Administration

Performance and Responsibility Standards for the Nuclear Medicine Technologist

The Socio-Economic Affairs Committee, Technologist Section, Society of Nuclear Medicine

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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 development of these standards were the NMTCB Task Analysis of Nuclear Medicine Technology (1), the Society of Nuclear Medicine Position Paper on Licensure, and the Job Description for the Nuclear Medicine Technologist (2). These standards should be considered a helpful checklist of those tasks that need to be performed in the various major subdivisions of nuclear medicine technology. While the editors tried to be complete, nuclear medicine technology is a dynamic, developing, and constantly changing field; therefore, any list is likely to be partially obsolete as soon as it is issued. In addition, the analysis is not designed to be a "how to" description for any of the listed activities, nor is it intended to modify or alter existing tort law. Activities listed may, at times, be legitimately omitted and, at other times, supplemented by unlisted activities.

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Nuclear medicine is that field of medicine that uses radioactive materials in the diagnosis and treatment of disease. This utilization includes the administration of a radioactive drug (radiopharmaceutical) to a patient and the subsequent imaging of its distribution in an organ or area of interest within the patient. In addition, nuclear medicine assay procedures involve either administering tracer amounts of radioactive materials to a patient and then measuring it in specimens taken from the patient or adding radioactive substances to specimens removed from the patient to obtain quantifiable data in relation to the patient's condition.

Nuclear Medicine Technology

Nuclear medicine requires a multidisciplinary team effort. The technical skills and responsibilities of the nuclear medicine technologist, fundamental to the activities of a nuclear medicine department, are directed toward assisting the nuclear medicine physician in the performance and evaluation of clinical procedures, including the preparation, calibration and administration of radioactive drugs, as well as the performance of quality control procedures and the operation of both imaging and in vitro instrumentation systems. The technologist may perform studies to evaluate new or improved nuclear medicine procedures and instrumentation. The technologist may also assist physicians in therapeutic procedures using radionuclides and may participate in medical research.

In order to perform these tasks, the nuclear medicine technologist must possess appropriate knowledge of the field of nuclear medicine technology and of those aspects of chemistry, physics, mathematics, biomedical sciences, and radiation health and safety that relate to it.

Formal education programs in nuclear medicine technology are accredited by the Joint Review Committee on Educational Programs in Nuclear Medicine Technology (JRCNMT) in collaboration with the Committee on Allied Health Education and Accreditation (CAHEA). Graduates of these programs are eligible to take the certification examination offered by the Nuclear Medicine Technology Certification Board (NMTCB), American Registry of Radiologic Technologists, (ARRT), or American Society of Clinical Pathologists (ASCP).

The scope of performance in nuclear medicine tech-

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nology may include, but is not limited to the following areas and responsibilities—

Patient care: Requiring the exercise of judgment to assess and respond to patient's needs incurred while in the nuclear medicine department.

Radiopharmaceuticals:Involving the procurement, preparation, calculation, identification, documentation, administration, disposal, storage, and safe handling of such materials.

Quality assurance: Requiring the maintenance of a quality assurance program for instrumentation, radiopharmaceuticals, patient care, and methodologies.

Imaging procedures: Requiring the utilization of the appropriate technical factors that will assure quality diagnostic images.

Non-Imaging procedures: Necessitating the selection and use of appropriate laboratory equipment and reagents to assure quality diagnostic laboratory procedures including labeling of blood components, performance of radioligand assays, and functional studies.

Radionuclide therapy: Nuclear medicine technologists assist nuclear medicine physicians in the therapeutic applications of radionuclides.

Radiation safety: Involving the use of techniques that will minimize radiation exposure to the patient, general public, and health care personnel.

Administrative responsibilities: Requiring current techniques and professional judgment to be used to provide an effective and efficient level of organizational performance in the nuclear medicine department.

Teaching responsibilities: Educating the general public, nuclear medicine technology students, other technologists, health care professionals, patients, and nuclear medicine community on selected topics related to nuclear medicine.

I. Nuclear Instrumentation—Quality Assurance

A. A nuclear medicine technologist performs evaluations of scintillation cameras

1. Obtaining field uniformity images
   a) selecting a radionuclide source of appropriate quantity and energy
   b) selecting pulse height analyzer (PHA) photopeak adjustment
   c) obtaining uniformity images using standardized imaging parameters, i.e., counts, information density (I.D.), intensity, etc.
   d) analyzing the images
   e) making comparisons with previous uniformity image and identifying any nonuniformities
   f) identifying a source of nonuniformity using proper procedures, i.e., checking collimator, PHA peak, detector, cathode ray tube (CRT), and photographic system
   g) initiating corrective action when necessary
2. Performing a detector spatial distortion evaluation
   a) selecting a radionuclide and phantom for spatial distortion check and obtaining images
   b) identifying any nonlinear distortion on the image
   c) determining the source of nonlinearity, i.e., camera system, components, detector-source geometry
   d) initiating corrective action when necessary
3. Performing spatial resolution checks
   a) selecting the appropriate radionuclide
   b) choosing a phantom that is compatible with the specified resolution of a camera
   c) analyzing the resulting images for degradation of resolution
   d) initiating corrective action when necessary
4. Conducting sensitivity checks
   a) positioning source with an appropriate half-life
   b) assuring that identical geometry and measurement parameters are used for repetitive checks
5. Checking the photographic recording device
   a) performing a lens focus check
   b) checking and adjusting CRT dot focus and shape
   c) assessing integrity of CRT phosphor
   d) maintaining cleanliness of all photographic surfaces
6. Maintaining the required records for quality assurance program

B. A nuclear medicine technologist performs routine imaging evaluations on a rectilinear scanner

1. Assessing performance of the sodium iodide NaI (Tl) scintillation detector and spectrometer
   a) calibrating spectrometer with a radionuclide source of appropriate quantity and energy
   b) determining energy resolution full-width half-maximum (FWHM)
   c) conducting a count-rate sensitivity check
   d) checking background and determining the cause for levels greater than established normal levels
2. Calibrating the photorecorder
   a) testing operation of contrast enhancement and background circuits
   b) comparing results with previous tests to determine any changes in system operation
3. Maintaining required records for quality assurance program

C. A nuclear medicine technologist evaluates the performance of NaI (Tl) scintillation probes and well counters

1. Calibrating a spectrometer with a radionuclide source of appropriate quantity and energy
2. Determining energy resolution at FWHM
3. Conducting count-rate sensitivity checks
4. Checking background and determining the cause for levels greater than established normal levels

when indicated
5. Conducting a chi-square test
6. Performing an energy check on spectrometer
7. Performing volumetric calibration on well counter
8. Maintaining required records for quality assurance program

D. A nuclear medicine technologist operates survey meters
1. Calibrating according to Nuclear Regulatory Commission or state agency specifications
2. Performing a reference check-source test and comparing with previous results
3. Maintaining required records for quality assurance program

E. A nuclear medicine technologist evaluates the operation of a dose calibrator (ionization chamber)
1. Ascertaining linearity over the entire range of radionuclide activity to be measured
2. Testing for significant geometric variation in activity measured as a function of sample volume or configuration and determining correction factors
3. Testing accuracy for quantity of activity for commonly used radionuclides that have adequate reference standards available
4. Checking for constancy using a long-lived radionuclide standard
5. Checking background and determining causes for levels greater than established normal levels
6. Establishing and maintaining tests and checks to assure continued proper performance on a daily basis
7. Maintaining required records for quality assurance program

F. A nuclear medicine technologist may operate and maintain film processors
1. Monitoring and recording the maximum film density level and temperature of water and dryer daily
   a) visually inspecting all moving parts for wear or failure
   b) determining the specific gravity of solutions after mixing and prior to releasing into the system
   c) determining pH of solutions after mixing and prior to releasing into the system
   d) maintaining adequate supply of replenishment chemicals
2. Providing monthly preventive maintenance to completely clean film processor and replace all worn parts
3. Reviewing frequency of worn parts and maintaining a replacement inventory in the department

II. Imaging Procedures

A. A nuclear medicine technologist provides patient care
1. Receiving patients and providing for proper nursing care during imaging procedure
2. Providing for patient comfort before, during, and after the procedure
3. Establishing and maintaining good communications with patients—explaining the procedures, answering questions, and listening to patients' comments
4. Providing functionally safe and sanitary conditions for patient
5. Recognizing an emergency condition
   a) initiating call for assistance
   b) monitoring and recording physiologic data including ECG, pulse rate, respiratory rate, temperature, and blood pressure
   c) administering cardiopulmonary resuscitation when necessary
   d) maintaining intravenous fluids, oxygen, and other life-support equipment until emergency code team arrives

B. A nuclear medicine technologist prepares the patient
1. Verifying patient identification and written orders for study
2. Checking for contraindications and obtaining pertinent history
3. Obtaining formal consent when necessary
4. Explaining procedure to patient
5. Checking patient clothing and linen for objects that may cause artifacts on images
6. Preparing patient with premedications (Lugol's, perchlorate), instructing patient to void, etc.
7. Waiting appropriate length of time after administration of radiopharmaceutical to begin imaging procedure

C. A nuclear medicine technologist performs imaging procedures
1. Selecting imaging parameters
   a) selecting the proper instrument and auxiliary equipment necessary to perform imaging procedure
   b) preparing instrument for procedure, i.e., selecting proper collimator, imaging parameters, etc.
   c) selecting appropriate parameters for data acquisition when using a computer
   d) recognizing artifacts that are due to instrument malfunction and initiating appropriate action
2. Positioning patient and obtaining images
   a) performing imaging views according to established protocols and selecting additional views as deemed necessary to optimize value of study
   b) placing patient in correct position using supportive materials and immobilizers to obtain scintigrams for each view
   c) determining correct detector-to-patient distance
   d) indicating appropriate anatomic landmarks

for each view of a procedure

3. Assisting in cardiac stress tests when performed in conjunction with nuclear medicine procedures
   a) preparing patient's skin for ECG lead placement
   b) selecting the correct placement of required ECG leads
   c) recognizing any changes that may occur on either a resting or stress ECG
   d) recognizing the parameters that will terminate a cardiac stress study
4. Performing data processing and data analysis
   a) performing any necessary data manipulations to achieve desired end product of imaging procedure
   b) processing film according to manufacturer's specifications and maintaining film processor to achieve optimum operation
   c) reviewing studies to assure that correct information is supplied and any special views have been obtained
   d) performing data analysis in accordance with physician-approved protocols and reporting results to physician(s) for interpretation
   e) storing data in permanent file for future reference
   f) maintaining quality control for all aspects of an imaging procedure

D. A nuclear medicine technologist performs administrative procedures

1. Maintaining adequate supplies of radiopharmaceuticals and all other materials including film to ensure that patient studies may be performed whenever necessary
2. Scheduling patient studies, ensuring that the correct study is scheduled, and interacting with hospital staff to effect proper and timely arrangements for patient study
3. Determining the most appropriate sequence for multiple procedures
4. Maintaining appropriate records of patient doses, quality control procedures, patient reports, and other required records
5. Maintaining procedure manual and updating manual on a regular basis

III. Radiopharmaceuticals

A. A nuclear medicine technologist initiates purchases of radiopharmaceutical products and adjunct supplies

1. Anticipating and procuring a sufficient supply of radioactive drugs for an appropriate time period in accordance with licensing possession limits
2. Storing drugs and supplies in a manner consistent with labeled product safeguards and with radiological safety considerations
3. Logging in receipts of radioactive materials in a permanent record

B. A nuclear medicine technologist prepares and verifies quality of radioactive drugs under the direction of an authorized physician

1. Employing aseptic technique for manipulation of injectable products
2. Assembling and maintaining radionuclide generators
3. Eluting radionuclide generators according to directions
4. Checking radionuclide generator eluates for desired quality in accordance with official standards and directions
5. Diluting radionuclide generator eluates to appropriate activity concentration, when applicable
6. Selecting appropriate quantity of radioactivity to prepare kit products
7. Confirming quality of a radiopharmaceutical in accordance with accepted techniques and official standards
8. Recording utilization and ultimate disposition of all radioactive materials in a permanent record
9. Measuring radioactivity in patient doses with a dose calibrator and recording results
10. Calculating concentration of radioactivity in a vial or patient dose and labeling the container appropriately

C. A nuclear medicine technologist is responsible for the identification and labeling of all radiopharmaceutical preparations

1. Labeling the immediate container with the radiopharmaceutical, hour, date, and radiation symbol
2. Labeling the outside container with appropriate information to facilitate safe and effective use of the doses
3. Recording all labeling information on a patient's administration form and permanent preparation records
4. Labeling and segregating radioactive waste and recording this information in a permanent record

D. A nuclear medicine technologist prepares and may administer individual dosages under the direction of an authorized physician

1. Applying radioactive decay calculations to determine required volume or unit form necessary to deliver prescribed radioactive dose
2. Drawing or selecting prescribed dosages and entering this information on a patient's administration form and other permanent records
3. Completing labeling of dose for administration
4. Checking radioactivity in dose for administration in a dose calibrator and comparing this measurement against the label of the dose's immediate container
5. Correctly identifying the patient destined to

receive the prescribed radiopharmaceutical
6. Applying aseptic technique when administering injectable dosage
7. Administering radiopharmaceutical by prescribed route of administration

IV. Non-Imaging Procedures

A. A nuclear medicine technologist performs in-vivo studies

1. Operating laboratory equipment
   a) checking accuracy, precision, and operation of pipetting device
   b) using microhematocrit centrifuge and determining hematocrit
   c) computing relative centrifugal force, operating centrifuges, and maintaining routine tachometer checks
   d) maintaining quality assurance records on all laboratory equipment
2. Preparing doses and standards
   a) Quantitating exact dose by
      1) determining decay constant and calculating remaining activity
      2) determining volume necessary to deliver activity according to protocol
      3) drawing dose into syringe using appropriate techniques and materials
      4) dispensing appropriate quantity of capsules, as necessary, for prescribed dose
      5) confirming calculated activity by using a dose calibrator
   b) Preparing standard by
      1) choosing appropriate volumetric or gravimetric techniques to dilute standard
      2) adding radioactive material identical to that given the patient and q.s. to appropriate volume
      3) diluting capsule in appropriate solvent, if necessary, for preparing a standard
3. Collecting proper specimen for procedures
   a) Collecting blood samples by
      1) selecting proper supplies (needles, syringes, evacuated tubes, anticoagulants, etc.)
      2) performing venipuncture at appropriate time intervals using aseptic technique
      3) adding hemolyzing compounds, when necessary
      4) centrifuging blood and separating blood components, as required
      5) storing aliquot of serum, plasma, or whole blood according to protocol
   b) Collecting urine samples by
      1) choosing appropriate container
      2) adding a small amount of preservative to container
      3) instructing patient and nursing staff as to correct method and time of urine collection
      4) aliquoting urine sample and measuring total urine volume
      5) measuring specific gravity of urine, if required
      6) recognizing all technical circumstances which would produce invalid results
   c) Collecting stool samples by
      1) choosing appropriate container
      2) instructing both patient and nursing staff as to correct method and time interval of stool collection
      3) homogenizing stool and aliquot sample for counting
      4) placing sample of stool in carton for counting, maintaining same geometry as used for standard
   d) Performing injections (example: intravenous, intramuscular, intradermal, subcutaneous)
      1) performing injections, as required, using proper aseptic techniques
      2) performing proper post-puncture care
4. Operating counting equipment
   a) setting PHA on scintillation detector and selecting the appropriate photopeak within the analyzer setting chosen for a procedure
   b) counting in-vitro samples, standards, and room background for a statistically significant number of counts, making corrections for geometrical differences, if necessary
   c) outlining organs to be counted externally and counting for a statistically significant number of counts
   d) choosing correct detector-to-patient distance for statistically significant count rate
5. Performing calculations
   a) subtracting room background 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) calculating organ ratios
   f) reporting both patient calculated values and normal range of specific procedure used

B. A nuclear medicine technologist performs in-vitro studies

1. Operating laboratory equipment
   a) checking accuracy, precision, and mechanical operation of all pipetting devices used
   b) maintaining constant temperatures in water baths, refrigerators, refrigerated centrifuges, and freezers and maintaining these records for adequate documentation
   c) computing relative centrifugal force, operating centrifuge, and maintaining routine tach-

ometer checks
d) calibrating and operating pH meters
e) calibrating and using laboratory scales and balances
f) operating vortex mixers and shakers and maintaining constant conditions
g) comparing thermometers with NBS traceable thermometer

2. Collecting blood specimens
a) selecting proper materials for aseptic blood collection (needles, syringes, etc.)
b) choosing proper anticoagulant for specific procedure
c) performing aseptic venipuncture at appropriate time intervals
d) collecting blood sample on ice, as required
e) centrifuging blood and separating blood components, as required
f) storing aliquot of patient sample as dictated by protocol

3. Performing assays
a) allowing assay and patient samples to equilibrate to room temperature, as required
b) preparing assay reagents, following the protocol of each
c) adding radioligand components according to adopted protocol
d) incubating standards and samples in appropriate environment for required time
e) separating bound from free radioactivity using necessary laboratory equipment and techniques
f) loading samples in counter and setting instrument, counting appropriate energy
g) counting all samples for appropriate time to give a statistically significant number of counts
h) reducing data to net counts by subtracting room background and nonspecific binding counts, as necessary
i) calculating the desired fraction (bound/total, bound/free, free/total, etc.) for generation of the standard curve and plotting the standard curve
j) determining data for all patient samples and control samples from derived curve obtained by data processing or manual methods
k) reporting assay results along with normal ranges on laboratory records and patient's request form

4. Maintaining quality assurance
a) developing and maintaining quality assurance procedures for all assays, using appropriate control sera
b) recording daily results of all controls on quality assurance charts
c) performing, periodically, appropriate control sera checks
d) maintaining records of antibody binding for each assay to note any reagent deterioration
e) recognizing a significant shift in assay control and taking appropriate action
f) participating in an external proficiency-testing survey program by
1. reviewing survey
2. observing deviations
3. documenting action taken to alleviate deviations

5. Evaluating assays
a) performing all tasks necessary to assess accuracy, precision, sensitivity, and specificity of an assay
b) developing a normal range for each assay

6. Evaluating kits
a) determining intra-assay and inter-assay variability
b) determining assay accuracy by performing recovery studies
c) recommending kit with best overall performance

7. Managing bio-hazardous waste
a) disposing of all bio-hazardous wastes as required by facility's adopted policy
b) maintaining appropriate documentation

V. Radionuclide Therapy

A. A nuclear medicine technologist assists the licensed physician in therapeutic applications of radionuclides

1. Assuring that correct radiopharmaceutical is prepared in prescribed dosage. The dosage is verified by the licensed physician
2. Maintaining radiation safety procedures while preparing radionuclide therapeutic dosages and/or assisting the licensed physician in administering dosages
3. Assisting the licensed physician in supplying proper patient care instructions to hospital staff, patient, and/or patient's family
4. Assisting the licensed physician in conducting radiation surveys of designated patient areas, when indicated
5. Assisting the licensed physician in supplying hospital staff, patient, and/or patient's family with proper instructions on handling and disposal of all patient excreta, when indicated

VI. Radiation Safety

A. A nuclear medicine technologist under supervision of a licensed physician(s) maintains compliance with local, state, or federal regulations

1. Notifying appropriate authority when change in safety program occurs

2. Assisting in preparation of license amendment application, when necessary
3. Reviewing regulations periodically
4. Maintaining required records
5. Posting appropriate signs in designated areas
6. Designing a program to follow regulations regarding receipt and disposition of all radionuclides
7. Designing and carrying out a program to follow regulations regarding therapeutic doses 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 protection procedures

1. Using personnel monitoring devices (dosimeters, film badges, TLDs, etc.)
   a) reviewing monthly personnel exposure records in regard to maximum permissible dose limits
   b) taking appropriate measures to reduce exposure when necessary
   c) keeping exposure as low as is reasonably achievable using appropriate protection methods continuously
   d) notifying proper authorities of excessive exposure upon occurrence
2. Selecting and using proper shielding to reduce radiation exposure, i.e., employing inverse square law and recommended half-value layers
3. Using proper methods for storage of radioactive materials
4. Identifying and using proper procedures for those radionuclides that pose special hazards

C. A nuclear medicine technologist performs surveys

1. Calibrating instruments at regular intervals, or after repairing and replacing batteries in survey instruments, every three months or as necessary
2. Setting frequency and locations for surveys and following schedules
3. Using proper survey meters for each type and level of activity
4. Following regulations regarding personnel surveys and reporting to the designated physician or R.S.O.
5. Performing constancy checks on survey meters
6. Performing wipe tests where applicable
7. Performing leak tests on sealed sources, when appropriate
8. Recording data in standard format

D. A nuclear medicine technologist performs decontamination procedures

1. Wearing appropriate clothing and foot covering as necessary
2. Blocking access to area and confining a spill
3. Removing contamination or reducing the activity to acceptable levels
4. Monitoring the area and personnel and repeating decontamination procedure until activity levels are acceptable
5. Closing off areas of fixed contamination that are above acceptable levels
6. Identifying, storing, or disposing of contaminated material in accordance with regulations
7. Maintaining adequate records concerning clean-up
8. Notifying appropriate authority in the event of possible overexposure or other violations of regulations

E. A nuclear medicine technologist disposes of radioactive waste

1. Maintaining appropriate records
2. Disposing of waste properly according to license specifications

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

1. 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 personnel arrive at the site of accident or spill.

References

1. NMTCB Task Analysis of Nuclear Medicine Technology, *J Nucl Med Technol* 1979; 7:102–07.
2. Position Description: Nuclear Medicine Technologist, *J Nucl Med Technol* 1979; 7:178–81.