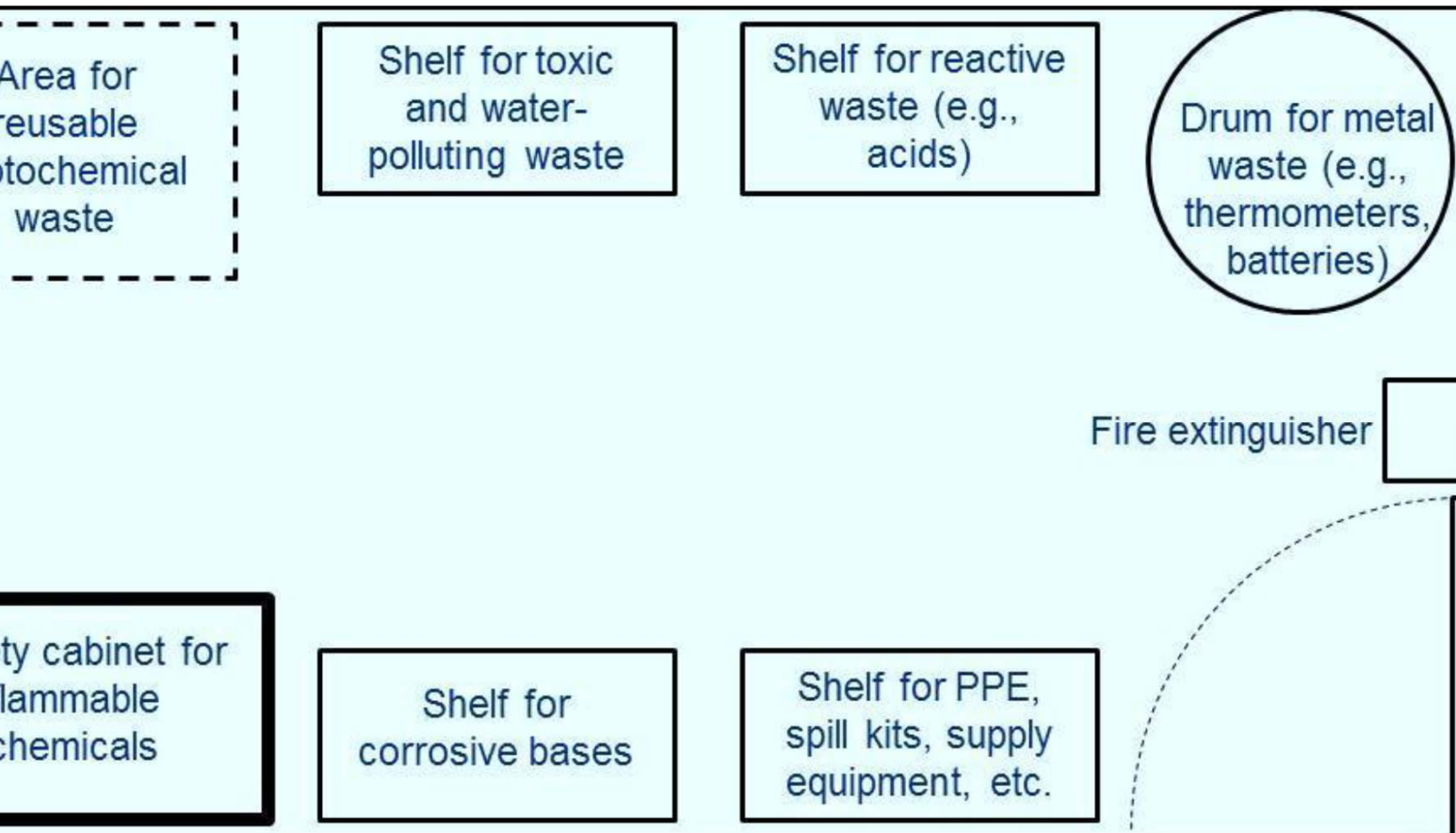
Temperature controlled or kept within acceptable range

Based on manufacturers' requirements

Labelled on the exterior with a sign



# Sample outline of chemical storage room





# Off-site transport

Transport vehicles to meet basic requirements:  
well maintained, bulkhead to separate driver from vehicle  
proper placards and markings including hazard symbol,  
kit, easy to decontaminate, etc.

Driver should be trained on:  
risks, safe handling methods, labeling,  
documentation and emergency procedures

Assignment or manifest system



# Treatment of chemical waste

## Chemical and Physical Treatment

Neutralization

Toxification

Chemical reduction or oxidation

Electrolytic oxidation

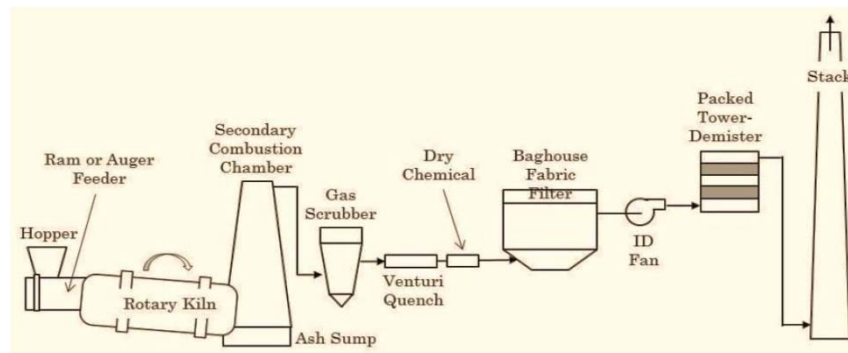
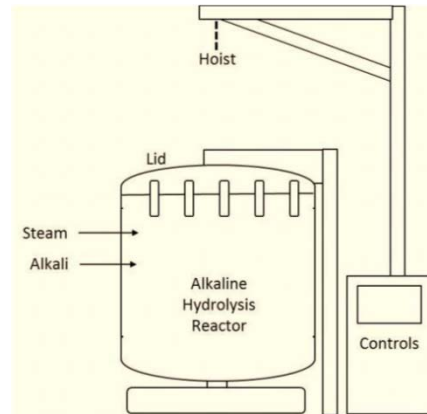
Hydrogenation, hydrolysis

## Biological Treatment

Biodegradation

## Thermal Treatment

High-temperature incineration with air pollution control



# Management of chemical waste in low-income countries

Encapsulation

Inertization with cement

Burial of encapsulated or inertized waste in engineered, controlled and secure landfills

Return of chemicals to manufacturers



# Chemical wastes containing heavy metals

## Chemical Wastes containing toxic metals, in general

Should not be burned or disposed in dumpsites

Some heavy metals, like silver in x-ray processing, can be recovered

Return to supplier for reprocessing or disposal if possible

If no options currently exist, store the waste safely in a medium-term storage site

Follow the Secretariat of the Basel Convention's guidelines on the environmentally sound management or reclamation of metals including mercury and lead

## Mercury

Develop safe clean-up, handling and storage procedures

Store mercury waste safely in a long-term storage facility

Avoid unnecessary use of mercury equipment

Replace mercury-containing products with mercury-free alternatives

Develop plans to become a mercury-free facility

## Mercury and Lead

Send to facilities that specialize in recovery of heavy metals

Return to suppliers if possible

Send to a treatment, storage and disposal facility for hazardous industrial waste

## Wastes not to be incinerated

Pressurized gas containers

Large amounts of reactive chemical waste

Silver salts or radiographic waste

Halogenated plastics (e.g. PVC)

Mercury or cadmium

Ampoules of heavy metals

# Disposal

Controlled dumping  
Engineered landfill  
Sanitary landfill

Do not lack proper facilities for hazardous waste

Disposal of hazardous ash:

Designated cells at engineered landfills,

encapsulated and placed in specialized monofill sites,

or deep pit

Could work with other stakeholders and the local municipal

authorities for safe disposal

# Chemical waste minimization

**Source Reduction** (most desirable method of waste minimization)

Segregate hazardous chemical waste

Evaluate possible substitutions using less hazardous or non-hazardous materials

Use steam cleaning or non-toxic cleaners instead

Control the inventory of chemicals

Minimize unnecessary dilution of wastes

Develop plans for a mercury phase-out

# Chemical waste minimization

## Recycling

Select vendors that are willing to reprocess or recycle their products

Use a silver recovery unit for photographic waste

Use a distillation column to recover solvents

Purchase compressed gas cylinders from manufacturers who accept return of empty or partially used cylinders



# Definition of cytotoxic agents

Cytotoxic agents - specific destructive action on certain cells

Cytostatic agents –suppress growth and multiplication of cells

Antineoplastic agents – inhibit the development of abnormal tissue growth.

Antineoplastic drugs selectively kill dividing cells.

# Sources of cytotoxic wastes

Contaminated materials from drug preparation and administration e.g. syringes, needles, gauzes, vials, packaging

Expired drugs, excess (leftover) solutions, drugs returned from wards

Urine, faeces and vomit from patients. (administered cytotoxic drugs or their metabolites)

Cytotoxic waste may also carry a risk of infection, i.e. infectious cytotoxic waste

# **Cytotoxic waste is highly hazardous**

should be carefully segregated, carefully stored away from other health-care waste in a designated secure location and collected separately, and should never be landfilled or discharged into the sewerage system.

# Examples of chemotherapy agents

**Alkylating agents** e.g. mechlorethamine, chlorambucil, cyclophosphamide, ifosfamide, melphalan, streptozocin, carmustine, busulfan, carbazone, thiotepa cisplatin

**Antimetabolites** e.g. 5-fluorouracil, methotrexate

**Mitotic inhibitors** e.g. paclitaxel, vinblastine, vincristine

**Anti-tumor antibiotics** (daunorubicin, doxorubicin, bleomycin)

**Topoisomerase inhibitors** (etoposide, teniposide)

# Hazards of chemotherapy wastes

Severity of hazards depend on substance toxicity and duration of exposure

Generally highly mutagenic, teratogenic and/or carcinogenic

Extremely irritant with harmful local effects on skin and eyes

May cause dizziness, nausea, headache or dermatitis

# Segregation of Cytotoxic Waste

Handled using proper personal protective equipment.

Should be stored separately from other waste in designated secure location

Collect in strong containers

Containers should be leak-proof

Clearly label containers "cytotoxic wastes"

Do not dispose in dumpsites or discharged into sewerage systems

# Treatment and disposal of chemotherapeutic waste

## Chemical degradation:

Used for drug residues and for cleaning contaminated urinals, spillages and protective clothing

Not used widely and require special knowledge

Not appropriate for treating contaminated body fluids

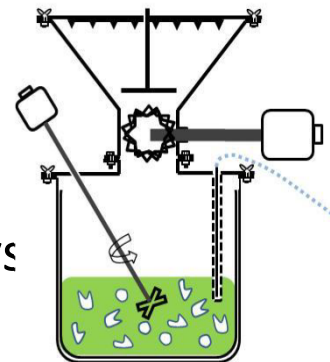
## High-temperature incineration with air pollution control:

Incineration up to 1200 °C and a minimum gas residence time of 2 sec. in a second chamber. The incinerator should be equipped with gas-cleaning equipment.

Recycle or return to original supplier

Recapsulation or inertization as a last resort

Do not dispose in dumpsites nor discharge into sewer systems



Neither incineration nor chemical degradation currently provide a completely satisfactory solution for treating waste items, spillages or biological fluids contaminated by cytotoxic agents.

Until such a solution is available, hospitals should exercise the utmost care in the use and handling of cytotoxic drugs.



## Treatment of Cytotoxic Infectious waste

Antineoplastic waste, mercury, other hazardous chemical waste and radiological waste should not be treated in an autoclave.

Chemical disinfection:

Most suitable for treating liquid waste, e.g. blood, urine, stools and hospital sewage.

Solid HCW (even highly hazardous) with limitations

Autoclave hydrolysis or alkaline digestion is a process that can be used to convert blood & body fluids into a decontaminated aqueous solution.

# Overview of disposal and treatment methods

Technology or method	Infectious waste	Anatomic waste	Sharps	Pharmaceutical waste	Cytotoxic waste	Chemical waste	Radioactive waste
Kiln	yes	yes	yes	yes	yes	yes	low-level infectious waste
Metric incinerator	yes	yes	yes	small quantities	no	small quantities	low-level infectious waste
Chamber incinerator	yes	yes	yes	no	no	no	low-level infectious waste
Refractory brick incinerator	yes	yes	yes	no	no	no	no
Chemical disinfection	yes	no	yes	no	no	no	no
Autoclave/thermal treatment	yes	no	yes	no	no	no	no
Gamma wave irradiation	yes	no	yes	no	no	no	no
Autoclave/sterilization	no	no	yes	yes	small quantities	small quantities	no
Burial/burying inside premises	yes	yes	yes	small quantities	no	small quantities	no
Controlled landfill	yes	no	no	small quantities	no	no	no
Discharge to the sewer	no	no	no	small quantities	no	no	low-level liquid waste
Decay in storage	no	no	no	yes	yes	no	no
Special handling methods				return expired drugs to supplier	return expired drugs to supplier	return unused chemicals to supplier	decay by storage

# Chemotherapeutic Waste Minimization

Segregate chemotherapy wastes through worker training and separate waste containers

Use degradable chemo agents instead of environmentally persistent agents, where possible

Purchase drug volumes based on need

Return expired agents to manufacturer

Develop spill containment and clean-up procedures that minimize waste clean-up volume

# Discharge into municipal sewage systems

Discharging into municipal sewage system after adequate pretreatment if municipal sewage-treatment plant fulfils the local regulatory requirements

Only basic sewerage systems → onsite treatment or at least pretreatment before discharge into the municipal sewerage system

Requirements:

Primary, secondary and tertiary treatment;

at least a 95% removal of bacteria;

further treatment of sludge e.g. anaerobic digestion,

maintains high standards

Thank you!