## Course Competency: Quality Assurance (QA)

**Competency 1:** The student will be able to demonstrate Quality Assurance (QA) by:

1. Defining and using the terminology associated with quality assurance/control in the proper text
2. Presenting a clear explanation of the sources of quality assurance/control regulations and procedures using appropriate terminology
3. Preparing a report about the effect of quality control on the quality of patient care in general and its application to nuclear medicine
4. Identifying the regulatory agencies that affect the practice of nuclear medicine, including specific regulations of the various agencies, the scope of their power, and enforcement considerations related to compliance versus noncompliance
5. Identifying methods and problems associated with standardization of quality assurance at the institutional level
6. Outlining a standardized record keeping system and discussing the rationale for each type of record, including patient records, employee records, radiopharmaceutical and instrumentation records
7. Explaining which parameters of a quality control program are recorded daily, weekly, monthly and at other periodic intervals and giving a rationale for the time factors
8. Discussing the function of the various types of calibrated sealed sources

## Learning Outcomes

- Communication
- Numbers / Data
- Critical thinking
- Information Literacy
- Social Responsibility

**Course Description:**

The student will learn to perform quality assurance and quality control testing of imaging systems; calibrate and operate scintillation counters; calibrate and operate gas-filled detectors; and perform quality assurance testing of routine imaging and assay procedures. (2-hour lecture)
**Competency 2:** The student will demonstrate the biological effects of nuclear medicine by:

1. Discussing the irradiation of the hematopoietic system  
2. Listing the components of the blood in the order of their radio-sensitivity  
3. Discussing the effects of whole body irradiation on the gastrointestinal system  
4. Identifying the most sensitive portion of the gastrointestinal system  
5. Discussing the effects of irradiation on the following body systems or tissue:  
   a. embryo in utero  
   b. muscular system  
   c. nervous system  
   d. reproductive system  
   e. respiratory system  
   f. skeletal system  
   g. urinary system  
   h. vascular system  
6. Listing and discussing chronic somatic effects of radiation exposure  
7. Comparing the normal aging process with radiological aging

**Competency 3:** The student will demonstrate Positron Emission Tomography (PET) radiation safety concerns by:

- Environmental Responsibility

1. Examining the concepts of personal protection/monitoring:  
   a. As low as (is) reasonably achievable (ALARA)  
   b. Personal protection:  
      i. Control room  
      ii. Distance  
      iii. Dose calibrator  
      iv. Patient dose  
      v. Patient holding room  
      vi. Scanning room  
      vii. Shielding  
      viii. Time  
      ix. Waiting room  
      x. Waste

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2. Examining the concepts of area/facilities monitoring:
   a. Survey equipment
   b. Radiation surveys
   c. Regulatory requirements
3. Examining the concepts of packaging and storage of radioactive materials, inspection of incoming/outgoing materials and the storage of radiopharmaceuticals.
4. Analyzing the significance of keeping records including those involving shipping, receipt, administration, storage, the disposal of radioactive materials and radiation surveys.
5. Indicating the implications of radioactive decontamination to the area as well as to personnel.
6. Summarizing the significance and concerns regarding the disposal of radioactive waste, its release to environment, the concept of decay to storage, incineration and the transfer to authorized recipients.

**Competency 4:** The student will be able to demonstrate PET radiopharmacy by:

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1. Describing specific radiopharmaceutical characteristics:
   a. Dose considerations
   b. Method of localization
   c. Radiopharmaceutical biodistribution
   d. Radiopharmaceutical kinetics
   e. Target organs
2. Listing the physical properties of radioactive materials:
   a. Decay rate and half-life
   b. Energies
   c. Radiopharmaceutical quality control
   d. Types of emissions
3. Correlating the intricacies of dosage determination:
   a. Calculation of pediatric dose
   b. Calculation of radiopharmaceutical/pharmaceutical dose
   c. Dose determination according to scan mode and equipment type
   d. Units - calculations and conversion
   e. Volume determination

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4. Correlating the procedure of proper dose preparation and administration including:
   a. Administration technique
   b. Assay in dose calibrator
   c. Preparation for administration
   d. Radiopharmaceutical labeling
   e. Residual dose measurement
   f. Verify correct radiopharmaceutical for exam
5. Discussing the positron radiopharmaceutical principles including:
   a. Annihilation reaction
   b. Bremsstrahlung radiation
   c. Decay factors
   d. Exposure rates
   e. Half value layer
   f. Positron decay
   g. Positron energy
6. Describing the process of radionuclide production including:
   a. Cyclotron
   b. Elution
   c. Generators
   d. Principles of operation
   e. Principles of operation
   f. Quality control
   g. Targetry
7. Discussing the synthesis of radiopharmaceuticals with regard to basic chemistry and synthesis modules.
8. Relating the various aspects of quality control of radiopharmaceuticals and radiochemicals:
   a. Apyrogenicity
   b. Identity
   c. pH
   d. Purity
   e. Stability
   f. Sterility

**Competency 5:** The student will be able to demonstrate PET instrumentation and Quality Control (QC) by:
1. Examining the principles of Scintillation Detector Systems.
2. Detector materials:
   a. BGO
   b. GSO
   c. LSO
3. NaI System types:
   a. Dedicated PET (Full ring, Partial ring, & Detector panels)
   b. Integrated PET/CT Quality control
   c. Blank scan.
   d. Calibration factors for quantification
   e. Gains (Singles)
   f. Normalization
   g. Scanner failure/recognition of instrumentation artifacts
   h. Coincidence timing malfunction
   i. Detector failure
   j. Energy drift
   k. Gain drift.
   Temperature drift (cooling system failure). Transmission source malfunction
4. System performance. NEMA standards and testing.
   Noise equivalent count rate (NEC). Randoms fraction. Scatter fraction
5. Examining and explaining the Theory of Operation:
   Principles of Coincidence Detection:
   a. Delayed event
   b. Lines of response (LORs)
   c. Randoms
   d. Image filters/cutoff frequencies
3. Examining and collecting Data Analysis Quantitative analysis. Region of


7. Imaging Artifacts

**Competency 6:** The student will demonstrate PET cardiology by:

1. Discussing Cardiology concepts:
   a. History and assessment
   b. Indications and contraindications
   c. Patient preparation/instructions
   d. pre-arrival
   e. pre-injection
   f. post-injection
   g. post-procedure- discharge instructions
   h. ECGs.
   i. Patient preparation, electrode placement
   j. Rate calculation
   k. Normal and abnormal rhythms
   l. Exercise

2. Identifying anatomy and physiology
3. Listing indications
4. Listing contrast media and recommended volumes
5. Discussing patient preparation
6. Executing proper procedures and protocol

**Course Competency 7:** The student will be able to demonstrate PET neurology by:
1. Discussing the principles and concepts:
   a. History of PET neurology and assessment techniques
   b. Indications and contraindications
   c. Patient preparation/instructions
   d. pre-arrival.
   e. pre-injection, post-injection, post-procedure-discharge instructions
   Seizure activity patterns
   g. Patient positioning
   h. Imaging techniques
   i. Anatomy/physiology/clinical indications
   j. Epileptic seizures
   k. Dementia
   l. Tumor
   m. Movement disorders
2. Identifying anatomy and physiology.
3. Listing indications.
4. Listing contrast media and recommended volumes.

Course Competency 8: The student will be able to demonstrate PET oncology by:

1. Discussing the principles and concepts:
   a. History and assessment
   b. Indications and contraindications
   c. Patient preparation/instructions
   d. pre-arrival
   e. pre-injection
   f. post-injection
   g. post-procedure - discharge instructions
   h. Uptake time Patient positioning
   i. Arms up/down
   j. Head first/feet first
   k. Imaging techniques
   l. Anatomy/physiology/clinical indications
   m. Colorectal cancer
   n. Head/Neck cancer
   o. Esophageal cancer

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2. Identifying anatomy and physiology.
3. Listing potential indications.
4. Listing contrast media and recommended volumes.

**Course Competency 9**: The student will be able to demonstrate PET/Computed Tomography (CT) scans:

1. Examining Scintillation detector systems: -Principles of scintillation detection-Properties of detector materials:
   a. Material types
   b. Atomic number
   c. Delay timed. Conversion efficiency-PET detector materials
   d. Sodium iodide (NaI). Bismuth germinate (BGO) Lutetium oxyorthosilicatate (LSO). Gadolinium oxyorthosilicatate (GSO)
2. Examining System types:-Terminology:
   a. Aperture size-Field of view-Overlap-Bed positions.
3. Identifying anatomy and physiology
4. Listing indications.
5. Listing contrast media and recommended volumes.
7. Examining Quality Control procedures:- Normalization-Blank scan-Gains (singles)-Cross-calibration:
   a. System performance
   b. Scatter fraction
   c. Noise equivalent count rated. National Electrical Manufacturers Association (NEMA) standards and testing
8. Examining CT System Principles, Operations and Components:
   a. Tube
   b. kVp

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c. mA
d. warm-up procedures
e. Generator and Transformers
f. Detector (single and multi-row) and DAS
g. Collimation
h. Computer and Array Processor
i. Equipment Maintenance

Course Competency 10: The student will be able to demonstrate PET/Magnetic Resonance Imaging (MRI) scans by:

1. Examining Scintillation detector systems: -Principles of scintillation detection-Properties of detector materials:
   a. Material types
   b. Atomic number
c. Delay timed. Conversion efficiency-PET detector materials
d. Sodium iodide (NaI)
e. Bismuth germinate (BGO)
f. Lutetium oxyorthosilicate (LSO)
g. Gadolinium oxyorthosilicate (GSO)
2. Discussing and examining System types
3. Examining MRI Instrumentation-Magnet:
   a. Types of magnets - permanent, resistive and super conductive
   b. Magnetic and RF fields
c. Gradients
d. Cross section of a magnet
e. Transmit and receive coils
f. Receive only
g. Transmit/receive
h. Linear
   i. Quadrature. Phased array. Multichannel. Shielding and shimming - both active and passive
4. Examining the following terms:
   a. Hertz (HZ), megahertz (MHZ)
b. Tesla (T), gauss (g)
c. Electromagnetic spectrum
5. Analyzing computer and digital imaging
6. Examining MRI imaging-Obtaining the MR Signal:
a. Properties of hydrogen and molecular structure  
b. Precession  
c. Net magnetization  
d. Angular momentum  
e. Magnetic domain  
f. Vector  
g. Resonance  
h. Larmour equation  
i. Faraday's laws  
j. RF pulses  
k. Spatial localization  
l. Paramagnetic  
m. Diamagnetic  
n. Super magnetic  
o. K-space  
p. Fourier transform, half and partial Fourier  
q. 2-D/3-D imaging  
r. Magnetization transfer  
s. Filming  
t. Windows and levels. Region of interest (ROI).  
Annotations  
u. Remote workstations (imaging manipulation)  
v. Archiving and data storage  
7. Examining tissue contrast  
8. Discussing extrinsic factors  

**Course Competency 11:** The student will be able to demonstrate CT applications by:  

1. Examining and discussing image processing and display: Image Reconstruction  
   a. filtered back projection reconstruction  
   b. reconstruction filters (algorithms)  
   c. raw data vs. image data  
   d. prospective/retrospective reconstruction (single and multi-row)  
   e. effective slice thickness  
   f. reconstruction interval-Image Display.  
   g. pixel, voxel, matrix, image magnification  
   h. field of view (scan, reconstruction and display)  
   i. attenuation coefficient  
   j. CT number  

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<td>plane specification (x, y, z coordinates)</td>
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<td>2.</td>
<td>Examining and discussing image quality:</td>
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<td>a. Spatial Resolution</td>
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<td>b. Contrast Resolution</td>
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<td>c. Noised. Quality Assurance Procedures</td>
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<td><strong>Course Competency 12</strong>:</td>
<td>The student will be able to demonstrate image processing by:</td>
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<td>1.</td>
<td>Examining and discussing the principles and the performance of acquisition techniques.</td>
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<td>2.</td>
<td>Examining and discussing the principles and the performance of reconstruction techniques such as filtered back projection and iterative.</td>
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<td>3.</td>
<td>Defining frequency.</td>
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<td>Describing the reason for use of filters.</td>
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<td>6.</td>
<td>Describing hybrid co-registration of images.</td>
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