NMED-1603: NUCLEAR RADIOPHARMACY AND PHARMACOLOGY

Cuyahoga Community College

Viewing: NMED-1603 : Nuclear Radiopharmacy and Pharmacology

Board of Trustees:
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Academic Term:
Fall 2022

Subject Code
NMED - Nuclear Medicine Technology

Course Number:
1603

Title:
Nuclear Radiopharmacy and Pharmacology

Catalog Description:
Theory and practice of radiopharmacy including non-radioactive interventional drugs and contrast media. Addresses the routes of administration, bio-distribution mechanisms, interfering agents, contraindications, and adverse effects for all administered materials. Preparation and calculation of the dose to be administered, quality control, radiation safety, and applicable regulations are also covered.

Credit Hour(s):
3

Lecture Hour(s):
3

Requisites

Prerequisite and Corequisite
Departmental approval: admission to the program.

Outcomes

Course Outcome(s):
Explain the creation, preparation, storage, quality control, and administration of radiopharmaceuticals in accordance with state and federal regulations.

Essential Learning Outcome Mapping:
Quantitative Reasoning: Analyze problems, including real-world scenarios, through the application of mathematical and numerical concepts and skills, including the interpretation of data, tables, charts, or graphs.

Objective(s):
1. Demonstrate radiation emergency procedures in the event of a spill, including radioactive waste material storage and evacuation of personnel and patients.
2. Identify and list the characteristics of the ideal radiopharmaceutical.
3. Determine and calculate appropriate patient doses.
4. Demonstrate proper compounding of radionuclide-labeled kits.
5. Determine acceptable dose ranges and what to do if provided unacceptable data.
6. Describe generator kinetics in the production of radionuclides.
7. Demonstrate appropriate generator elution techniques.
8. Describe quality control procedures, including radionuclide purity, radiochemical purity, and chemical impurities.
9. Demonstrate proper storage of reconstituted and radionuclide labelled kits.

Course Outcome(s):

Explain the concepts of radionuclides and radiopharmaceuticals.

Objective(s):

1. Discuss the production and characteristics of positron emitters and positron-labeled radiopharmaceuticals.
2. Describe the basic concepts of radiochemistry.
3. Explain the normal and altered biodistribution properties of radiopharmaceuticals.
4. Describe the characteristics, proper use, and pharmacokinetics of radiopharmaceuticals, pharmaceuticals, and contrast media.
5. Describe the Food and Drug Administration and US Pharmacopeia control of pharmaceuticals and radiopharmaceuticals.

Course Outcome(s):

Analyze patient information to determine adverse reactions, interfering drugs, and contraindications for administration of radiopharmaceuticals, pharmaceuticals, and contrast media.

Objective(s):

1. Describe protocols and drugs to respond to adverse reactions and proper administration techniques.
2. Describe what to do in the event of a contrast media reaction.
3. Identify drugs that may interfere with the administration of radiopharmaceuticals and contrast media.
4. Discuss precautions and contraindications for the use of radiopharmaceuticals and contrast media.

Methods of Evaluation:

1. Class participation
2. Worksheets
3. Quizzes
4. Midterm examination
5. Final examination

Course Content Outline:

1. Basics of radiation physics and radiochemistry
    a. Atomic structure
    b. Forces affecting the atom
    c. Nomenclature
    d. Chemical bonding
2. Radioactive decay
    a. Methods of decay
    b. Interactions of radiation with matter
    c. Decay modes and schemes
3. Radiation detection instruments
    a. Gas detectors
    b. Scintillaton detectors
    c. Quality control techniques and performance
4. Methods of production
    a. Reactors
    b. Generator
        i. Components and configuration
        ii. Parent-daughter relationships
        iii. Transient versus secular equilibrium
        iv. Elution efficiency
        v. Yield calculation
        vi. Elution technique
        vii. Wet versus dry
        viii. Moly-Tech
        ix. Strontium-Rubidium
        x. Quality control and problems effecting labeling yield
    c. Cyclotron
5. Radioactive Decay formula

   a. Units or radioactivity
   b. Physical half-life
   c. Decay formula
   d. Decay factors
   e. Pre-calibration factors
6. Calculation of Patient Dose
   a. Specific concentration
   b. Dose volume determination
   c. Unit does adjustment
   d. Dilution of doses
   e. Considertion for decay
   f. Pediatric dose adjustments
7. Radiation Safety
   a. Nuclear Regulatory Commission
   b. As low as reasonably achievable (ALARA)
   c. Nuclear pharmacy
   d. Radioactive spills
   e. Posting and trigger limits
8. Desirable characteristics of a radiopharmaceutical
   a. Diagnostic versus therapeutic radionuclide
   b. Desirable energy
   c. Biologic and effective half-life
   d. Target to non-target ration
   e. Availability and shelf life
   f. Methods of localization
   g. Limiting agents
   h. Photon flux
      i. ALARA
      ii. Instrument limitations
9. Radiolabeling
   a. Important factors of labeling
      i. Stoichiometry
      ii. Clearance time
      iii. Stability/compatibility
      iv. Protein binding
      v. Biodistribution
   b. Clearance and uptake times
   c. Plasma clearance
   d. Organ/tissue uptake and retention
   e. Organ clearance and redistribution
   f. Excretion routes
   g. Biological half-life
10. Design of a radiopharmaceutical
   a. Investigational New Drug
   b. Research and investigation
   c. New drug application and approval
   d. Food and Drug Administration
   e. United States Pharmacopeia
11. Radiochemistry
   a. Aqueous solutions
   b. Reactivity
      i. Valence state
      ii. Oxidation
12. Kit Preparation
   a. Oxidation/Reduction states
   b. Quality Control
      i. Radionuclide purity
      ii. Radiochemical purity and thin-layer chromatography

1. Chemical purity
2. Sterility and biological testing
3. pH

iii. Particle size
iv. Visual appearance
v. Aseptic technique

13. Individual radiopharmaceuticals
    a. 99mTechnetium labeled
    b. Iodine labeled
        i. Special considerations for radioiodine
    c. Indium labeled
    d. Positron Emission Tomography agents
    e. Indium labled
    f. Positron Emission Tomography agents
    g. Miscellaneous diagnostic
    h. Therapeutic radiopharmaceuticals
14. For each radiopharmaceutical on the Nuclear Medicine Technology Certification Board Pharmacy List (NMTCB) and the American Radiologic Registry Technology (ARRT) Nuclear Medicine radionuclide list, the following elements will be examined:
    a. Alternate names
    b. Specific chemical and physical properties
    c. Volatile gases
        i. Storage requirements
        ii. Room clearance times
        iii. Negative pressure requirements and postings
    d. Indications for use
    e. Method of localization and biodistribution
    f. Dose to critical organs
    g. Adverse reactions and precautions
    h. Contraindications and interfering agents
    i. Route of administration and doses ranges
    j. Method of preparation
    k. Quality control consideration and limits
15. Pharmaceutical: Interventional and non-radioactive agents
    a. Administration by Nuclear Medicine Technologists
        i. Regulations
        ii. Ethical implications
        iii. Training
        iv. Procedural considerations
16. For each pharmaceutical on the Nuclear Medicine Technology Certification Board harmacy List (NMTCB) and the American Radiologic Registry Technology (ARRT) Nuclear Medicine radionuclide list, the following elements will be examined interventional agents:
    a. Class of drug
    b. Alternate names
    c. Indications
    d. Mechanism of action
    e. Pharmacokinetics
    f. Dosage range
    g. Precautions and contraindications
    h. Adverse reactions
17. Contrast Media
    a. Alternate names
    b. Indications
    c. Pharmacokinetics
    d. Dose range including pediatric calculation
    e. Adverse reactions and reporting
    f. High-osmolality ionic agents
    g. Low-osmolality ionic agents
    h. Low-osmolality nonionic

   i. Barium sulfate
   j. Sodium amidotrisoate
   k. Meglumine amidotrizoate
   l. Other
   m. Air
18. Record keeping
   a. Proper charting and documentation
   b. Legal ramifications of improper charting and documentation
   c. Ownership and release of medical information
   d. Radiopharmacy information system/Unit Dose Management Systems

Resources

Wells, Patricia. (2011) *Practical Mathemics in Nuclear Medicine*, Elsevier.

Waterstram-Rich & Gilmore. (2016) *Nuclear Medicine and PET/CT Technology and Techniques*, Elsevier.

Mettler. (2018) *Essentials of Nuclear Medicine Imaging*, Elsevier.

Tri-C Program Manual. *Nuclear Medicine Lab Manual*. Cuyahoga Community College, 2019.

Thrail & Zeisman. (2018) *Nuclear Medicine: The Requisites*, Elsevier.

Bolus & Glasgow. (2018) *Review of Nuclear Medicine Technology*, Elsevier.

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