NMED-1020: NUCLEAR MEDICINE COMPUTERS, MATH, AND STATISTICS

Cuyahoga Community College

Viewing: NMED-1020 : Nuclear Medicine Computers, Math, and Statistics

Board of Trustees:

January 2024

Academic Term:

Fall 2024

Subject Code

NMED - Nuclear Medicine Technology

Course Number:

1020

Title:

Nuclear Medicine Computers, Math, and Statistics

Catalog Description:

Examines the mathematics associated with the field of nuclear medicine including formulas and calculations involving radioactive decay, radiations safety, quality control, clinical procedures, statistical analysis, and kit and dose preparation. Also covers study of computer systems in the field of nuclear medicine. Topics include the gamma camera computer system interface, data acquisition, image processing software and techniques, quality control, tomography, radiopharmacy record keeping, teleradiography, and medical informatics.

Credit Hour(s):

1

Lecture Hour(s):

1.5

Lab Hour(s):

1

Requisites

Prerequisite and Corequisite

Departmental approval: admission to program.

Outcomes

Course Outcome(s):

Complete mathematical equations associated with the field of nuclear medicine.

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 mathematical and statistical calculations and analysis for nuclear medicine clinical procedures.
2. Perform radiation protection calculations including half-value layer.
3. Perform radiation exposure in regards to time, distance, and shielding.
4. Calculate quality control for accuracy, linearity, geometry, constancy, and efficiency of nuclear medicine instrumentation.
5. Determine radioactive decay using various methods of the radiation decay formula.

Course Outcome(s):

Perform statistical and curve analysis on given data.

Objective(s):

1. Complete statistical equations with understanding of mean, median, and mode.
2. Demonstrate mathematical and statistical calculations and analysis for nuclear medicine clinical procedures.
3. Calculate standard deviations.
4. Explain and graph Levey-Jennings plot.

Course Outcome(s):

Analyze data for preparation, procedure, and results of exams performed by a nuclear medicine technologist.

Objective(s):

1. Calculate patient dose and volume including pediatric doses.
2. Demonstrate mathematical and statistical calculations and analysis for nuclear medicine clinical procedures.
3. Perform radiopharmacy calculations for generator elution and quality control.
4. Perform radiopharmacy calculations for kit preparation and quality control.

Course Outcome(s):

Discuss the components and applications of nuclear medicine computer systems.

Objective(s):

1. Describe the components of nuclear medicine computer systems.
2. Explain how nuclear medicine computer systems are used to collect, process, and store data.

Course Outcome(s):

Discuss and apply effective data processing techniques utilized in the field of nuclear medicine.

Objective(s):

1. Describe the various data processing systems used in the field of nuclear medicine.
2. Apply the appropriate data processing techniques for various nuclear medicine exams.

Course Outcome(s):

Explain medical informatics applications as they apply to nuclear medicine.

Objective(s):

1. Determine how to accurately program and assess proper computer filters for high performance quality control processing images used in diagnostic imaging.
2. Understand the computer/gamma camera interfacing and what steps to take to correct poor target to background ratios.

Methods of Evaluation:

1. Assignments/worksheets
2. Quizzes
3. Mid-term exam
4. Final exam

Course Content Outline:

1. Basic Math for Nuclear Medicine Technology
    a. Powers and exponents
    b. Roots
    c. Scientific notation
    d. Exponential equations
    e. Direct and inverse proportions
    f. Converting nuclear medicine units

   g. Natural logs and anti-logs
   h. Graphing on linear and semi-logs
   i. Slope calculations
2. Statistics
   a. Percent error
   b. Counting rate
   c. Median, mean, and mode
   d. Standard deviations
   e. Determination of statistical significance
   f. Propagation of errors
   g. Levey-Jennings plot
3. Radiation Protection
   a. Converting counts per minute to disintegrations per minute
   b. Exposure rates
   c. Calculation using a half-value layer
   d. Radiation dose versus protective methods
      i. Time
      ii. Distance
      iii. Shielding
   e. Effective half-life using biological and physical half-life
4. Instrumentation
   a. Energy resolution using full-width half-maximum
   b. Dose calibration
      i. Accuracy and constancy
         1. Acceptable ranges
         2. Percent of error
      ii. Geometry and linearity
         1. Geometry and percent error for syringes
         2. Geometry and percent error for volume
         3. Linearity of response percent error
         4. Calculation and use of correction factors
   c. Well counter and uptake probes
      i. Chi-square
      ii. Efficiency
   d. Gamma camera
      i. Upper and lower discriminators
      ii. Window percent calculations and the centerline
      iii. Sensitivity
      iv. Matrix size
         1. Pixel total per matrix size
         2. Pixel calibration
         3. Computer memory based on matrix and storage
      v. Flood and phantom fill
      vi. Acquisition times and counts per image
5. Radiopharmacy
   a. Radioactive decay
      i. Using half-life
      ii. Using decay charts
      iii. Using the decay table
      iv. Pre-calibration
   b. Specific concentration
   c. Generator quality control
      i. Generator yield based of efficiency
      ii. 99Mo/99mTc generator yield based on decay
      iii. Molybdenum breakthrough
      iv. Alumina testing
      v. Eluate and kit expiration
   d. Kit preparation
   e. Dose volume concentrations

    f. Dose calculation
        i. Dose adjustments
    g. Pediatric dose
        i. Clark's method
        ii. Talbot's
        iii. Body-surface method
        iv. Maximum and minimum
    h. Chromatography
    i. Particle calculations
    j. Capsule calculations
    k. Centrifugal force calculations
6. Clinical Procedures
    a. Calculation of concentration in a solution
    b. Ejection fraction calculations
        i. Left ventricle
        ii. gallbladder
    c. Time activity graphing
    d. Gastric emptying
    e. Gastric reflux
    f. Calculation of bladder capacity, volume, and reflux
    g. Lung quantitation
    h. Calculation of standardized uptake volume
7. Nuclear Medicine Computer Systems
    a. Gamma camera/computer interface
        i. Analog-to-digital converters
        ii. Buffer
        iii. Zoom
            1. Magnification versus resolution
            2. Interpolation
        iv. Acquisition modes
            1. Frame
            2. List
            3. Multiple gated
            4. Tomographic
            5. Whole body
        v. Matrix types and sizes
            1. Byte versus word
            2. Number and size of pixel
            3. Voxel
        vi. Memory requirements
        vii. Video display systems
        viii. Planar filter options
            1. Temporal
            2. Spatial/smoothing
    b. Single-photon emission computed tomography (SPECT)
        i. Orientation
        ii. Back projection
        iii. Fourier reconstruction
        iv. Iterative reconstruction
        v. Slice-thickness selection
        vi. Reorientation
        vii. SPECT filters
            1. Filter design
            2. Selection criteria
            3. Types
            4. Cutoff
            5. Frequency
            6. Nyquist frequency
            7. Multicamera head reconstruction techniques

c. Data processing programs
    i. Field uniformity correction
    ii. Background and foreground correction
    iii. Attenuation correction
    iv. Motion correction
    v. Contrast enhancement
    vi. Scaling and normalization
    vii. Image arithmetic
    viii. Display manipulations
    ix. Dead time corrections
    x. Center of rotation error corrections
    xi. Regions of interest
        1. Effects of poorly drawn regions of interest
    xii. Curve generation and image manipulation
        1. Image profiles
        2. Time-activity curves
        3. Harmonic analysis
        4. Color scales
        5. Image registration and co-registration
        6. Three-dimensional reconstruction
        7. Polar map generation
        8. Standard uptake values

8. Use of computers in quality control programs
    a. Linearity
    b. Sensitivity
    c. Gain
    d. Analog versus digital conversion
    e. Resolution
    f. Spatial distortion
    g. Integration with imaging systems
    h. Validation of software
    i. Center of rotation
    j. Test patterns
    k. Pixel sizing (x, y gain setting)
9. Radiopharmacy/hot lab computers
    a. Radiopharmacy management systems
    b. Hot lab and patient management
    c. Health physics
    d. Pharmacy management
10. Processing of Nuclear Medicine Exams
    a. Skeletal Exams
    b. Endocrine
    c. Gastric
    d. Respiratory
    e. Lymphatic/abscess/infection
    f. Neurological
    g. Cardiac
    h. Genitourinary
    i. Tumor
    j. SPECT
    k. Positron Emission Tomography
    l. Fusion imaging
11. Picture Archiving and Communication System (PACS)
    a. Acquisition device
    b. Types of system interfaces
    c. Digital Imaging and Communication in Medicine (DICOM)
    d. Networking and servers

        i. Centralized servers
        ii. Distribution servers
        iii. Hybrids
        iv. Virtual private network
    e. Imaging display
    f. Printers
        i. Formatter, multi-imager
        ii. Laser printer
        iii. Dry film
        iv. Video systems
    g. Teleradiology
    h. Archiving
    i. Internet safety within a hospital regarding PACS
    j. Integration with other systems
        i. Radiology information systems (RIS)
        ii. Hospital information systems

Resources

Christian, Paul and Kristen Watersham-Rich. *Nuclear Medicine and PET/CT Technology and Techniques*. 8th ed. St. Louis, MO.; Elsevier, 2016.

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Mettler, F. & Guiberteau, M. *Essentials of Nuclear Medicine Imaging*. 7th ed. Elsevier, 2018.

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