SOCIETY OF NUCLEAR MEDICINE AND MOLECULAR IMAGING

TECHNOLOGIST SECTION

Nuclear Medicine Technologist Performance Standards

Prepared by: Society of Nuclear Medicine and Molecular Imaging Technologist Section

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Overview of Document

The spectrum of the nuclear medicine technologist's responsibilities varies widely across the country and may exceed basic skills outlined in the technologist's initial education and certification. Practice components presented in this document provide a basis for establishing the areas of knowledge and performance for the nuclear medicine technologist. It is assumed that for all activities included in this scope of practice, the nuclear medicine technologist has received the proper education and is in compliance with all federal, state and institutional guidelines including proper documentation of initial and continued competency in those practices and activities. Continuing education is a necessary component in maintaining the skills required to perform all duties and tasks of the nuclear medicine technologist in this ever-evolving field.

Limitation of Scope and Disclaimer

This document is intended to set forth the standards in important areas of the nuclear medicine technologist's responsibilities. It may not cover all areas which may present themselves in actual practice. These standards do not supersede the judgment of the individual nuclear medicine technologist and other healthcare professionals serving the patient in light of all of the facts of the individual case. THE SOCIETY OF NUCLEAR MEDICINE AND MOLECULAR IMAGING THE SOCIETY OF NUCLEAR AND MOLECULAR IMAGING TECHNOLOGIST SECTION DISCLAIM ALL LIABILITY ARISING FROM USE OF THESE DOCUMENTS.

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Overview:
Nuclear medicine which includes molecular imaging, is the medical specialty that utilizes sealed and unsealed radioactive materials in the diagnosis and therapy of various diseases. This practice also includes the utilization of pharmaceuticals (used as adjunctive medications) and other imaging modalities with or without contrast to enhance the evaluation of physiologic processes at a molecular level.

Nuclear Medicine Technologist Definition:
The nuclear medicine technologist is an allied health professional, certified in nuclear medicine technology, who under the direction of an authorized user, is committed to applying the art and skill of their profession to optimize diagnostic evaluation and therapy through the safe and effective use of radiopharmaceuticals and adjunctive medications. Nuclear medicine which includes molecular imaging is the medical specialty that utilizes sealed and unsealed radioactive materials in the diagnosis and therapy of various diseases. This practice also includes the utilization of pharmaceuticals (used as adjunctive medications) and other imaging modalities with or without contrast to enhance the evaluation of physiologic processes at a molecular level.

In order to perform these tasks, the nuclear medicine technologist must successfully complete didactic and clinical education. Education includes, but is not limited to, methods of patient care, immunology, cross sectional anatomy, pharmacology, nuclear medicine and radiation physics, radiation biology, radiation safety and protection, nuclear medicine instrumentation, quality control and quality assurance, computer applications for nuclear medicine, general diagnostic nuclear medicine procedures, radionuclide therapy, positron emission tomography (PET), computed tomography (CT), radionuclide chemistry, radiopharmacy, medical ethics and law, healthcare administration, health sciences and research methods, and medical informatics. Introductory education in magnetic resonance (MR) is recommended.

When caring for a patient, the technologist will review the patient's medical history to understand the patient's illness and pending diagnostic procedure or therapy, instruct the patient before, during and following the procedure, evaluate the satisfactory preparation of the patient before beginning a procedure, and recognize emergency patient conditions and initiate life-saving first aid when appropriate.

Administrative functions may include supervising other nuclear medicine technologists, students, and other personnel; participating in procuring supplies and equipment; documenting laboratory operations; participating in departmental inspections conducted by various licensing, regulatory, and accrediting agencies; and participating in scheduling patient examinations.

Education:
Nuclear Medicine Technologists may complete a one- or two-year certificate program, a two-year associate's degree, or a four-year bachelor's degree.

Based on the amount and complexity of knowledge and skills that must be acquired before the graduate enters the workplace, a baccalaureate degree is the appropriate level of education. If the new graduate is expected to acquire a very diverse skill set as well as develop the critical thinking skills that come with exposure to a wide variety of subjects, it is virtually impossible to impart that education in 1 or 2 years. For these reasons, the SNMMI-TS recommends enhancements to existing educational curriculum to adequately prepare the technologist of 2015 with the necessary skills and knowledge. Furthermore, entry-level education of NMTs should be raised to the baccalaureate level to more appropriately reflect the educational accomplishments of the graduating student.

Graduates of accredited programs are eligible to sit for certification examinations offered by the *Nuclear Medicine Technology Certification Board* and the *American Registry of Radiologic Technologists*.

Generally, certificate programs are offered in hospitals, associate degree programs in community colleges, and bachelor's degree programs in 4-year colleges and universities. Courses cover the physical sciences, biological effects of radiation exposure, radiation protection and procedures, the use of radiopharmaceuticals, imaging techniques, and computer applications.

One-year certificate programs are typically for health professionals who already possess an associate or bachelor's degree—but who wish to specialize in nuclear medicine. The programs also attract radiologic technologists, medical technologists, registered nurses, and others who wish to change fields or specialize.

The Society of Nuclear Medicine and Molecular Imaging Technologist Section (SNMMI-TS) recommends that by the year 2015, education leading to the baccalaureate degree become the standard for entry level nuclear medicine technologists. This recommendation is based on the knowledge and skills considered as essential for technologists who enter the profession by the end of the next decade. It is recognized that although the implementation of new entry-level requirements will help new technologists meet the needs of a continuously evolving field, some programs will need assistance in transitioning their programs to meet the new requirements. This recommendation should in no way be construed to mean that non-baccalaureate prepared technologists, should no longer practice in the field after the implementation date of this proposal.

The Joint Review Committee on Education Programs in Nuclear Medicine Technology accredits associate and bachelor's degree training programs in nuclear medicine technology.

Licensure:

Requirements for licensure of nuclear medicine technologists vary from State to State, so it is important that technologists check the requirements of the State in which they plan to work.

Certification and other Qualifications:

Certification is available from the American Registry of Radiologic Technologists (ARRT) and from the Nuclear Medicine Technology Certification Board (NMTCB). Some technologists receive certification from both agencies. ARRT and NMTCB have different eligibility requirements, but both require that workers pass a comprehensive exam with an overall score of 75 or better to become certified.

In addition to the general certification requirements, certified technologists also must complete a certain number of continuing education hours to retain certification. Continuing education is required primarily because of the frequent technological and innovative changes in the field of nuclear medicine.

Code of Ethics:

Nuclear Medicine Technologists, as members of the health care profession, must strive as individuals and as a group to maintain the highest of ethical standards.

The Principles (SNMMI-TS Code of Ethics) listed below are not laws, but standards of conduct to be used as ethical guidelines by nuclear medical technologists.

Principle 1

The Nuclear Medicine Technologist will provide services with compassion and respect for the dignity of the individual and with the intent to provide the highest quality of patient care.

Principle 2

The Nuclear Medicine Technologist will provide care without discrimination regarding the nature of the illness or disease, gender, race, religion, sexual preference or socioeconomic status of the patient.

Principle 3

The Nuclear Medicine Technologist will maintain strict patient confidentiality in accordance with state and federal regulations.

Principle 4

The Nuclear Medicine Technologist will comply with the laws, regulations, and policies governing the practice of nuclear medicine.

Principle 5

The Nuclear Medicine Technologist will continually strive to improve their knowledge and technical skills.

Principle 6

The Nuclear Medicine Technologist will not engage in fraud, deception, or criminal activities.

Principle 7

The Nuclear Medicine Technologist will be an advocate for their profession.

Definitions

ALARA– **A**c**r**onym for **A**s **L**ow **A**s **R**easonably **A**chievable. This is a radiation safety principle for minimizing radiation doses and releases of radioactive materials by employing all reasonable methods.

Authorized User – – The NRC definition under 10 CFR Part 35.2 of an *Authorized User* can be found here: http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/part035-0002.html

Computed Tomography - A medical imaging technology that uses a computer to acquire a volume of x-ray based images, generally reconstructed as two-dimensional (2D) or three-dimensional (3D) pictures of inside the body. These images can be rotated and viewed from any angle. Each CT image is effectively a single 'slice' of anatomy.

Diagnostic Imaging - Diagnostic imaging uses technologies such as x-ray, CT, MRI, ultrasound, PET and SPECT to provide physicians with a way to look inside the body without surgery. Diagnostic imaging is considered a non-invasive diagnostic technique, as opposed to a biopsy or exploratory surgery. PET, SPECT and some types of MR imaging also provide information about how certain tissues and organs are functioning.

Hybrid Imaging - The combination of the two imaging technologies that allows information from two different studies to be viewed in a single set of images.

Imaging Device - A technological apparatus used to produce detailed images of the inside of the body for diagnostic or therapeutic purposes. In molecular imaging, examples of these devices include the gamma camera, CT scanner, PET scanner, MRI unit, optical imaging detector, and ultrasound machine.

Isotope - Atoms of a single element that have differing masses. Isotopes are either stable or unstable (radioisotope). Radioisotopes are radioactive: they emit particulate (alpha, beta) or electromagnetic (gamma) radiation as they transform or decay into stable isotopes.

Magnetic Resonance Imaging – Magnetic resonance imaging is a diagnostic scan that uses high-strength magnetic fields rather than radiation. MRI techniques are used primarily to study anatomy, but a special type of MR scan, functional MRI (fMRI) can be used to map blood flow for functional studies.

Molecular Imaging – Molecular imaging is an array of non-invasive, diagnostic imaging technologies that can create images of both physical and functional aspects of the living body. It can provide information that would otherwise require surgery or other invasive procedures to obtain. Molecular imaging differs from microscopy, which can also produce images at the molecular level, in that microscopy is used on samples of tissue that have been removed from the body, not on tissues still within a living organism. It differs from X-rays and other radiological techniques in that molecular imaging primarily provides information about biological processes (function) while CT, X-rays, MRI and ultrasound, image physical structure (anatomy).

Molecular imaging technologies include traditional nuclear medicine, optical imaging, magnetic resonance spectroscopy, PET and SPECT.

Nuclear Medicine - The use of very small amounts of radioactive materials (called radiopharmaceuticals or radiotracers) to evaluate molecular, metabolic, physiologic and pathologic conditions of the body for the purposes of diagnosis, therapy and research. Nuclear medicine procedures can often identify abnormalities very early in the progression of a disease — long before many medical problems are apparent with other diagnostic tests.

Positron Emission Tomography – Positron emission tomography (PET) is a medical imaging technology that uses radiopharmaceuticals that emit positrons (positively charged electrons). A radiopharmaceutical such as FDG is injected into the patient. The fluorine emits positrons which react with the first electron they come in contact with, annihilating both and producing energy according to Einstein's famous $E=mc^2$ formula. This energy takes the form of two photons (particles of light) with a very specific energy level that shoot off in opposite directions. When these photon pairs are detected by the PET scanner, the location of the original fluorine atom can be extrapolated. Although positron/electron annihilation is one of the most powerful reactions known to science, the amount of mass involved is so small that the actual energy produced is not harmful to the patient, and the fluorine decays rapidly into harmless oxygen.

THE SCOPE OF PRACTICE

The scope of practice in nuclear medicine technology includes, *but is not limited to*, the following areas and responsibilities:

Patient Care: Requires the exercise of judgment to assess and respond to the patient's needs before, during and after diagnostic imaging and therapeutic procedures and in patient medication reconciliation. This includes record keeping in accordance with the Health Insurance Portability and Accountability Act (HIPAA).

Quality Control: Requires the evaluation and maintenance of a quality control program for all instrumentation to ensure optimal performance and stability.

Diagnostic Procedures: Requires the utilization of appropriate techniques, radiopharmaceuticals and adjunctive medications as part of a standard protocol to ensure quality diagnostic images and/or laboratory results.

Radiopharmaceuticals: Involves the safe handling and storage of radioactive materials during the procurement, identification, calibration, preparation, quality control, dose calculation, dispensing documentation, administration and disposal.

Adjunctive Medications: Involves the identification, preparation, calculation, documentation, administration and monitoring of adjunctive medication(s) used during an in-vitro, diagnostic imaging, or therapeutic procedure. Adjunctive medications are defined as those medications used to evoke a specific physiological or biochemical response. Also included are the preparation and administration of oral and IV contrast used in the performance of imaging studies.

In Vitro Diagnostic Testing: Involves the acquisition of biological specimens with or without oral, intramuscular, intravenous, inhaled or other administration of radiopharmaceuticals and adjunctive medications for the assessment of physiologic function.

Operation of Instrumentation: Involves the operation of imaging instrumentation:

Gamma camera systems with or without sealed sources of radioactive materials or x-ray tubes for attenuation correction, transmission imaging, diagnostic CT, (when appropriately educated, trained and/or credentialed).

PET imaging systems with or without sealed sources of radioactive materials or x-ray tubes for attenuation correction, transmission imaging, diagnostic CT or MR imaging (when appropriately trained and/or credentialed)

Bone density imaging systems with x-ray tubes

Non-imaging instrumentation:

- Dose calibrators
- Survey instrumentation for exposure and contamination
- Probe and well instrumentation
- Ancillary patient care equipment as authorized by institutional policies.

Radionuclide Therapy: Involves patient management, preparation and administration of therapeutic radiopharmaceuticals, under the personal supervision of the Authorized User

Radiation Safety: Involves practicing techniques that will minimize radiation exposure to the patient, health care personnel and general public, through consistent use of protective devices, shields, and monitors-consistent with ALARA (as low as reasonably achievable) and establishing protocols for managing spills and unplanned releases of radiation.

THE CLINICAL PERFORMANCE STANDARDS

The Clinical Performance Standards for the Nuclear Medicine Technologist were initially developed by the Socio Economic Affairs Committee and approved in 1994 and have been periodically revised as the profession and educational requirements evolved. Over this past year, the SNMMI-TS Scope of Practice Task Force has worked to revise the SNMMI-TS Scope of Practice to serve more as an overview of responsibilities, allowing the Clinical Performance Standards (previously the Performance and Responsibility Guidelines) to serve as the task list for nuclear medicine technologists.

The scope of performance in nuclear medicine technology includes, but is not limited to, the following areas and responsibilities:

Patient Care:
Requires the exercise of judgment to assess and respond to the patient's needs before, during, and after diagnostic imaging and therapeutic procedures and inpatient medication reconciliation. This includes record keeping in accordance with the Health Insurance Portability and Accountability Act (HIPAA).

In Vitro Diagnostic Testing:
Involves the acquisition of biological specimens with or without oral, intramuscular, intravenous, inhaled, or other administration of radiopharmaceuticals and adjunctive medications for the assessment of physiologic function.

Instrumentation:
Involves the operation of imaging instrumentation:

A. Gamma camera systems with or without sealed sources of radioactive materials, x-ray tubes, or MRI systems for attenuation correction, transmission imaging, or diagnostic CT or MRI (when appropriately educated, trained, and/or credentialed).
B. PET imaging systems with or without sealed sources of radioactive materials, x-ray tubes, or MRI systems for attenuation correction, transmission imaging, or diagnostic CT or MRI (when appropriately trained and/or credentialed).
C. Bone density imaging systems with x-ray tubes (involves the operation of nonimaging instrumentation).
D. Dose calibrators.
E. Survey instrumentation for exposure and contamination.
F. Probe and well instrumentation.
G. Ancillary patient care equipment as authorized by institutional policies.

Quality Control:
Requires the evaluation and maintenance of a quality control program for all instrumentation to ensure optimal performance and stability.

Diagnostic Procedures:
Requires the utilization of appropriate techniques, radiopharmaceuticals, and adjunctive medications as part of standard protocols to ensure quality diagnostic images and/or laboratory results.

Adjunctive Medications:
Involves the identification, calculation, documentation, administration, and monitoring of adjunctive medication(s) used during an in vitro, diagnostic imaging, or therapeutic procedure. Adjunctive medications are defined as those medications used to evoke a specific physiological or biochemical response. Also included are the preparation and administration of oral and IV contrast used in the performance of imaging studies.

Radiopharmaceuticals:
Involve the safe handling and storage of radioactive materials, including procurement, identification, calibration, preparation, quality control, dose calculation, dispensing of documentation, administration, and disposal.

Radionuclide Therapy:
Involves patient management, preparation, and administration of therapeutic radiopharmaceuticals, under the personal supervision of the authorized user.

Radiation Safety:
Involves practicing techniques that will minimize radiation exposure to the patient, health care personnel, and general public, through consistently using protective devices, shields, dose reduction, and monitors consistent with ALARA (as low as reasonably achievable) principles and establishing protocols for managing spills and unplanned releases of radiation.

I. Patient Care

A. A nuclear medicine technologist provides patient care by:

1. Providing for proper comfort and care to the patient prior to, during, and after a procedure, including but not limited to the monitoring of intravenous lines (i.e., central lines, peripherally inserted central catheters [PICC]), oxygen supplies, and drains, and operation of blood pressure cuffs, electrocardiogram (ECG) machines, pulse oximeters, glucometer intravenous pumps, and oxygen delivery regulators as authorized by institutional policies.
2. Inserting and monitoring peripheral intravenous catheters.
3. Monitoring patients who are under minimal sedation (in those facilities that approve such practice, with subsequent documentation of competency of all monitoring staff in accordance with the American Society of Anesthesiology [ASA] guidelines for conscious sedation).
4. Establishing and maintaining proper communication with patients (i.e., proper introduction, appropriate explanation of procedure, etc.).
5. Behaving in a professional manner in consideration and observation of patients' rights, resulting in the provision of the highest-quality patient care possible.

6. Providing a safe and sanitary working environment for patients and the general public, using proper infection control practices in compliance with accepted precaution policies.
7. Recognizing and responding to an emergency situation at a level commensurate with one's training and competency, including cardiopulmonary resuscitation (CPR); the use of automatic external defibrillators (AED), if applicable; advanced cardiac life support (ACLS); and advanced pediatric life support (PALS).

B. A nuclear medicine technologist prepares the patient by:
1. Reviewing the indication for the study for appropriateness and consulting with the authorized user and/or referring physician whenever necessary to ensure that the proper study is performed.
2. Verifying patient identification, date of last menstrual period, pregnancy/breastfeeding status (and alerting the authorized user if there are concerns about possible pregnancy), and written orders for the procedure.
3. Obtaining a pertinent medical history, including medications and allergies, and confirming the patient's candidacy for the procedure.
4. Ensuring that any preprocedural preparation has been completed (e.g., fasting, hydration, thyroid blocking, voiding, bowel cleansing, and suspension of interfering medications).
5. Ensuring that informed consent has been obtained, as prescribed by the institution, whenever necessary.
6. Properly explaining the procedure to the patient and/or family and, where appropriate, to the parent and/or legal guardian, and when necessary, obtaining the assistance of an interpreter or translator. This includes, but is not limited to, patient involvement, length of study, radiation safety issues, and postprocedure instructions.
7. Collecting and performing pertinent laboratory procedures.
8. Performing in vitro diagnostic testing laboratory analyses, including urine pregnancy testing and fasting blood sugar. Additionally, performing in vitro diagnostic testing laboratory procedures involving, but not limited to, secretions, saliva, breath, blood, and stool, to measure biodistribution of radiopharmaceuticals.

C. A nuclear medicine technologist performs administrative procedures by:
1. Maintaining an adequate volume of medical/surgical supplies, radiopharmaceuticals, storage media, and other items required to perform procedures in a timely manner.
2. Scheduling patient procedures appropriate to the indication and in the proper sequence.
3. Maintaining appropriate records of administered radioactivity, quality control procedures, patient reports, and other required records.
4. Developing and revising, when necessary, policies and procedures in accordance with applicable regulations.

5. Actively participating in total quality management/continuous quality improvement programs (i.e., age-specific competencies, patient education, and patient restraint and immobilization).

II. Instrumentation/Quality Control

A nuclear medicine technologist evaluates the performance, initiates corrective action when necessary, and maintains required records for the quality control program of the:

A. Gamma camera.

1. Obtaining uniformity images on imaging detectors.
    a. Selecting a radionuclide source of appropriate type, size, quantity, and energy.
    b. Selecting an appropriate pulse height analyzer (PHA), photopeak, and window.
    c. Obtaining uniformity images using standardized imaging parameters.
    d. Evaluating the images qualitatively and/or quantitatively in comparison to the manufacturer's specifications and the performance requirements based on the studies for which the unit is used.
    e. Identifying the source of any significant nonuniformity (e.g., checking collimator and PHA peak setting)
    f. Initiating corrective action when necessary based on the physicist recommendations.
2. Performing a detector linearity evaluation on imaging detectors.
    a. Selecting a radionuclide, selecting a linearity phantom, and obtaining images.
    b. Identifying any nonlinear distortion in the image.
    c. Determining the source of nonlinearity (e.g., detector–source geometry).
    d. Initiating corrective action when necessary based on the physicist recommendations.
3. Performing spatial resolution checks on imaging detectors.
    a. Selecting an appropriate radionuclide.
    b. Choosing a phantom that is compatible with the specified resolution of the camera.
    c. Analyzing the resulting images for degradation of resolution and determining the causes.
    d. Initiating corrective action when necessary based on the physicist recommendations.
4. Conducting sensitivity checks on imaging detectors yearly in conjunction with a physicist.
    a. Selecting a source with an appropriate level of activity and half-life.
    b. Ensuring identical geometry, source placement, and measurement parameters for repetitive checks.
    c. Evaluating results.

d. Initiating corrective action when necessary based on the physicist recommendations.

5. Performing single-photon emission computed tomography (SPECT) quality control procedures.
   a. Obtaining a high-count uniformity calibration flood.
   b. Obtaining a center-of-rotation calibration.
   c. Obtaining a multihead detector alignment calibration.
   d. Evaluating reconstruction results of an acquired cylindrical SPECT phantom with contrast and spatial resolution inserts:
      i. Uniformity and noise are evaluated qualitatively by inspection of reconstructed tomographic sections. Optimal density ranges should be comparable to those used for clinical images.
      ii. Contrast is number of "cold" spheres that can be discerned.
      iii. Spatial resolution is judged by identifying the smallest "cold" rod.

B. Positron emission tomography (PET) and computed tomography (CT) imaging systems (hybrid imaging).

1. Identifying system-specific quality control requirements by following recommended initial acceptance quality control procedures and daily, weekly, monthly, quarterly, and annual quality control procedures to evaluate allowable parameter ranges for photon detection/discrimination, spatial resolution, scatter correction, count loss, randoms measurement, sensitivity, dead-time loss, and randoms count correction accuracy.
2. Recognizing image artifacts requiring imaging system correction and performing corrections and quality assurance as directed by institutional and manufacturer recommendations.
3. Performing and evaluating sinogram acquisition or other routine quality control acquisition per the manufacturer's recommendation to evaluate detector integrity.
4. Acquiring a uniform phantom to evaluate SUV accuracy.
5. Performing PET/CT system quality control.
   a. Performing CT system quality assurance.
      i. Daily: Follow manufacturer's described warm-up procedure and automatic monitoring, at various tube voltage (kVp) or current (mAs) settings, of the tube output and detector response.
      ii. Monthly: Scan a phantom for the evaluation of tomographic uniformity, the accuracy of the CT number of water, image noise, and slice thickness.
   b. Acquiring consistent 2D and/or 3D images, depending on the scanner's capability, with appropriate reconstruction, and displaying them.
   c. Acquiring consistent CT images, depending on scanner capability, with appropriate reconstruction and displaying them.

d. Setting CT/AC protocols, including mAs, kVp, pitch, and helical scanning.
e. Verifying the accuracy of ECG and respiratory gating if available and used routinely.
f. Performing glucometer quality assurance using high and low standards.
g. Performing rubidium generator quality assurance, daily, before the use of the generator, to include dose calibrator/generator calibration and parent/daughter breakthrough.

C. Other imaging systems, storage media, and radiation detection and counting devices, including but not limited to imaging detectors, dose calibrators, survey instruments, scintillation probes, well counters, and data processing and image production devices.
1. Maintaining and operating auxiliary equipment used in nuclear medicine procedures.
   a. ECG machine.
   b. Infusion pumps.
   c. Blood pressure machine.
2. A nuclear medicine technologist actively participates in total quality management/continuous quality improvement programs by:
   a. Identifying indicators to be analyzed.
   b. Gathering and presenting data in appropriate formats and analyzing data and recommending changes.

D. NaI (TI) scintillation probes, well counters, and other laboratory equipment.
1. Calibrating a spectrometer with a long–half-life radionuclide source.
2. Determining energy resolution.
3. Conducting sensitivity measurements at appropriate energies with a standard, long-lived source such as Cs-137 or I-129.
4. Checking background and determining the cause for levels greater than established normal levels.
5. Conducting a chi-square test, a statistical measure of the counting system performance.
6. Maintaining required records for quality control programs.

E. Survey meters.
1. Ensuring that calibration has been completed within the last 12 months.
2. Performing a battery check to verify the meter is operational.
3. Performing a check-source test and comparing with previous results.
4. Maintaining required records for the quality control program.

F. Dose calibrator.
1. Verifying constancy every day that isotopes are administered to patients, including weekends and on-call hours, and checking channels of the isotopes used that day using a check source with a long half-life.

2. Verifying linearity quarterly over the entire range of radionuclide activity to be administered to patients, comparing calculated activities to measured activities, and determining correction factors when necessary. Tc-99m is commonly used.
3. Determining accuracy annually by comparing a set of known activities to measured activities using isotopes of varying energy emissions; Co-57, Ba-133, and Cs-137 are commonly used.
4. Upon installation, testing for significant geometric variation in activity measured as a function of sample volume or configuration and determining correction factors when necessary.
5. Maintaining required records for the quality control program.

G. Image Processors/Computer Monitors.

1. Verifying the calibration of the instrument.
2. Ensuring that materials required for image processing are at acceptable levels.
3. Maintaining required records for the quality control program.

III. Diagnostic Procedures

A. A nuclear medicine technologist performs imaging procedures by:

1. Determining appropriate imaging parameters.
    a. Preparing (see Section V.C.), evaluating, and properly administering the prescribed amount of various radiopharmaceuticals and/or pharmaceuticals and contrast.
    b. Selecting the appropriate imaging or data collection parameters.
2. Administering radiopharmaceuticals and/or pharmaceuticals through various routes after appropriate access has been obtained, including but not limited to oral, intravesical, inhalation, intravenous, intramuscular, subcutaneous, , and intradermal in accordance with established protocols.
3. Verifying patient identity prior to the administration of medication or radiopharmaceuticals.
    a. Determining route of administration according to established protocol (e.g., subcutaneous, intramuscular, or intravenous).
    b. Establishing and/or verifying venipuncture access using aseptic technique.
    c. Using and maintaining established venous access routes (e.g., heparin infusion or infusion pump).
    d. Establishing patient-patterned breathing when introducing radiopharmaceuticals (e.g., inhalants or aerosols).
    e. Reconciling patient medications, performing per policy to ensure that the patient's current medications will not interact with the radiopharmaceutical and/or adjunctive medication used for the ordered exam.
    f. Preparing (see Section V.C.) and administering adjunctive pharmacologic agents, including oral and IV contrast agents, per the appropriate route.

g. Documenting medications and/or radiopharmaceutical administrations in the patient medical record according to policy.
h. Observing the patient carefully after radiopharmaceutical administration for any side effects, and handling such side effects appropriately as described in established policies or as directed by medical staff.

4. Positioning the patient and obtaining images.
   a. Waiting an appropriate time following the administration of a radiopharmaceutical or pharmaceutical to begin the imaging procedure protocols, and acquiring additional views as necessary to optimize information content.
   b. Exercising professional judgment in positioning a patient or detector unit to best demonstrate pathology and to adapt to the patient's limitations.
   c. Positioning the patient using supportive materials and immobilizers, as necessary.
   d. Indicating appropriate anatomic landmarks for each view of the procedure.
   e. Reviewing images to ensure that the required information has been acquired and that the images have been processed properly and are of the highest quality.
5. Assisting in exercise and pharmacologic cardiac testing procedures.
   a. Preparing patients and placing ECG electrodes.
   b. Determining if the appropriate test has been ordered based on the ECG rhythm, medical history, and current medications.
   c. Recognizing and responding to ECG changes.
   d. Recognizing the parameters that indicate termination of a cardiac stress study.
   e. Recognizing ECG patterns that are appropriate for image gating.
6. Performing data collection, processing, and analysis.
   a. Performing data collection, processing, and analysis in accordance with established protocols.
   b. Exercising independent judgment in selecting appropriate images for processing.
   c. Selecting appropriate filters, frequency cutoff, attenuation, and motion correction when reconstructing SPECT images.
   d. Defining regions of interest (ROIs) with reproducible results and correctly applying background subtraction.
   e. Performing computer data manipulations as required by standard nuclear medicine procedures, e.g., activity curve generation, quantitation, and SPECT slice production.
   f. Labeling processed images (e.g., anatomical positioning, ROIs, date, and time).
   g. Archiving and retrieving data from storage media.

B. A nuclear medicine technologist performs nonimaging in vivo and/or radioassay studies by:

1. Operating laboratory equipment, including well counters, probes, and other detection devices to measure the biodistribution of radiopharmaceuticals.
    - a. Confirming accuracy, precision, and operation of pipetting devices.
    - b. Using microhematocrit centrifuges and determining hematocrit.
2. Preparing dosses
    - a. Quantitating doses.
        - i. Determining decay factor and calculating remaining activity.
        - ii. Calculating the volume necessary to deliver activity for the prescribed dose.
        - iii. Drawing doses into syringes using appropriate aseptic techniques and materials if the doses are intended for parenteral administration.
        - iv. Dispensing an appropriate quantity of liquid or capsules for oral administrations, as necessary, for the prescribed dose.
        - v. Confirming calculated activity by using a dose calibrator.
    - b. Preparing standard solutions.
        - i. Choosing appropriate volumetric or gravimetric techniques to dilute the standard.
        - ii. Adding radioactive material identical to that given the patient, in a quantity sufficient (qs) to meet the appropriate volume.
        - iii. Dissolving a capsule in an appropriate solvent, if necessary, for preparing a standard.
3. Collecting appropriate specimens for procedures using standard precaution techniques by:
    - a. Collecting blood samples.
        - i. Selecting proper supplies (e.g., needles, syringes, evacuated tubes, or anticoagulants).
        - ii. Identifying the patient and labeling patient demographics on collection containers.
        - iii. Performing venipuncture at appropriate intervals using aseptic technique.
        - iv. Adding hemolyzing compounds or anticoagulants to samples when necessary.
        - v. Centrifuging blood and separating blood components, as required.
        - vi. Storing aliquots of serum, plasma, or whole blood according to protocol.
    - b. Collecting urine samples by:
        - i. Instructing the patient and/or nursing staff regarding the correct method and time of urine collection.
        - ii. Aliquoting the urine sample and measuring total urine volume.

iii. Measuring the specific gravity of urine, if required.
iv. Recognizing and documenting all technical circumstances that would produce invalid results.

c. Collecting and/or analyzing other biological samples using appropriate techniques..

4. Gathering, validating, and documenting data.
   a. Subtracting room background or patient background from appropriate samples.
   b. Applying appropriate formulas, including conversion and dilution factors.
   c. Calculating results according to the procedure used.
   d. Plotting a graph, if necessary, and determining half time by extrapolating to zero time.
   e. Reporting both calculated values for a patient and normal range of specific procedures used.
   f. Evaluating results for potential error.
5. Managing biohazardous, chemical, and radioactive waste in accordance with applicable state and federal regulations and specific facility policy.

IV. Adjunctive Medications

A nuclear medicine technologist displays:

A. A thorough understanding and knowledge of indications, contraindications, warnings, precautions, proper use, drug interactions, and adverse reactions for each adjunct medication to be used.

B. The ability to procure and maintain pharmaceutical products and adjunct supplies by:
   1. Anticipating and procuring a sufficient supply of pharmaceuticals for an appropriate period in accordance with anticipated need.
   2. Storing pharmaceuticals and supplies in a manner consistent with labeled product safeguards and established facility policies.

C. The ability to properly prepare and administer pharmaceuticals under the direction of an authorized user in accordance with all federal and state regulations, and institutional policies by:
   1. Employing aseptic technique for manipulation of sterile products and preparations (see Section V.C.).
   2. Selecting and preparing pharmaceuticals in accordance with the manufacturer's specifications.
   3. Confirming the quality of a pharmaceutical in accordance with accepted techniques and official standards.
   4. Documenting the administered dose, date, and time of all pharmaceuticals in a permanent medical record.
   5. Observing the patient for possible complications (e.g., adverse reactions) of adjunctive medication administration, and handling such complications appropriately in conjunction with other available staff.

V. Radiopharmaceuticals

A. A nuclear medicine technologist displays a:

1. Thorough knowledge of indications, contra-indications, warnings, precautions, proper use, drug interactions, and adverse reactions for each radiopharmaceutical to be used.
2. Thorough knowledge of molecular-level physiological functions that relate to glucose metabolism, blood flow, brain oxygen utilization, perfusion, and receptor–ligand binding rates.
3. Thorough knowledge of the physiological processes that relate to organ system function and anatomy and radiopharmaceutical demonstration of normal and pathologic states.

B. A nuclear medicine technologist maintains radiopharmaceutical products and adjunct supplies by:

1. Anticipating and procuring a sufficient supply of radiopharmaceuticals for an appropriate period in accordance with anticipated need and license possession limits.
2. Storing pharmaceuticals, radiopharmaceuticals, and supplies in a manner consistent with the manufacturer's labeled product safeguards and with radiation safety considerations and with established facility policies
3. Performing and documenting radiation survey and wipe tests upon receipt of radioactive materials.
4. Recording receipt of radioactive materials in a permanent record.
5. Following Department of Transportation (DOT) regulations and radiation safety guidelines in the transport, receipt, and shipment of radioactivity.

C. A nuclear medicine technologist properly prepares and administers diagnostic radiopharmaceuticals under the direction of an authorized user in accordance with all federal and state regulations and institutional policies by:

1. Preparing all sterile radiopharmaceuticals and adjunct pharmaceuticals in appropriate environments in compliance with USP<797> standards.
2. Following appropriate personnel cleansing and garbing protocols when entering "clean" areas in accordance with USP<797> standards.
3. Employing aseptic technique, consistent with USP <797> standards, when mixing and manipulating sterile products.
4. Following appropriate USP<797> standards for beyond-use date (time-of-use) and vial puncture standards.
5. Assembling and maintaining radionuclide generators.
6. Eluting radionuclide generators according to the manufacturer's specification in a "clean" environment that complies with USP<797> standards.
7. Verifying the radionuclidic purity of generator eluates.
8. Selecting and preparing radiopharmaceuticals in accordance with the manufacturer's specifications.
9. Measuring the radioactivity of the radiopharmaceutical using a dose

calibrator.

10. Confirming the quality of a radiopharmaceutical in accordance with accepted techniques and official standards (e.g., radiochemical purity and physical appearance).
11. Handling and preparing blood or blood products for labeling and/or labeled blood cells in accordance with established regulations and protocols and in an environment in compliance with USP<797> standards, and ensuring that when blood products are handled and compounded they are separated from other radiopharmaceuticals.
12. Recording use and/or disposition of all radioactive materials in a permanent record.
    a. Properly storing pharmaceuticals, radiopharmaceutical kits, and radiopharmaceuticals as stated in USP<797> standards.
    b. Recording results of radionuclide generator eluates' quality assurance tests to include dose calibrator/generator calibration and radionuclidic purity of eluates.

D. A nuclear medicine technologist is responsible for the identification and labeling of all radiopharmaceutical preparations by:
1. Labeling vials and syringes as required by regulation and established facility policies.
2. Recording radiopharmaceutical and medication information on a patient's administration form and permanent preparation records.
3. Labeling and segregating radioactive waste and recording this information in a permanent record.

E. A nuclear medicine technologist prepares individual dosages under the direction of an authorized user by:
1. Applying radioactive decay calculations to determine the required volume or unit form necessary to deliver the prescribed radioactive dose.
2. Selecting and preparing prescribed dosages and entering this information on a patient's administration form and other permanent records.
3. Appropriately labeling the dose for administration.
4. Checking the dose activity prior to administration in a dose calibrator and comparing this measurement against the identification label of the dose's immediate container.
5. Confirming that the dosage to be administered falls within an acceptable deviation (e.g., within +/- 10%) of the prescribed dose at the time of administration as defined by written policy or regulation.

VI. Radionuclide Therapy

A. A nuclear medicine technologist properly prepares and administers therapeutic radionuclides, radiopharmaceuticals, and pharmaceutical agents by oral and/or intravenous routes when these agents are part of a standard procedure that is required for treatment under the direction of an authorized user in accordance with federal, state, and institutional policies by:

1. Ensuring that the correct radiopharmaceutical and dosage is prepared.
2. Following the quality management program in effect at the facility in regard to patient identification and verification and the use of therapeutic radionuclides.
3. Observing prescribed radiation safety and USP procedures during the preparation and administration of such treatment.
4. Assisting the authorized user in supplying proper patient care instructions to hospital staff, patient, and/or caregivers.
5. Conducting and documenting radiation surveys of designated patient areas, when indicated.
6. Instructing the patient, family, and staff in radiation safety precautions after the administration of therapeutic radiopharmaceuticals.
7. Coordinating/scheduling pre-/posttreatment blood draws and/or imaging.
8. Maintaining all appropriate records.

VII. Radiation Safety

A. A nuclear medicine technologist performs all procedures utilizing ionizing radiation safely and effectively, applying federal and state regulations, and institutional policies, including, but not limited to:
1. Notifying the appropriate authority when changes occur in the radiation safety program.
2. Assisting in the preparation of license amendments, when necessary.
3. Keeping up to date on regulatory changes and complying with all applicable regulations.
4. Maintaining required records.
5. Posting appropriate signs in designated areas.
6. Following federal and state regulations regarding receipt, storage, disposal, and usage of all radioactive materials.
7. Carrying out a program to follow federal and state regulations and institutional policies regarding therapeutic procedures and follow-up.
8. Recommending the purchase of radiation protection equipment to meet federal and state regulations and institutional policies.
9. Packaging and monitoring radioactive material for transport according to federal and state regulations, and keeping accurate records of transfer.

B. A nuclear medicine technologist follows appropriate radiation protection procedures by:
1. Using personnel monitoring devices (film badges, Optically Stimulated Luminescence [OSL] thermoluminescent dosimeters, etc.).
   a. Reviewing monthly personnel exposure records in regard to maximum permissible dose limits.
   b. Taking appropriate measures to reduce exposure.
   c. Notifying proper authorities of excessive exposure upon occurrence.
2. Selecting and using proper syringe shields and other shielding configurations to reduce radiation exposure to patients, personnel, and the

general public.

3. Identifying specific radionuclide emissions and energies for a particular radiopharmaceutical (gamma, beta, positron) and using proper shielding and disposal procedures in compliance with federal and state regulations to maximize patient, technologist, and public protection.
4. Performing technologist bioassays as per federal and state regulations.
5. Working in a safe but timely manner in order to decrease radiation exposure in consideration of ALARA programs.
6. Reviewing personal monitoring device readings to determine if radiation exposure can be further reduced.
7. Working in a manner that minimizes potential contamination of patients, technologists, the public, and work areas.

C. A nuclear medicine technologist performs radioactivity contamination monitoring by:

1. Ensuring that instruments are calibrated at regular intervals or after repairs, according to federal and state regulations.
2. Setting the frequency and locations for surveys and following schedules.
3. Using appropriate survey meters for each type and level of activity.
4. Following federal and state regulations regarding personnel surveys and reporting to the designated authorized user or Radiation Safety Officer.
5. Performing constancy checks on survey meters.
6. Performing wipe tests where applicable.
7. Performing leak tests on sealed sources, when so authorized.
8. Recording data in the required format (e.g., dpm instead of cpm).
9. Evaluating the results of wipe tests and area surveys to determine if action is required.
10. Notifying the Radiation Safety Officer when actions are required by federal and state regulations and institutional policies.

D. A nuclear medicine technologist performs decontamination procedures by:

1. Wearing personal protective equipment as necessary.
2. Restricting access to the affected area and confining a spill.
3. Removing contamination and monitoring the area and personnel, and repeating the decontamination procedure until activity levels are acceptable.
4. Closing off all areas of fixed contamination that are above acceptable levels, and posting appropriate signs.
5. Identifying, storing, or disposing of contaminated material in accordance with federal and state regulations and institutional policies.
6. Maintaining adequate records concerning decontamination.
7. Notifying the appropriate authority (e.g., Radiation Safety Officer) in the event of possible overexposure or other violations of federal and state regulations and institutional policies.

E. A nuclear medicine technologist disposes of radioactive waste in accordance with federal and state regulations and institutional policies by:

1. Maintaining appropriate records.
2. Disposing according to license specifications.
3. Maintaining long- and short-term storage areas.

F. A nuclear medicine technologist participates in programs designed to instruct other personnel about radiation hazards and principles of radiation safety by:

1. Using the following teaching concepts.
   a. Types of ionizing radiation.
   b. The biological effects of ionizing radiation.
   c. Limits of dose, exposure, and radiation effect.
   d. Concepts of low-level radiation and health.
   e. Concept of risk versus benefit.
2. Providing instruction on appropriate radiation safety measures.
3. Providing instruction on proper emergency procedures to be followed until radiation safety personnel arrive at the site of the accident or spill.
4. Modeling proper radiation safety techniques and shielding in the course of daily duties.

G. A nuclear medicine technologist assists in performing radiation safety procedures associated with radionuclide therapy according to federal and state regulations and institutional policies by:

1. Following the administration of therapeutic radiopharmaceuticals and the release of patients administered therapeutic radiopharmaceuticals.
2. Following the administration of therapeutic radiopharmaceuticals.
3. Following the release of patients administered radioactive materials.
4. Following the proper procedures for patients requiring hospitalization after administration of therapeutic radiopharmaceuticals.
5. Providing appropriate instruction on radiation safety procedures for patients, care givers, and staff.

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