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## Reducing UPOPs and Mercury Releases from The Health Sector in Africa

### *Module 11*

# *Management of pharmaceuticals and cytotoxics*

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# Module Overview

- Describe sources and types of cytotoxic and pharmaceutical wastes
- Discuss risks associated with exposure to these specific wastes
- Describe all aspects of management of these specific wastes
- Describe treatment and disposal methods



# Learning Objectives

- ▶ Understand sources and impacts of pharmaceutical pollution
- ▶ Identify key steps avoidance, **collection, handling, storage, transport**, treatment and disposal of these wastes



# PHARMACEUTICAL WASTE

## Definition:

- ▶ Pharmaceutical waste is waste, produced during the production, distribution and application of pharmaceuticals. It includes transportation packaging as well as expired products.



- ▶ Non-risk pharmaceutical waste
- ▶ Hazardous pharmaceutical waste
- ▶ Controlled drugs



# Pharmaceutical waste

## Generated in the hospital

- ▶ Pharmacy
- ▶ Ward
- ▶ Operation theatre
- ▶ Central laboratory
- ▶ Pathology

## Generated elsewhere

- ▶ Homes
- ▶ Research laboratories
- ▶ Veterinary practices
- ▶ Nursing homes
- ▶ Pharmacies





# Pharmaceutical waste

- ▶ Expired pharmaceuticals
- ▶ Discontinued drugs
- ▶ IV preparations
- ▶ Partially used vials, syringe and packages
- ▶ Compounding of drugs
- ▶ Breakage and spills of pharmaceuticals
- ▶ Unused single-dose repackaged drugs
- ▶ Patients' personal medications
- ▶ Residues from treatment (eg giving sets)
- ▶ Manufacturing waste
- ▶ Excretions from patients in hospitals
- ▶ Excretions from patients treated at home
- ▶ Unwanted donations



# NON HAZARDOUS PHARMACEUTICAL WASTE

Examples non-hazardous pharmaceutical waste:

- ▶ Unsealed syrups or eye drops (expired or unexpired)
- ▶ Unsealed tubes of creams, ointments (expired or unexpired)
- ▶ Unsealed injection or infusion solutions
- ▶ Bulky or loose tablets, capsules, suppositories.
- ▶ Loose ampoules
- ▶ Materials necessary for making preparations
  - non-toxic chemicals, salts, sugars, etc.
- ▶ Other pharmacy related solid waste



# Characteristics of Pharmaceutical Waste

- ▶ Pharmaceuticals can be
  - **Acutely hazardous** (e.g., arsenic trioxide, epinephrine, nitroglycerin, warfarin >0.3%)
  - **Toxic** (e.g., barium, chloral hydrate, chloroform, chlorambucil, cyclophosphamide, mitomycin C, streptozotocin, lindane, phenol, thimerosal)
  - **Flammable or ignitable** (e.g., isopropanol, paregoric, collodion-based preparations)
  - **Corrosive** (e.g., acetic acid used for compounding)





# Chemotherapeutic Waste

- ▶ **Chemotherapeutic waste** – waste generated from the use of chemical agents for treatment, especially cancer therapy
- ▶ **Cytotoxic agents** – substances capable of killing or stopping the growth of cells
- ▶ **Cytostatic agents** – capable of suppressing growth and multiplication of cells
- ▶ **Antineoplastic agents** – inhibiting the development of abnormal tissue growth
- ▶ **Genotoxic agents** – capable of inducing genetic mutation
- ▶ **Teratogenic agents** – capable of causing defects in an embryo or fetus



# Examples of Cytotoxic Waste

## ▶ Examples of sources

- Contaminated materials from drug preparation including vials and syringes
- Contaminated materials from drug administration including gloves, gauze, needles

## ▶ Examples of specific agents

- Alkylating agents (e.g., mechlorethamine, chlorambucil, cyclophosphamide, ifosfamide, melphalan, streptozocin, carmustine, busulfan, dacarbazine, thiotepa cisplatin)
- Antimetabolites (e.g., 5-fluorouracil, methotrexate)
- Anti-tumor antibiotics (daunorubicin, doxorubicin, bleomycin)
- Topoisomerase inhibitors (etoposide, teniposide)
- Mitotic inhibitors (paclitaxel, vinblastine, vincristine)



# CONTROLLED DRUG WASTE

Examples of controlled drugs:

- ▶ Morphine containing substances
- ▶ Amphetamines
- ▶ Opiate
- ▶ Narcotics, psychotropic substances,
- ▶ Certain anesthetic gases





# Impacts of pharmaceuticals

- ▶ Designed to have biological effects
- ▶ Some – esp cancer drugs- are carcinogens
- ▶ Endocrine disruption
- ▶ Antimicrobial resistance
- ▶ Often environmentally persistent
- ▶ Mixtures have unknown effects
- ▶ Other hazardous chemicals eg phthalates in formulations and pills
- ▶ Environment affected by continual releases



# Pollution from pharmaceutical life cycle

- ▶ Manufacturing emissions
  - Toxics and carbon footprint
- ▶ Sewage- excretions
  - Mostly from home patients
  - Small percentage from hospitals
- ▶ Drain disposal- homes and hospitals
- ▶ Incineration (dioxins/furans/CO<sub>2</sub>/others)
- ▶ Prod<sup>n</sup> and incin<sup>n</sup> of PVC blister packs
- ▶ Landfill/dumping



# Environmental Impact of Pharmaceutical Waste

- ▶ Pharmaceuticals are present in most hospital wastewater
- ▶ More than 100 different types of pharmaceuticals or their metabolites are found in water bodies in Europe and the U.S.
- ▶ Some pharmaceuticals can seep into the groundwater
- ▶ Environmental concentrations could affect fish and other wildlife
- ▶ Antibiotics found in streams worldwide raise concerns of the possible rise of antibiotic-resistant organisms



# Reducing waste

- ▶ Purchase only according to need
- ▶ Earliest expiry used first
- ▶ Prescribe only required amount (split packages)
- ▶ Refuse inappropriate donations
  - Unwanted materials, foreign names
  - Short expiry date





# Ways to avoid overuse

- ▶ Doctors prescribe what the patients want, not what they need
  - Need tighter rules and support for doctors to implement them
- ▶ Stop open sale of critical medicines
  - Esp antibiotics
- ▶ Choose oral medicines over injectables
- ▶ Reduce use of meat produced with unnecessary antibiotics



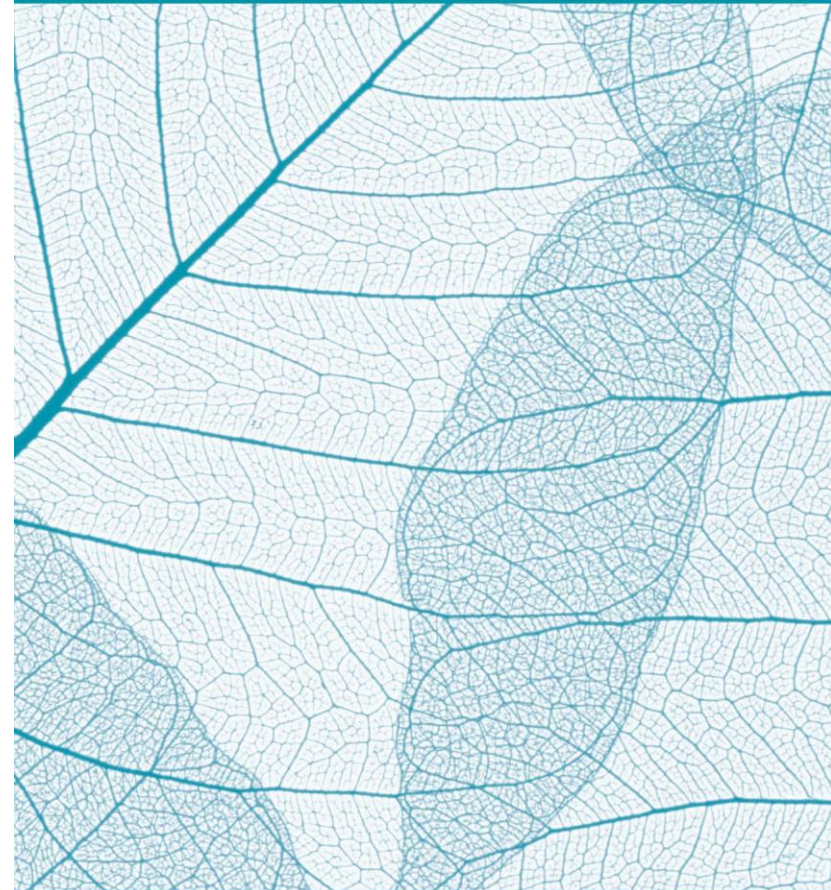


# Green procurement

- ▶ Stockholm County Council, Sweden has classified 800 pharmaceuticals according to environmental harm so that doctors can choose to prescribe less harmful pharmaceuticals
- ▶ Also produce a “Wise list” of the best pharmaceuticals to prescribe- 80% of prescriptions in SCC area are from this list
- ▶ Regularly updated:  
[www.janusinfo.se/environment](http://www.janusinfo.se/environment)
- ▶ [http://www.janusinfo.se/Documents/Kloka\\_Listan/The-Wise-List-2015.pdf](http://www.janusinfo.se/Documents/Kloka_Listan/The-Wise-List-2015.pdf)
- ▶ <http://www.janusinfo.se/In-English/The-Wise-List-2015-in-English/>

2014-2015

ENVIRONMENTALLY  
CLASSIFIED  
PHARMACEUTICALS





# Segregation of Pharmaceuticals

## ► General Principles

- Keep packaging so contents can be identified
- Return to pharmacy
- Liquids should be safely contained

## ► Cytotoxic/Genotoxic Waste

- 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

# SORTING OF PHARMACEUTICAL WASTE

The sorting process includes:

- ▶ Identifying each item
- ▶ Making a decision whether it is usable or unusable
- ▶ If it is unusable the packing should be removed
- ▶ The hazardous or controlled pharmaceuticals should be put in special drums, flasks or containers, suitable for the item.
- ▶ Non hazardous solid, semi-solid and powders pharmaceuticals (e.g. tablets, capsules, granules, powders for injection, mixtures, creams, lotions, gels, suppositories, etc.) should be stored together in one bin
- ▶ Non hazardous liquids (solutions, suspensions, syrups, etc.) can be put together in another bin



# Disposal options

- ▶ Not advisable for each facility to take responsibility for disposal of waste pharmaceuticals, esp smaller ones
- ▶ Centralised treatment is more efficient
- ▶ Negotiate take-back with supplier
- ▶ Extended producer responsibility
  - Set up or fund take back programs
  - Dispose of unwanted drugs



# Disposal of Pharmaceutical Waste in Low-Income Countries

- ▶ **Reverse distribution** (return to supplier)
- ▶ **Safe burial** on hospital premises- not recommended
- ▶ **Encapsulation or inertization**
  - Solid, liquid, or semi-liquid waste can be encapsulated in metal drums
  - Solids ground up; mixed with cement, lime and water; made into pellets or blocks
- ▶ **Chemical Neutralisation**
  - Specific reagents for different cytotoxics (see Blue Book for more information)
- ▶ **Landfill disposal**
  - Landfilling large quantities of pharmaceuticals is not recommended, unless waste is encapsulated and disposed in a sanitary landfill where there is no risk of leaching into the groundwater
- ▶ **Discharge to a sewer**
  - Only for relatively mild liquid or semi-liquids (vitamins, cough syrups, eye drops, saline solution, glucose, electrolytes, etc.)
  - Discharge into a large flow of water and into municipal sanitary sewers
  - Antibiotics and cytotoxic drugs should not be discharged in a sewer



# Wastewater treatment

- ▶ One of the largest sources of pharmaceuticals into the environment is via municipal sewage
- ▶ Hospital sewage is a far smaller source
- ▶ The most efficient option is for good centralised sewage treatment
- ▶ Forcing hospitals to install WWTPs will not solve the problem
- ▶ New technologies are better at removing pharma from sewage, research for better options is continuing



# Low tech- encapsulation





# Potential future solutions

- ▶ Alkaline hydrolysis
  - Method originally intended for hazardous waste
  - Mostly sold for tissue digestion
  - Being validated for pharmaceuticals
  
- ▶ ?? Thermophilic anaerobic digestion??
- ▶ ?? Improved wastewater treatment??
- ▶ ?? Fenton reagent reactor??





# Conclusions and recommendations

- ▶ Requires action from regulators, industry, municipalities as well as healthcare sector
- ▶ Need to control emissions from whole life cycle
  - Protect aquatic environment from emissions from factories, patient excretion and drain disposal
- ▶ Healthcare sector- priority on reducing waste by better procurement, management and prescription
- ▶ Take-back and centralised treatment is more efficient
- ▶ Non-incineration technologies increasingly available