SOCIETY OF NUCLEAR MEDICINE AND MOLECULAR IMAGING
TECHNOLOGIST SECTION

Nuclear Medicine Technologist Scope of Practice and Performance Standards

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Overview of Document

This document includes the Scope of Practice and the Performance Standards for health care professionals that, for the purposes of this document, will be referred to as a nuclear medicine technologist.

The spectrum of responsibilities for a nuclear medicine technologist varies widely across the United States. Practice components presented in this document provide a basis for establishing the areas of knowledge and performance for the nuclear medicine technologist. The nuclear medicine technologist must be 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 AND THE SOCIETY OF NUCLEAR MEDICINE AND MOLECULAR IMAGING TECHNOLOGIST SECTION DISCLAIM ALL LIABILITY ARISING FROM USE OF THESE DOCUMENTS.

Overview

Nuclear medicine is a medical technology that utilizes sealed and unsealed radioactive materials for diagnostic, treatment, and research purposes. Nuclear medicine instrumentation may be combined with, computed tomography (CT), or other modalities to generate attenuation correction and produce three-dimensional images with or without contrast (adjunctive medications) to enhance the evaluation of physiological processes at a molecular level.

Technologist Qualified to Perform Nuclear Medicine Procedures

Under the direction of an authorized user, the nuclear medicine technologist is responsible for the safe use of ionizing and nonionizing radiation to for diagnostic, therapeutic, and research purposes. The technologist will review the patient's medical history to understand the patient's illness and pending diagnostic or treatment procedure; 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 lifesaving first aid when appropriate.

Administrative functions may include supervising other technologists, students, and other

personnel; participating in procuring supplies and equipment; documenting laboratory operations; participating in radiation safety protocols and taking an active role in radiation reduction programs; participating in departmental inspections conducted by various licensing, regulatory, and accrediting agencies; participating in departmental quality assurance or quality improvement projects; and participating in scheduling patient procedures.

A certified nuclear medicine technologist is qualified to perform general nuclear medicine procedures, nuclear medicine therapy, nuclear cardiology procedures, and positron emission tomography (PET) procedures at entry level. The certified nuclear medicine technologist is an individual who is registered or certified by the *Nuclear Medicine Technology Certification Board* (NMTCB) or the *American Registry of Radiologic Technologists* (ARRT) in nuclear medicine technology or is a registered technologist with the Canadian Association of Medical Radiation Technologists (CAMRT).

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. Didactic courses include but are not limited to the physical sciences, biological effects of radiation exposure, radiation protection and procedures, the use of radiopharmaceuticals and adjunct pharmaceuticals, imaging techniques, and computer applications. A structured clinical education component provides experience in the clinical environment. Clinical education is designed to meet the requirements of the certification exams. Graduates of accredited programs are eligible to sit for certification examinations offered by the NMTCB and ARRT.

The Joint Review Committee on Education Programs in Nuclear Medicine Technology accredits training programs in nuclear medicine technology.

Licensure

Requirements for licensure of all imaging 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

Certification is available from the NMTCB, ARRT, and CAMRT.

Continuing Education

In addition to the general certification requirements, certified technologists also must complete a certain number of continuing education hours to maintain certification. Continuing education is required primarily because of the frequent technological and radiopharmaceutical innovations.

Code of Ethics

Technologists qualified to perform nuclear medicine procedures are members of the health care profession and must strive as individuals and as a group to maintain the highest of ethical standards by adhering to the *Nuclear Medicine Technologist Code of Ethics* approved by the *Society of Nuclear Medicine and Molecular Imaging Technologist Section* (SNMMITS).

The principles of the *Nuclear Medicine Technologist Code of Ethics* as listed below are not laws, but standards of conduct to be used as ethical guidelines by nuclear medicine 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 his or her 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 his or her profession.

Definitions

Adjunctive Medication: Involves the identification, preparation, calculation, documentation, administration, and monitoring of adjunctive medication(s) used during diagnostic, therapeutic, or research procedures. 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.

ALARA: Acronym 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, MR, ultrasound, traditional nuclear medicine, PET, and single-photon emission computed tomography (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.

Diagnostic 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 and research. Nuclear medicine procedures often identify abnormalities very early in the progression of a disease.

Hybrid Imaging: The combination of two imaging technologies that allows information from two different studies to be presented as a single set of images.

Imaging Device: A technological apparatus used to produce detailed images of the inside of the body for diagnostic, therapeutic, or research purposes. Examples of these devices include the gamma camera, CT scanner, PET scanner, MR 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 (MR) imaging is a diagnostic scan that uses

high-strength magnetic fields rather than radiation. MR imaging techniques are used primarily to study anatomy, but a special type of MR scan, functional MR imaging (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 at a molecular level. Molecular imaging technologies include, but are not limited to, traditional nuclear medicine, optical imaging, spectroscopy, PET, and SPECT.

Nuclear Medicine Therapy: The use of radioactive materials (called radiopharmaceuticals or radiotracers) to treat disease processes.

Positron Emission Tomography: Positron emission tomography is a medical imaging technology using radiopharmaceuticals emitting positrons which annihilate into two photons. These photon pairs are detected by the PET scanner, where the location of the original positron atom is extrapolated.

Single Photon Computed Tomography: SPECT imaging uses a gamma camera to acquire multiple 2-D images (projections) from multiple angles. Tomographic reconstruction algorithms are applied to the multiple projections, yielding a 3-D dataset. This dataset may then be manipulated to show thin slices along any chosen axis of the body, similar to those obtained from other tomographic techniques, such as CT, PET and MRI

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 treatment procedures and in patient medication reconciliation. This includes record keeping in accordance with the Health Insurance Portability and Accountability Act (HIPAA).

Instrumentation/Quality Control:
Involves the operation of:

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

Non-imaging instrumentation:
- Dose calibrators
- Survey instrumentation for exposure and contamination
- Probe and well instrumentation
- Ancillary patient care equipment as authorized by institutional policies
- Infusion systems
- Radionuclide generators

Quality control:
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. Obtains biological samples to perform testing as required for the optimization of patient care and quality of diagnostic procedures.

Therapeutic Procedures: Requires the utilization of appropriate techniques, radiopharmaceuticals, and adjunctive medications as part of a standard protocol to ensure proper treatment of the disease process. Obtains biological samples to perform testing as required for the optimization of patient care.

Adjunctive Medications: Involves the identification, preparation, calculation, documentation, administration, and monitoring of adjunctive medication(s) used during 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: Involves the safe handling and storage of radiopharmaceuticals. This includes, but is not limited to, the procurement, identification, dose calculation, and administration of radiopharmaceuticals. It also includes all associated documentation and disposal as appropriate.

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 principles and establishing protocols for managing spills and unplanned releases of radiation.

THE CLINICAL PERFORMANCE STANDARDS

The clinical performance standards for the nuclear medicine technologist include, *but are not limited to*, the following areas and responsibilities:

I. Patient Care

A. A nuclear medicine technologist prepares the patient by:

1. 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.
2. Assuring study appropriateness based on indication and patient symptoms. Consulting with the authorized user and/or referring physician whenever the request is called into question.
3. Obtaining a pertinent medical history, including medications and allergies, and confirming the patient's candidacy for the procedure.
4. Ensuring that any pre-procedural preparation has been completed (e.g., fasting, diet, hydration, glucose levels, 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 post-procedure instructions.
7. Collecting specimens and performing pertinent laboratory procedures. Performing in vitro diagnostic testing laboratory analyses as required by established protocols. Additionally, performing in vitro diagnostic testing laboratory procedures to measure the biodistribution of radiopharmaceuticals.

B. A nuclear medicine technologist provides patient care by:

1. Verifying the patient ID according to institutional policy and verifying the appropriateness of the test being ordered.
2. Assuring comfort and care to the patient prior to, during, and after a procedure. This includes, but is not limited to, the monitoring of intravenous lines (i.e., central lines, peripherally inserted central catheters [PICC]), oxygen supplies, and drains. This also includes the operation of blood pressure cuffs, electrocardiogram (ECG) machines, pulse oximeters, glucometers, intravenous pumps, and oxygen delivery regulators as authorized by institutional policies.
3. Inserting and monitoring peripheral intravenous catheters.
4. Monitoring patients who are under minimal sedation in accordance with the American Society of Anesthesiologists [ASA] guidelines for conscious sedation and per institutional guidelines.
5. Establishing and maintaining proper communication with patients (i.e., proper introduction, appropriate explanation of procedure, etc.).

6. Maintaining a professional demeanor at all times to assure the preservation of patients' rights, resulting in the provision of the highest-quality patient care possible.
7. Following recognized infection control practices to provide a safe and sanitary working environment for patients and the general public.
8. 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).
9. Recognizing, responding to, reporting, and documenting adverse events.

C. A nuclear medicine technologist performs administrative procedures by:
1. Maintaining an adequate volume of medical/surgical supplies, pharmaceuticals, 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 applying state and federal guidelines and institutional policies.
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).
6. Complying with licensing standards and institutional policies. The nuclear medicine technologist involved with research must also follow Institutional Research Board protocols, comply with Institutional Animal Care and Use Committee, and Food and Drug Administration standards.

II. Instrumentation/Quality Control

A. A nuclear medicine technologist evaluates equipment performance, initiates corrective action when necessary, and maintains required records for the quality control program of gamma camera imaging systems, PET systems, and hybrid imaging systems, CT, and/or MR in accordance with federal and state regulations and institutional policy. Responsibilities include but are not limited to:
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 uniformity, photon detection/discrimination, spatial resolution, scatter correction, count loss, measurement of random interactions, sensitivity, dead-time loss, and random count correction accuracy as recommended by the manufacturer, and required by institutional and accreditation policies.

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 procedures per manufacturer recommendations to evaluate detector integrity.
4. Performing imaging system quality assurance:
    a. Obtaining uniformity images on imaging detectors.
        i. Selecting a radionuclide source of appropriate type, size, quantity, and energy.
        ii. Selecting an appropriate pulse height analyzer (PHA), photopeak, and window.
        iii. Obtaining uniformity images using standardized imaging parameters.
        iv. 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.
        v. Identifying the source of any significant nonuniformity (e.g., checking collimator and PHA peak setting).
        vi. Initiating corrective action when necessary based on the physicist recommendations.
    b. Performing a detector linearity evaluation on imaging detectors.
        i. Selecting a radionuclide, selecting a linearity phantom, and obtaining images.
        ii. Identifying any nonlinear distortion in the image.
        iii. Determining the source of nonlinearity (e.g., detector–source geometry).
        iv. Initiating corrective action when necessary based on the physicist recommendations.
    c. Performing spatial resolution checks on imaging detectors.
        i. Selecting an appropriate radionuclide.
        ii. Choosing a phantom that is compatible with the specified resolution of the camera.
        iii. Analyzing the resulting images for degradation of resolution and determining the causes.
        iv. Initiating corrective action when necessary based on the physicist recommendations.
    d. Conducting sensitivity checks on imaging detectors yearly in conjunction with a physicist.
        i. Selecting a source with an appropriate level of activity and half-life.
        ii. Ensuring identical geometry, source placement, and measurement parameters for repetitive checks.
        iii. Evaluating results.
        iv. Initiating corrective action when necessary based on the physicist

recommendations.

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

f. 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: Perform a phantom evaluation to determine tomographic uniformity accuracy of the CT number for water, image noise, and slice thickness.

b. Acquiring consistent 2D and/or 3D PET images, using appropriate reconstruction techniques, to display images for interpretation.

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.

5. Performing radionuclide generator quality assurance, daily and before the use of the generator, to include dose calibrator/generator calibration and parent/daughter breakthrough.
6. Performing infusion device quality control per manufacturer recommendations.
7. Operating 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:
   a. Maintaining and operating auxiliary equipment used in procedures.
   b. Actively participating in total quality management/continuous quality improvement programs by:
      i. Identifying indicators to be analyzed.
      ii. Gathering and presenting data in appropriate formats, analyzing data, and recommending changes.

8. Operating scintillation probes, well counters, and other laboratory equipment:
    a. Calibrating a spectrometer with a long–half-life radionuclide source.
    b. Determining energy resolution.
    c. Conducting sensitivity measurements at appropriate energies with a standard, long-lived source such as Cs-137 or I-129.
    d. Checking background and determining the cause for levels greater than established normal levels.
    e. Conducting a chi-square test.
    f. Maintaining required records for quality control programs in accordance with federal and state regulations and institutional policies.
    g. Performing glucometer quality assurance using high and low standards.
9. Operating survey meters:
    a. Ensuring that calibration has been completed within the last 12 months.
    b. Performing a battery check to verify the meter is operational.
    c. Performing a check-source test and comparing with previous results.
    d. Maintaining required records for the quality control program.
10. Operating dose calibrator:
    a. 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.
    b. 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.
    c. Determining accuracy annually by comparing a set of known activities to measured activities using isotopes of varying energy emissions such as Co-57, Ba-133, and Cs-137.
    d. Upon installation, testing for significant geometric variation in activity measured as a function of sample volume or configuration and determining correction factors when necessary.
    e. Maintaining required records for the quality control program in accordance with federal and state regulations and institutional policies.
11. Operating image processors/computer monitors:
    a. Verifying the calibration of the instrument.
    b. 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 verified and obtained in accordance with

established protocols and verifying that the radiopharmaceutical meets quality specifications prior to administration (i.e., expiry time, pH, half-life, etc.).

3. Administering adjunctive medications or radiopharmaceuticals:
    a. Verifying patient ID according to institutional policy.
    b. Determining route of administration according to established protocol.
    c. Establishing and/or verifying venipuncture access using aseptic technique.
    d. Using and maintaining established venous access routes (e.g., heparin infusion or infusion pump).
    e. Reconciling patient medications according to institutional 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 IV.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 in accordance with federal and state regulations and institutional policies.
    h. Observing the patient carefully after any pharmaceutical 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 protocol, and acquiring additional views as necessary to optimize information content.
    b. Exercising professional judgment in positioning a patient 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 to include the correct placement of 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 institutional protocols.

b. Exercising independent judgment in selecting appropriate images for processing.
c. Obtaining quantitative measurements such as SUV, coronary flow reserve, kinetic modeling, regional brain analysis, biliary and cardiac ejection fractions, and renal function, as appropriate for the procedure performed.
d. Defining regions of interest (ROIs) with reproducible results and correctly applying background subtraction.
e. Performing computer data manipulations as required.
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 may perform non-imaging in vitro and/or radioassay studies by:
1. Operating laboratory equipment, including well counters, probes, and other detection devices to measure the biodistribution of radiopharmaceuticals.
2. Preparing doses:
a. Quantitating doses.
i. Calculating and confirming the activity to be used.
ii. Calculating the volume necessary to deliver activity for the prescribed dose.
b. Preparing standard solutions or dosage for phantom use as needed using appropriate volumetric or gravimetric techniques to dilute the standard per institutional protocol.
3. Collecting appropriate biological specimens for procedures using standard precaution techniques as required by protocol:
i. Collecting blood samples:
a. Selecting proper supplies (e.g., needles, syringes, evacuated tubes, or anticoagulants).
b. Identifying the patient and labeling patient demographics on collection containers.
c. Performing venipuncture at appropriate intervals using aseptic technique.
d. Adding hemolyzing compounds or anticoagulants to samples according to protocol.
e. Centrifuging blood and separating blood components, according to protocol.
f. Storing aliquots of serum, plasma, or whole blood according to protocol.
ii. Collecting urine samples by:
a. Instructing the patient and/or nursing staff regarding the correct method and time of urine collection.
b. Aliquoting the urine sample and measuring total urine volume.
c. Measuring the specific gravity of urine, if required.

d. Recognizing and documenting all technical circumstances that would produce invalid results.

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 institutional 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.
    2. Selecting and preparing pharmaceuticals in accordance with the manufacturer's specifications and institutional polciy.
    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, contraindications, 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, but not limited 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. Maintaining security while storing pharmaceuticals, radiopharmaceuticals, and supplies in a manner consistent with the manufacturer's labeled product safeguards, radiation safety considerations, and established institutional policies.
   3. Performing and documenting radiation survey and wipe tests upon receipt of radioactive materials in accordance with federal and state regulations and institutional policies.
   4. Recording receipt of radioactive materials in a permanent record in accordance with federal and state regulations and institutional policies.
   5. Following Department of Transportation (DOT) regulations and radiation safety guidelines in the transport, receipt, and shipment of radioactivity in accordance with federal and state regulations and institutional policies.

C. A nuclear medicine technologist properly prepares and administers 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.

C. A nuclear medicine technologist is responsible for the identification and labeling of all radiopharmaceutical preparations by:
1. Labeling vials and syringes in accordance with federal and state regulations and institutional policies.
2. Recording radiopharmaceutical and medication information on a patient's administration form and permanent preparation records in accordance with federal and state regulations and institutional policies.
3. Labeling and segregating radioactive waste and recording the information in a permanent record in accordance with federal and state regulations and institutional policies.

D. 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 the 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 shipment documentation.
5. Recording use and/or disposition of radioactive materials in a permanent record by properly storing pharmaceuticals and radiopharmaceuticals as stated in federal and state regulations and institutional policies

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-/post treatment 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 in accordance with federal and state regulations and institutional policies including, but not limited to:

1. Maintaining security of radioactive materials.
2. Notifying the appropriate authority when changes occur in the radiation safety program.
3. Assisting in the preparation of license amendments when necessary.
4. Keeping up to date on regulatory changes and complying with all applicable regulations.
5. Maintaining required records.
6. Posting appropriate radiation signage in designated areas.
7. Following federal and state regulations regarding receipt, storage, disposal, and usage of all radioactive materials.
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.).

744 a. Reviewing personnel exposure records in regard to maximum permissible
745 dose limits.
746 b. Taking appropriate measures to reduce exposure.
747 c. Notifying proper authorities of excessive exposure upon
748 discovery/occurrence.
749 2. Selecting and using proper syringe shields and other shielding configurations to
750 reduce radiation exposure to patients, personnel, and the general public.
751 3. Using proper shielding and disposal procedures in compliance with federal and
752 state regulations to maximize patient, technologist, and public protection.
753 4. Working in a safe but timely manner in order to decrease radiation exposure in
754 consideration of ALARA guidelines.
755 5. Reviewing personal monitoring device readings to determine if radiation exposure
756 can be further reduced.
757 6. Working in a manner that minimizes potential contamination of patients,
758 technologists, the public and work areas.
759
760 C. A nuclear medicine technologist monitors for radioactive contamination by:
761 1. Ensuring that instruments are calibrated at regular intervals or after repairs,
762 according to federal and state regulations.
763 2. Setting the frequency and locations for surveys and following schedules.
764 3. Using appropriate survey meters for each type and level of activity.
765 4. Following federal and state regulations regarding personnel surveys and reporting
766 to the designated authorized user or radiation safety officer.
767 5. Performing constancy checks on survey meters.
768 6. Performing wipe tests where applicable.
769 7. Performing leak tests on sealed sources, when so authorized.
770 8. Recording data in the required format (e.g., dpm instead of cpm).
771 9. Evaluating the results of wipe tests and area surveys to determine if action is
772 required.
773 10. Notifying the radiation safety officer when actions are required by federal and
774 state regulations and institutional policies.
775
776 D. A nuclear medicine technologist performs decontamination procedures in accordance
777 with federal and state regulations and institutional policies by:
778 1. Wearing personal protective equipment as necessary.
779 2. Restricting access to the affected area and confining a spill.
780 3. Removing contamination and monitoring the area and personnel, and repeating
781 the decontamination procedure until activity levels are acceptable.
782 4. Closing off all areas of fixed contamination that are above acceptable levels,
783 shielding the area, and posting appropriate signs.
784 5. Identifying, storing, or disposing of contaminated material in accordance with
785 federal and state regulations and institutional policies.
786 6. Maintaining appropriate decontamination records.

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

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