PERFORMANCE AND RESPONSIBILITY GUIDELINES

FOR THE NUCLEAR MEDICINE TECHNOLOGIST

(Revision 2003)

The Performance and Responsibility Guidelines for the Nuclear Medicine Technologist were initially developed by the Socio Economic Affairs Committee and approved in 1994 and revised in 1998. Over this past year, the Academic Affairs and Socio Economic Affairs Committees have worked on revising the 1998 guidelines to bring them in line with current practice for nuclear medicine technologists. The National Council and House of Delegates approved this latest version during the Society of Nuclear Medicine June 2003 Annual Meeting.

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The spectrum of nuclear medicine technology skills and responsibilities varies widely across the country. The broad descriptions of this document will provide a basis for determining the areas of knowledge and of performance for the nuclear medicine technologist. The documents used in the revision and development of these guidelines were the Society of Nuclear Medicine Technologist Section (SNMTS) Performance and Responsibility Standards for the Nuclear Medicine Technologist (1998); Nuclear Medicine Technology Certification Board (NMTCB) Report: Equipment and Procedures in Current Practice (2003); NMTCB, Critical Task Analysis Report (2002); and the Essentials and Guidelines for an Accredited Educational Program for the Nuclear Medicine Technologist (1997). These guidelines should be considered a helpful checklist of those skills necessary to perform a variety of nuclear medicine procedures. Although the editors tried to be complete, nuclear medicine technology is a dynamic and evolving field; therefore, any list is likely to be partially obsolete as soon as it is issued. In addition, this document is not designed to be a "how to" description for any of the listed activities, nor is it intended to be used to represent entry level competencies, but rather the spectrum of NMT responsibilities. It is not intended to modify or alter existing tort law.

Nuclear Medicine is the field of medicine that uses radioactive materials in the diagnosis and treatment of disease. This includes the administration of radiopharmaceuticals to patients for the therapeutic treatment and/or imaging of the radiopharmaceutical distribution in an organ or area of interest within the patient.

Nuclear Medicine Technology

The practice of nuclear medicine technology encompasses multidisciplinary skills. The responsibilities of the nuclear medicine technologist include an empathetic and instructional approach to patient care, the preparation, calibration and administration of radiopharmaceuticals and pharmaceuticals under the direction of an authorized user, the performance of quality control procedures, the operation of imaging, laboratory and computer instrumentation and the application of accepted standards (ALARA) of radiation safety and protection.

In order to perform these responsibilities, the nuclear medicine technologist must successfully complete didactic and clinical training. Recommended course work includes, but is not limited to: anatomy, physiology, pathophysiology, chemistry, physics, mathematics, computer utilization, biomedical sciences, ethics, and radiation science health and safety. Direct patient contact hours are obtained by training in a clinical setting and continuing education is a necessary component in maintaining the skills required to perform the duties and tasks of the nuclear medicine technologist.

Formal education programs in nuclear medicine technology are accredited by the Joint Review Committee on Educational Programs in Nuclear Medicine Technology (JRCNMT). Graduates of accredited programs are eligible to take the certification examination offered by the NMTCB and/or American Registry of Radiologic Technologists (ARRT).

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

Patient Care: The exercise of judgment to assess and respond to patients needs prior to, during and following nuclear medicine procedures.

Quality Control: The evaluation and maintenance of a quality control program to ensure instrumentation credibility and reliability.

Diagnostic Procedures: The utilization of appropriate technique to ensure quality diagnostic images and/or laboratory results.

Radiopharmaceuticals: The procurement, preparation, quality control, calculation, identification, documentation, administration, disposal, storage, and safe handling of such radiopharmaceuticals.

Radionuclide therapy: The collaboration with an authorized user to apply and manage a therapeutic radionuclide treatment.

Radiation safety: The use of techniques and education that will minimize radiation exposure to patients, the general public, and health care personnel consistent with the ALARA (as low as is reasonably achievable) concept.

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 the monitoring of intravenous lines (IVs), oxygen supplies, and drains.

2. 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's [ASA] guidelines for sedation).

3. establishing and maintaining proper communication with patients.

4. behaving in a professional manner in consideration and observation of patients' rights and dignity.

5. providing functionally safe and sanitary conditions for the patient and staff in compliance with standard precautions policies.

6. recognizing and responding to medical emergency conditions by:

a) initiating a call for assistance.

b) monitoring and recording physiologic data (e.g., electrocardiogram [ECG], pulse rate, respiratory rate).

c) administering cardiopulmonary resuscitation when necessary.

d) maintaining intravenous fluids, oxygen, and other life-support assistance until dedicated medical emergency staff arrives.

B. A nuclear medicine technologist prepares the patient by:

1. reviews the indication for the study for appropriateness, and following up with the authorized user and/or referring physician as necessary, to assure that the proper study is being performed.

2. verifying patient identification, date of last menstrual period, pregnancy/breastfeeding status and written orders for the procedure.

3. obtaining a pertinent medical history and confirming the patient's candidacy for the procedure.

4. assuring that any pre-study preparation has been completed (e.g., hydration, voiding, bowel cleansing, suspension of interfering drugs, blood serum glucose assessments prior to FDG-PET procedures, intravenous line and/or bladder catheter placement).

5. assuring that informed consent has been obtained, when necessary.

6. properly explaining the procedure to the patient, parent or guardian, and when necessary, obtain the assistance of an interpreter or translator.

7. checking patient clothing and linen for objects that may cause image artifacts.

C. A nuclear medicine technologist performs administrative procedures by:

1. maintaining an adequate volume of medical/surgical supplies, pharmaceuticals, radiopharmaceuticals, imaging, and image production supplies.

2. scheduling patient procedures in a timely manner.

3. determining the appropriate sequence for multiple procedure requests.

4. maintaining appropriate records of patient doses, quality control procedures, patient reports, and other required data.

5. participating in a quality assurance program.

II. Nuclear Instrumentation - Quality Control

A. A nuclear medicine technologist evaluates the performance of scintillation cameras by:

1. obtaining uniformity images.

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 unit is used;

e) identifying the source of any nonuniformity (e.g., checking collimator, PHA peak setting);

f) initiating corrective action when necessary; and

g) maintaining required records for the quality control program.

2. performing a detector linearity evaluation.

a) selecting a radionuclide, 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; and

e) maintaining required records for the quality control program.

3. performing spatial resolution checks.

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;

d) initiating corrective action when necessary; and

e) maintaining required records for the quality control program.

4. conducting sensitivity checks.

a) selecting a source with an appropriate level of activity and half-life;

b) assuring identical geometry, source placement and measurement parameters for repetitive checks;

c) evaluating results;

d) initiating corrective action when necessary; and

e) maintaining required records for the quality control program.

5. performing single photon emission computed tomography (SPECT) quality control procedures.

a) obtaining a high count uniformity flood;

b) verifying center of rotation correction;

c) verifying energy correction and spatial coordinates;

d) verifying multi-head detector alignment;

e) evaluating reconstruction results of phantom acquisition;

f) analyzing the results for degradation;

g) initiating corrective action when necessary; and

h) maintaining required records for the quality control program.

6. performing positron emission tomography (PET) quality control procedures.

a. evaluating the performance of PET and hybrid PET/CT systems:

(i) with an intimate knowledge of PET detectors, types of crystals (e.g., BGO, LSO, GSO, NaI), transmission sources of various configurations, retractable rod sources/septa, ring planes, and methods of coincidence detection.

(ii) identifying system-specific quality control requirements by following recommended initial acceptance, daily, weekly, monthly, and quarterly quality control procedures to evaluate allowable parameter ranges for:

a) photon detection/discrimination
b) spatial resolution
c) scatter reaction
d) count loss
e) random measurement
f) sensitivity
g) deadtime loss and random count correction accuracy

(iii) recognizing image artifacts requiring imaging system correction and performing corrections and quality assuranance as directed by institutional and manufacturer recommendations.

a) sinogram acquisition and evaluation
b) well counter SUV calibration;
c) PET/CT system alignment calibration;
d) CT system quality assurance;
e) glucometer quality assurance using high and low standards;
f) rubidium generator quality assurance to include dose calibrator/generator calibration and parent/daughter breakthrough

(iv) assisting with the development of 2D and 3D tomographic normalization algorithms used for image acquisition, recontruction, and display.

(v) demonstrating knowledge and technical skills in computed tomography (CT) when used to perform PET/CT examinations.

a) x-ray production
b) radiographic techniques
c) scanning parameters (MA, kVp and helical scanning)

7. verifying computer parameter settings and data interface.

a) assuring that the camera detector and computer register the same count rate at the maximum frame rate;

b) verifying that the camera detector and computer have the same image orientation;

c) obtaining a dead time measurement on the computer;

d) verifying accuracy of ECG gating;

e) performing pixel calibration; and

f) operating PET computer hardware, processing software and basic Windows and Unix platforms.

8. verifying the quality of analog and/or digital recording device(s).

a) performing a lens focus check (e.g., CRT);

b) checking and adjusting imaging device for contrast and brightness (e.g., densitometry);

c) assessing integrity of imaging device; and

d) maintaining cleanliness of all equipment (e.g., lens, fan covers).

9. 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

c) analyzing data and recommending changes.

B. A nuclear medicine technologist evaluates the performance of NaI (TI) scintillation probes, well counters and other laboratory equipment by:

1. calibrating a spectrometer with a calibrated, long half-life radionuclide source.

2. determining energy resolution.

3. conducting sensitivity measurements at appropriate energies.

4. checking background and determining the cause for levels greater than established normal levels.

5. conducting a chi-square test.

6. maintaining required records for quality control programs.

C. A nuclear medicine technologist operates survey meters by:

1. ensuring that calibration is completed with an approved source.

2. performing a check-source test and comparing with previous results.

3. maintaining required records for quality control program.

D. A nuclear medicine technologist evaluates the operation of a dose calibrator by:

1. determining precision (constancy).

2. determining accuracy.

3. ascertaining linearity over the entire range of radionuclide activity to be measured and determining correction factors when necessary.

4. 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.

E. A nuclear medicine technologist operates and maintains image processors by:

1. verifying the calibration of the instrument.

2. ensuring that materials required for image processing are at acceptable levels.

3. maintaining required records for quality control program.

III. Diagnostic Procedures

A. A nuclear medicine technologist performs imaging procedures by:

1. determining imaging parameters.

a) selecting and preparing the instrument for the procedure;

b) selecting appropriate parameters for acquisition; and

c) recognizing artifacts that are due to instrumentation malfunction and initiating appropriate action.

2. administrating radiopharmaceuticals and/or pharmaceuticals using

standard precaution techniques.

a) verifying patient identity prior to the administration of medication or radiopharmaceuticals;

b) determining route of administration according to established protocol (e.g., subcutaneous, intramuscular, intravenous, etc.);

c) establishing and/or verifying venipuncture access using aseptic technique;

d) using and maintaining established venous access routes (e.g., heparin infusion, IMED);

e) establishing patient patterned breathing when introducing radiopharmaceuticals (e.g., inhalants or aerosols);

f) administering oral radiopharmaceuticals; and

g) properly documenting medications and/or radiopharmaceutical administrations on the patient medical record.

3. Positioning the patient and obtaining images.

a. waiting an appropriate length of time following the administration of a radiopharmaceutical to begin the imaging procedure;

b) acquiring imaging views according to established protocols and acquiring additional views to optimize information content;

c) properly positioning the patient using supportive materials and immobilizers, as necessary;

d) exercising independent judgment in positioning a patient or detector unit to best demonstrate pathology and to adapt to the patient's limitations;

e) indicating appropriate anatomic landmarks for each view of the procedure; and

f) reviewing images to assure that the correct information is supplied.

4. assisting the physician in cardiac stress testing when performed in conjunction with nuclear medicine procedures.

a) preparing patients for placement of ECG electrodes;

b) recognizing and responding to any ECG changes;

c) recognizing the parameters that indicate termination of cardiac stress study; and

d) recognizing ECG patterns that are appropriate for image gating.

5. 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 (ROI's) 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, SPECT slice production;

f) labeling processed images (e.g., anatomical positioning, ROI's, date, etc.);

g) processing PET data to produce parametric images; and

h) preserving and retrieving data from storage media.

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

1. operating laboratory equipment.

a) confirming accuracy, precision, and operation of pipetting device; and

b) using microhematocrit centrifuge and determining hematocrit.

2. preparing doses and guidelines.

a) quantitating dose

(i) determining decay factor and calculating remaining activity;

(ii) determining volume necessary to deliver activity for the prescribed dose;

(iii) drawing dose into syringe using appropriate techniques and materials;

(iv) dispensing appropriate quantity of liquid or capsules, 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 standard;

(ii) adding radioactive material identical to that given the patient quantity sufficient (qs) to appropriate volume; and

(iii) dissolving capsule in appropriate solvent, if necessary, for preparing a standard

3. collecting proper specimen for procedures using standard precaution techniques by:

a) collecting blood samples.

(i) selecting proper supplies (e.g., needles, syringes, evacuated tubes, anticoagulants, etc.);

(ii) labeling patient demographics on collection containers;

(iii) performing venipuncture at appropriate time intervals using aseptic technique;

(iv) adding hemolyzing compounds or anticoagulants to samples when necessary;

(v) centrifuging blood and separating blood components, as required; and

(vi) storing aliquots of serum, plasma, or whole blood

according to protocol.

b) collecting urine samples by:

(i) instructing patient and nursing staff regarding the correct method and time of urine collection;

(ii) aliquoting urine sample and measuring total urine volume;

(iii) measuring specific gravity of urine, if required; and

(iv) recognizing and documenting all technical circumstances which would produce invalid results.

4. performing calculations.

a) subtracting room or patient background from appropriate samples;

b) applying appropriate formulas, including conversion and dilution factors;

c) calculating results according to procedure used;

d) plotting graph, if necessary, and determining half time by extrapolating to zero time;

e) reporting both patient calculated values and normal range of specific procedures used; and

f) evaluating results for potential error.

5. managing bio-hazardous waste using disposal methods adopted as facility policy.

IV. Radiopharmaceuticals

A. A nuclear medicine technologist displays:

1. thorough knowledge of molecular level physiological functions that relate to glucose metabolism, blood flow, brain oxygen utilization, perfusion, and receptor-ligand binding rates.

2. thorough knowledge of physiological and processes that relate to organ system function and anatomy and their radiopharmaceutical demonstration of normal and pathologic states.

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

1. anticipating and procuring a sufficient supply of radiopharmaceuticals for an appropriate time period in accordance with anticipated need and license possession limits.

2. storing pharmaceuticals, radiopharmaceuticals and supplies in a manner consistent with labeled product safeguards and with radiation safety considerations.

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) and radiation safety guidelines in the transport, receipt and shipment of radioactivity.

C. A nuclear medicine technologist prepares and verifies quality of radiopharmaceuticals under the direction of an authorized user by:

1. employing aseptic technique for manipulation of injectable products.

2. assembling and maintaining radionuclide generators.

3. eluting radionuclide generators according to manufacturer's specification.

4. verifying radionuclide purity of generator eluates.

5. selecting and preparing radiopharmaceuticals in accordance with manufacturer's specifications.

6. measuring and calculating activity of the radionuclide with a dose calibrator.

7. confirming the quality of a radiopharmaceutical in accordance with accepted techniques and official guidelines (e.g., radiochemical purity, physical appearance).

8. preparing blood or blood products for labeling and/or labeled blood cells, e.g., ^{111}Indium WBC in accordance with established protocols.

9. recording use and/or disposition of all radioactive materials in a permanent record.

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.

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 or Radiation Safety Officer by:

1. applying radioactive decay calculations to determine 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. 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.

V. Radionuclide Therapy

A. Nuclear medicine technologist assists an authorized user in the preparation and applications of therapeutic radionuclides by:

1. assuring that the correct radiopharmaceutical and dosage is prepared.

2. following the NRC mandated quality management program in effect at the facility in regard to patient identification and the use of therapeutic radionuclides.

3. observing prescribed radiation safety procedures during the preparation and the 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. supplying hospital staff, patient, and/or caregivers with proper instructions on handling and disposal of all contaminated supplies, when necessary.

7. coordinating/scheduling pre/post treatment blood draws and/or imaging.

VI. Radiation Safety

A. A nuclear medicine technologist under supervision of an authorized user and/or under the supervision of, or serving as the Radiation Safety Officer, maintains compliance with local, state and/or federal regulations in radiation safety practices by:

1. notifying 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 by complying with all applicable regulations.

4. maintaining required records.

5. posting appropriate signs in designated areas.

6. following regulations regarding receipt, disposal and usage of all radioactive materials.

7. carrying out a program to follow regulations regarding therapeutic procedures and follow-up.

8. recommending purchase of protection equipment to meet regulations.

9. packaging radioactive material according to regulations and keeping accurate records of transfer.

B. A nuclear medicine technologist follows appropriate radiation protection procedures by:

1. using personnel monitoring devices (dosimeters, film badges, thermoluminescent dosimeters, etc.).

a) reviewing monthly personnel exposure records in regard to maximum permissible dose limits;

b) taking appropriate measures to reduce exposure, when necessary; and

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 radionuclides emissions and energies per radiopharmaceutical (gamma, beta, positron) and using proper shielding and disposal procedures in compliance with NRC regulations to maximize patient, technologist, and public protection.

4. performing technologist bioassays as per state and/or federal 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 surveys by:

1. ensuring that instruments are calibrated at regular intervals, or after repairs according to regulations.

2. setting frequency and locations for surveys and following schedules.

3. using appropriate survey meters for each type and level of activity.

4. following 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 required format (e.g., dpm instead of cpm).

9. evaluating results of wipe tests and area surveys to determine if action is required.

10. notifying the Radiation Safety Officer when actions are required.

D. A nuclear medicine technologist performs decontamination procedures by:

1. wearing personal protective equipment as necessary.

2. restricting access to affected area and confining a spill.

3. removing contamination and monitoring the area and personnel and repeating decontamination procedure until activity levels are acceptable.

5. closing off all areas of fixed contamination that are above acceptable levels, and posting appropriate signs.

6. identifying, storing, or disposing of contaminated material in accordance with regulations.

7. maintaining adequate records concerning decontamination.

8. notifying appropriate authority (e.g., Radiation Safety Officer) in the event of possible overexposure or other violations of regulations.

E. A nuclear medicine technologist disposes of radioactive waste by:

1. maintaining appropriate records.

2. disposal according to license specifications.

3. maintaining long- and short-term storage areas according to regulation.

F. A nuclear medicine technologist participates in a hospital's in-service program 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; and

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 accident or spill.

4. modeling proper radiation safety techniques and shielding in the course of daily duties.

References:

Essentials and Guidelines for an Accredited Educational Program for the Nuclear Medicine Technologist (1997 Revision)

Nuclear Medicine Technology Certification Board (NMTCB) Report: Critical Task Analysis (2002)

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