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**GLOBAL HEALTHCARE WASTE PROJECT**

# MODULE 23: Management of Healthcare Wastewater



# Module Overview

- Describe sources of wastewater in a healthcare facility
- Describe characteristics and hazards associated with wastewater from healthcare facilities
- Describe treatment and disposal options for wastewater from healthcare facilities

# Learning Objectives

- Identify sources and hazards of wastewater in your healthcare facility
- Identify appropriate methods collection, treatment and disposal of wastewater
- Describe your facility's wastewater management program
- Discuss possible options to improve management of wastewater in your facility

# Healthcare Wastewater

- Any water adversely affected in quality during provision of healthcare services
- It is mainly liquid waste
  - containing some solids disposed by staff and patients, or
  - during other healthcare-related processes, such as cooking, cleaning or laundry

# Categories of Healthcare Wastewater

- **Blackwater** (sewage) is heavily polluted wastewater containing high concentrations of:
  - faecal matter and urine
  - food residues
  - toxic chemicals
- **Greywater** (sullage) is low polluted wastewater with residues from:
  - washing, bathing, laboratory processes, laundry, or technical processes such as cooling water or the rinsing of X-ray films
- **Stormwater** is technically not wastewater but consists of rainfall collected on hospital roofs, grounds, and paved surfaces
  - It may seep into groundwater, or be used for irrigation of hospital grounds or toilet flushing.

# Sources of Healthcare Wastewater

- Administration and wards
- Kitchen
- Laundry
- Operating rooms and ICU
- Laboratories
- Radiology
- Haemodialysis
- Dental departments
- Toilets
- Engineering and maintenance department
- Runoff from paved areas,

# Health and Environmental Hazards of Healthcare Wastewater

- **Wastewater contaminants:**
  - Important chemicals in hospital wastewater include anesthetics, disinfectants (formaldehyde, glutaraldehyde), chemicals from laboratory activities, photochemical solutions (hydroquinone), and X-ray contrast media containing absorbable organohalogen compounds (AOX)
  - Mercury from dental amalgams or lab chemicals
  - Excessive nutrients and nitrates
  - Pharmaceuticals, including antibiotics
  - Radioactive wastes
  - Infectious agents, including bacteria, viruses and parasites

# Health and Environmental Hazards of Wastewater

- Wastewater is potentially infectious
- Some healthcare facilities in low-income areas have no sewer systems
- Some sewers of healthcare facilities are not watertight, and wastewater can leak into groundwater
- Improper wastewater management, collection, treatment, and disposal may result in the pollution of local drinking water sources, or the contamination of natural resources



# Health and Environmental Hazards of Wastewater

- **Environmental implications**
  - Excessive nutrients cause biological degradation in groundwater, lakes and rivers by using up oxygen (eutrophication) resulting in algal blooms and biotoxins
  - Pharmaceuticals in water may act as endocrine disruptors
  - Antibiotics could result in antibiotic-resistant pathogens
  - Mercury and heavy metal poisoning
- **Water-borne disease outbreaks in communities**
  - Campylobacteriosis, cholera, Hepatitis A and E, schistosomiasis, and typhoid fever
- **Vector-borne diseases and parasites**
  - Dengue fever, malaria, roundworms

# Wastewater Management

- Basic underlying principle of effective wastewater management
  - ❖ **Strictly limit the discharge of hazardous liquids to sewers.**
- Segregation, waste minimization, and safe storage are just as important for liquid wastes as for solid wastes
- Chemical and pharmaceutical wastes—such as photographic chemicals, aldehydes, colorants and antibiotics—should not be discharged directly into the sewer drain

# Wastewater Management

- Two traditional collection arrangements:
  - “**Central system**” of sewage pipes bringing wastewater from throughout the facility to a central underground location for treatment or disposal
  - “**De-centralized system**” wherein pipes from some medical areas pass wastewater to septic tanks or cesspits (not a preferred approach)

# Wastewater Management

- Recommended set-up
  - Construction of two separate collection systems
    - **Sewage system** for wastewater
    - **Stormwater system** for rainwater, which can be used for gardens, toilet flushing or washing of paved areas
  - **Manholes** to allow access for maintenance every 50 meters or less
  - **Watertight** sewage pipes and manholes
  - **Pre-treatment** to reduce or eliminate contaminants in non-domestic wastewater, or in altering its nature before discharging it into the sewer

# Pre-Treatment of Hazardous Liquids

- Pre-treatment for the **medical laboratory** (recommended) includes acid-base neutralization, filtration and sedimentation, or autoclaving
- Pre-treatment for **feaces or vomit during an outbreak** such as cholera involves decontamination with lime milk (hydrated calcium oxide or calcium hydroxide) – ratio of 1:2 for stool and vomit with lime for 6 hours minimum; ratio of 1:1 for urine with lime for 2 hours minimum.
- **Blood** can be discharged in the sewer (using PPE to protect from blood splatter) if a risk assessment shows that the organic loading does not require pre-treatment. Otherwise, blood can be pre-treated by a thermal method or disposed directly into a septic tank if safety measure are used. *NOTE: 5% hypochlorite is not effective for high organic loads like blood.*

# Pre-treatment of Hazardous Liquids

- Pre-treatment for the **dental department** entails installing amalgam separators in sinks, especially by patient treatment chairs; the separated mercury waste must be safely stored.
- Pre-treatment for the **radiotherapy department** involves separate collection of radioactive wastewater (e.g. urine of patients from the thyroid treatment) and storage for decay in a secured die-away basin until background concentrations have decreased; after the required storage time, the wastewater can be disposed of in the sewer system.
- Pre-treatment for **kitchens** entails a grease trap to remove grease, oil, and other floating materials

# Liquids That Do Not Require Pre-Treatment

- Non-hazardous chemicals such as syrups, vitamins, or eye drops
- Small quantities of blood and rinsing liquids from surgical theaters can be discharged in the sewer system without pre-treatment
- Large quantities of blood may require pre-treatment if it is indicated by a risk assessment.

# Healthcare Sewage System

- The preferred method is to connect the healthcare sewage system to the municipal sewage system and to **discharge healthcare wastewater after adequate pre-treatment to municipal sewage** if the municipal sewage treatment plant meets the following minimum requirements:
  - Use of primary, secondary and tertiary treatment
  - Removal of >95% of bacteria
  - Treatment of sewage sludge to destroy helminth eggs to < 1 egg per liter
  - Compliance with local regulatory requirements

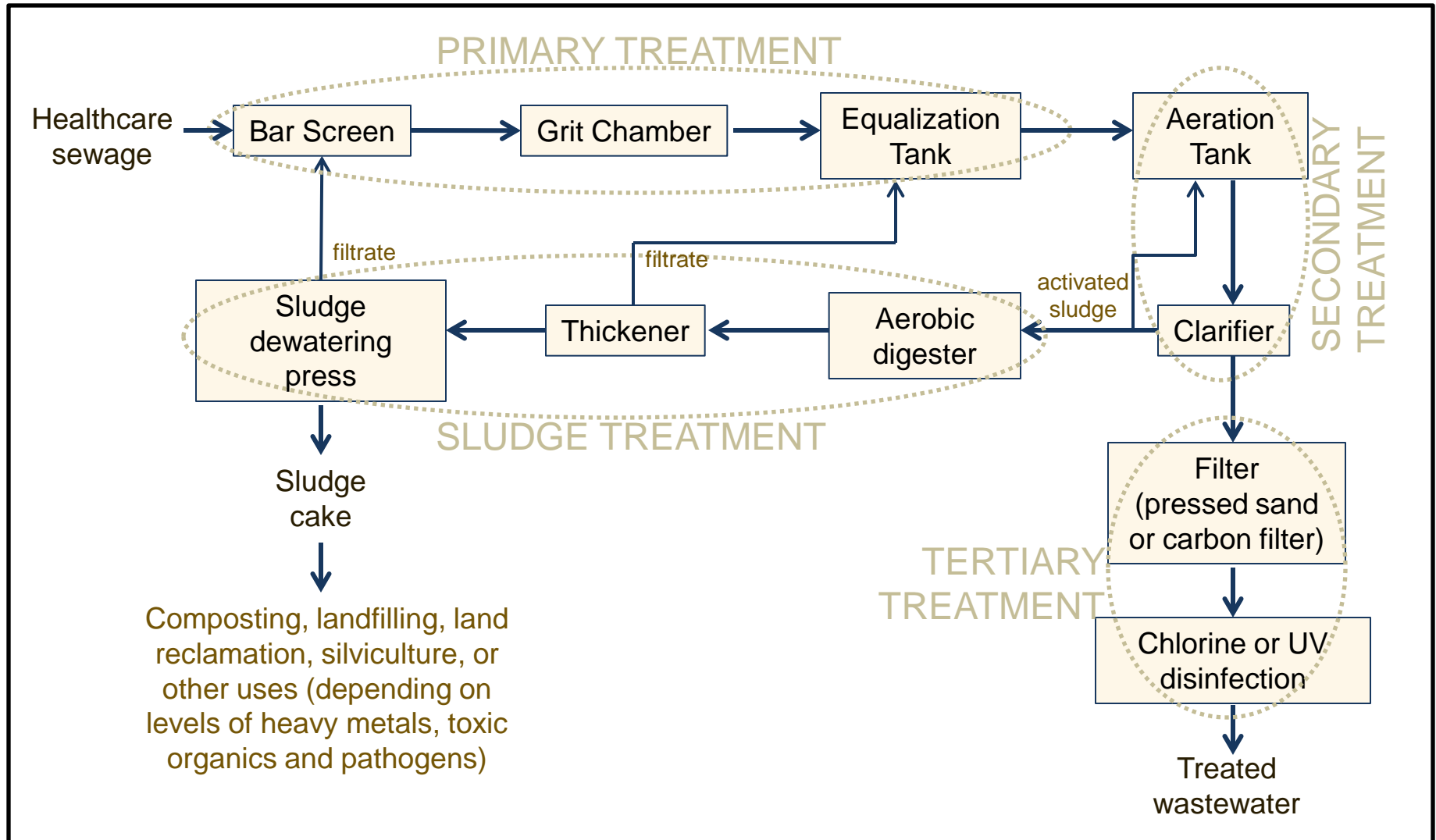
# Healthcare Sewage System

- If no municipal sewage system exists, or
- If the municipal sewage system does not meet basic requirements, or
- If the area experiences epidemics of enteric diseases or endemic intestinal helminthiasis
  - The recommended option is on-site wastewater treatment
  - The objective is to treat effluent so it is suitable for reuse or discharge into the environment, usually into surface water

# On-Site Wastewater Treatment for Large Healthcare Facilities

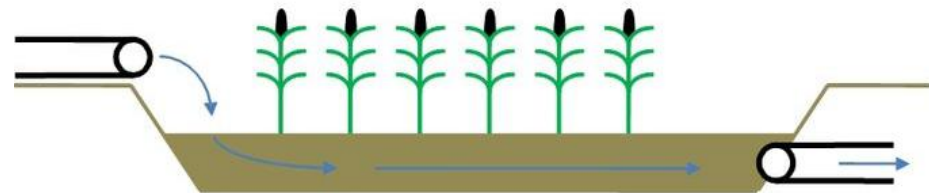
- 3 Stages for efficient on-site treatment:
  - **Primary treatment**: to remove of heavy solids
  - **Secondary treatment**: to remove dissolved and suspended biological matter using indigenous bacteria
  - **Tertiary treatment**: to further treat the wastewater for the purpose of reducing pathogens, suspended solids, excessive phosphorus and nitrogen nutrients, and/or chemical contaminants

# Example of On-Site Wastewater Treatment for a Large Healthcare Facility



# On-Site Wastewater Treatment

- On-site wastewater treatment produces sludge which contains high concentrations of pathogens
- Options for treatment of sludge:
  - Anaerobic digestion
  - Aerobic digestion
  - Composting
  - Reed beds



Horizontal reed bed

# On-Site Wastewater Treatment

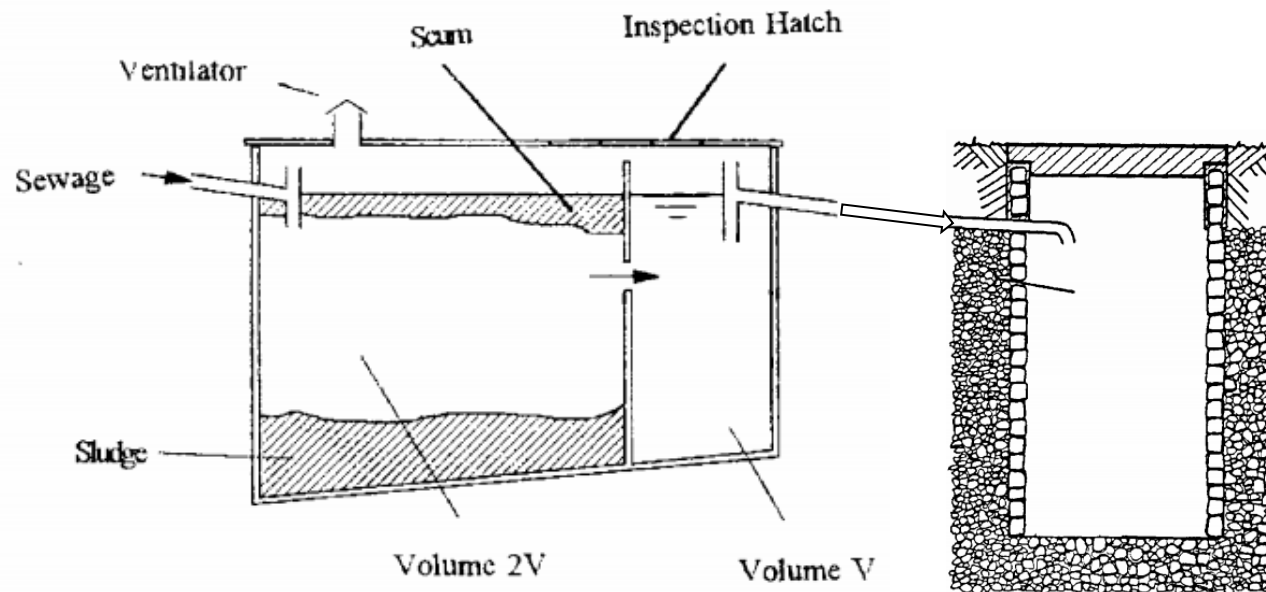
- Common parameters for monitoring the effluent quality
  - Temperature
  - pH
  - Total suspended solids
  - BOD5 (biochemical oxygen demand for 5 days at 20°C)
  - Chemical oxygen demand
  - Nitrate
  - Total phosphorus
  - E. coli concentration

# Minimum Approach to Wastewater Management

- Sufficient toilets (WHO 2008)
  - 1 toilet per 20 users for inpatient settings
  - 4 toilets per outpatient setting (per setting: 1 each for male and female staff, 1 for female patients, 1 for male patients).
  - toilets should ideally be connected to a sewerage system.

# Minimum Approach to Wastewater Management

- Two-chamber septic tank with a lined soakaway



# Minimum Approach to a Liquid Hazardous Waste Management System

- **Body-fluids and the contents of suction systems from highly infectious patients (e.g., cholera)**
  - Should be thermally treated (e.g. in a waste treatment autoclave) and then discharged via the drain, or
  - Disinfected with hydrated calcium oxide for several hours before being discharged via the drain
- **Stool, vomit and mucus from infectious patients should be separately collected**
  - thermally treated prior to disposal or treatment with hydrated calcium oxide for several hours

# Minimum Approach to a Liquid Hazardous Waste Management System

- Hazardous pharmaceuticals and chemicals should never be disposed of via the wastewater system.
- Liquid laboratory hazardous waste (colorants, formalin) should be separately collected, mixed with an absorbent (e.g., saw dust), and immobilized or encapsulated.
- Chlorine based disinfectants should be diluted to reach a concentration of <math><0.5\%</math> active chlorine.
- Liquid pharmaceuticals in vials (but not cytotoxic materials) could be crushed in a closed bucket, mixed with sawdust and encapsulated
- Glutaraldehyde should be stored after use, neutralized with glycine, and slowly disposed of via a soak away pit

# Minimum Approach to a Liquid Hazardous Waste Management System

- Options for management of expired blood bags:
  - PPE and other precautions should be taken to protect against blood splatter
  - Dispose of at a controlled sanitary landfill, or
  - Treat in a high temperature incinerator (1100 °C) , or
  - Treat in an autoclave with a special liquid treatment cycle, or
  - Bury unopened in a protected pit within the healthcare facility or other secure location



# New Technology

- Ask participants if they are aware of any new technology available in their country.

# National and Local Regulations Related to Wastewater Discharges

# Discussion

- What are some major sources of wastewater within your healthcare facility? What about minor sources?
- What are some public and environmental health hazards associated with healthcare wastewater? Are there certain hazards you perceive within your own facility?
- What happens to the wastewater in your facility after it goes down the drain? What procedures does your facility use in the overall management of wastewater and other hazardous liquid wastes? What safety measures are in place? Does the facility use waste minimization techniques to limit the amount of discharged liquids?

# Discussion

- Does your facility have wastewater treatment on-site? If not, what pre-treatment methods are used, if any, before release to the main municipal sewer system? Are septic tanks and cesspools used?
- What are the country/region-specific regulations and guidelines for managing wastewater (segregation, treatment, disposal, etc.) from healthcare facilities?
- Discuss some ways to minimize wastewater in your facility.