Radiopharmaceuticals

Storage of Radiopharmaceuticals

What are Radiopharmaceuticals?

- Radiopharmaceuticals are medicinal products that contain radioactive isotopes.
- They are used in diagnosis (e.g., imaging) and therapy (e.g., treatment of cancer).
- They emit ionizing radiation and are mainly utilized in nuclear medicine.
    - **Diagnostic**: e.g., Technetium-99m, Fluorine-18 (FDG)
    - **Therapeutic**: e.g., Iodine-131, Lutetium-177

Objectives:

- To prevent radiation exposure to personnel.
- To ensure radiochemical stability.
- To prevent contamination and loss of radioactivity.

Key Principles:

Shielding

- Radiopharmaceuticals emit ionizing radiation; therefore, proper shielding materials are necessary.
    - Lead is commonly used for gamma emitters.
    - Plastic or acrylic is used for beta emitters to avoid bremsstrahlung radiation.
- Storage containers (often lead-lined boxes) must be labeled and shielded appropriately based on the type of radiation.

Segregation

- Different isotopes must be stored separately to avoid cross-contamination.
- Short-lived isotopes (e.g., Tc-99m) are often kept in "hot labs" near the point of use.

Security

- Radiopharmaceuticals must be stored in secured, restricted-access areas to prevent unauthorized access.
- Regulatory agencies (like the Nuclear Regulatory Commission or local radiation safety authorities) enforce these rules.

Environmental Conditions

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- Temperature and humidity control are important to preserve the chemical and physical stability.
- Refrigeration may be necessary for some compounds.

Dispensing of Radiopharmaceuticals

Objective

- To ensure accurate, sterile, and safe preparation and delivery of radiopharmaceutical doses while protecting staff and patients from radiation exposure.

Qualified Personnel

- Only licensed nuclear medicine physicians, radiopharmacists, or certified technologists may dispense.
- **Must wear:**
  - Dosimeters (TLD or film badges)
  - Gloves, lab coats
  - Lead aprons or thyroid shields (as needed)
  - Protective eyewear

Preparation & Dispensing

- **Conducted in sterile environments:**
  - Laminar airflow hoods (Class II BSC)
  - Lead-shielded isolators or fume hoods
- **Use:**
  - Lead-shielded syringes/vials
  - Dose calibrators
  - Automated dispensers (if available)

Aseptic Technique:

- Mandatory for IV-administered products

Activity Measurement:

- Measured in **MBq or mCi** using dose calibrators
- Must include decay correction and patient-specific dosing

Format:

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- Dispensed as **unit doses** in syringes or lead containers

Labeling Requirements

- Each dose must include:
  - Patient ID
  - Radiopharmaceutical name
  - Activity (MBq/mCi)
  - Calibration date/time
  - Expiry time (based on half-life)
  - Radiation warning symbol

Contamination Control

- Use absorbent pads and trays
- Routine surface monitoring
- Immediate cleanup and decontamination of spills

Disposal of Radiopharmaceuticals

Objective:

- To manage radioactive waste safely and in compliance with environmental and public health regulations.

Types of Waste:

1. **Solid Waste:** Syringes, gloves, vials, packaging.
2. **Liquid Waste:** Residual solutions, patient excreta.
3. **Gaseous Waste:** Rare but possible during handling of certain volatile isotopes.

Methods of Disposal:

Decay-in-Storage (DIS)

- Short-lived isotopes (half-life < 120 days, e.g., Tc-99m) are stored in shielded containers until their radioactivity decays to background levels.
- After decay, the material is checked with a radiation detector and, if safe, disposed of as regular medical waste.

Sewer Disposal

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- In some cases, very low levels of water-soluble, short-lived isotopes can be disposed of through the sanitary sewer system under strict regulations.

Authorized Return

- Some unused or expired materials may be returned to the supplier or manufacturer, especially for sealed sources.

Burial or Incineration

- For long-lived or high-activity isotopes, disposal may involve transfer to specialized facilities for deep burial or controlled incineration under regulatory oversight.

Regulatory Compliance:

- All disposal procedures must align with local and national radiation protection regulations (e.g., NRC, IAEA, AERB in India).
- Records must be meticulously maintained:
  - Isotope type
  - Amount of activity
  - Date of disposal
  - Disposal method
  - Personnel involved

Safety and Monitoring

- Radiation surveys and contamination checks are conducted regularly in hot labs and storage/dispensing areas.
- Personnel monitoring (via dosimeters) and bioassays ensure that internal and external radiation exposure is within limits.
- Training: All personnel involved in handling radiopharmaceuticals must receive formal training in radiation safety and handling procedures.

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