Nuclear medicine

Background

Nuclear medicine is a specialized area of radiology that uses radioactive and stable tracers (radiopharmaceuticals) to study patients’ physiological, biochemical, and cellular processes for diagnosis, therapy, and research. According to the Society of Nuclear Medicine (SNM), nuclear medicine physicians use noninvasive techniques to gather medical information that otherwise would be unavailable, require surgery, or necessitate more expensive diagnostic tests. Nuclear medicine imaging procedures can identify abnormalities early in the progress of a disease or condition (e.g., cancer, heart disease, thyroid disorders, and bone fractures), often before other diagnostic tests can detect medical problems.

During nuclear medicine procedures, small amounts of radioactive materials called radiopharmaceuticals are injected, swallowed, or inhaled to diagnose and treat disease. Nuclear medicine physicians carefully select the amount of materials to use to provide the least amount of radiation exposure to the patient while ensuring an accurate test. The materials are attracted to specific organs, bones, or tissues.

In imaging, the radiopharmaceuticals are detected by positron emission tomography (PET), single-photon emission computed tomography (SPECT), or gamma cameras that work with computers to show precise pictures of the body that provide data and information about the area.

Nuclear medicine physicians complete one or more years of training in an Accreditation Council for Graduate Medical Education (ACGME)—, American Osteopathic Association (AOA)—, or Royal College of Physicians and Surgeons of Canada (RCPSC)—accredited residency program. They then complete a fellowship program in nuclear medicine, which typically lasts three years. The level at which they are applying for the fellowship (NM1, NM2, or NM3) determines the specifics of their prerequisite training. Residents must have successfully completed one year in emergency medicine, family medicine, internal medicine, neurology, obstetrics and gynecology, pediatrics, surgery or surgical specialties, or a transitional year accredited by the ACGME, RCPSC, or the AOA for acceptance into the NM1-level residency.

Radiologists complete a diagnostic radiology residency, followed by successful completion of a nuclear radiology fellowship accredited by the ACGME or the RCPSC or other training judged suitable by the program director.
Involved specialties

Nuclear medicine physicians, nuclear radiologists

Positions of specialty boards

**ABNM**

The American Board of Nuclear Medicine (ABNM) grants certification to nuclear medicine physicians who have:

- Successfully completed the required preparatory training
- Been judged to be competent in the practice of clinical nuclear medicine by the director of their nuclear medicine training program
- Passed a secure computer-based examination encompassing the medical uses of tracers, most often radiopharmaceuticals, and related physical sciences, thereby demonstrating mastery of the knowledge required for excellence in the practice of nuclear medicine

The following training requirements must be fulfilled prior to admission to the ABNM certification exam:

- **General professional education:** Applicants must have graduated from a medical school approved by the Liaison Committee on Medical Education (LCME) or the American Association of Colleges of Osteopathic Medicine. Graduates of medical schools outside the United States or Canada are required to have a certificate from the Educational Commission for Foreign Medical Graduates (ECFMG).
- **Preparatory postdoctoral training:** Before entering nuclear medicine residency, trainees must satisfactorily complete one or more years of residency training that provides broad clinical education, with primary emphasis on the patient and the patient’s clinical problems.
  - Residents should have a sufficiently broad knowledge of medicine to obtain a pertinent history, perform an appropriate physical examination, arrive at a differential diagnosis, and communicate effectively. The training program must be accredited by one of the following organizations or provide equivalent clinical training: ACGME, AOA, RCPSC, or Professional Corporation of Physicians of Quebec (PCPQ).
  - If the preparatory postdoctoral training is not accredited by one of the programs listed above, potential trainees must have a personal interview with a program director of an ACGME-approved nuclear medicine residency, and the program director must confirm equivalent training.
- **Postdoctoral training in nuclear medicine:** After completion of the preparatory postdoctoral training program, the resident must satisfactorily complete a two-year nuclear medicine residency training program (this requirement increases to three years for residents starting their training after July 2007) accredited by the ACGME, RCPSC, or PCPQ. ACGME-accredited nuclear-radiology-only programs do not qualify. The residency training program in nuclear medicine must include:
- Training in clinical nuclear medicine including PET/CT
- Training in basic and allied sciences
- Training based on the six ACGME competencies (patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice)

Applicants who fail the ABNM certification examination three times or who completed their training more than seven years prior to the date of the certification examination are required to satisfactorily complete another year of training in an accredited nuclear medicine training program before they can take or retake the examination. Once they have completed this additional training, they will have three more chances to pass the exam in the seven-year period following completion of their additional training.

Requirements for candidates with other clinical training: Candidates who satisfactorily completed training in another clinical specialty are not required to complete three years of nuclear medicine training.

- If a candidate satisfactorily completes 12 months of training in a nuclear medicine program accredited by the ACGME, RCPSC, or PCPQ before enrolling in a diagnostic radiology residency program accredited by the ACGME or RCPSC, that candidate will meet the training requirements of the ABNM and will be able to apply to take the ABNM certification examination in the final year of the candidate’s radiology residency training provided that the nuclear program director verifies that the candidate successfully completed the training and experience requirements of the Nuclear Regulatory Commission (NRC), the radiology program director verifies that the candidate has completed four months of additional nuclear medicine training during the radiology residency, and the candidate meets the other conditions for taking the ABNM certification exam.

- If a candidate satisfactorily completes 12 months of training in a nuclear medicine program accredited by the ACGME, RCPSC, or PCPQ after satisfactorily completing a diagnostic radiology residency program accredited by the ACGME or RCPSC, that candidate will meet the training requirements of the ABNM provided that the nuclear program director verifies that the candidate successfully completed the training and experience requirements of the NRC and the candidate meets the other conditions for taking the ABNM certification exam.

- If a candidate satisfactorily completes 24 months of training in a nuclear medicine program accredited by the ACGME, RCPSC, or PCPQ after satisfactorily completing a clinically related residency program (e.g., internal medicine, family practice, pathology, pediatrics, surgery) accredited by the ACGME or RCPSC, that candidate will meet the training requirements of the ABNM provided that the nuclear program director verifies that the candidate successfully completed the training and experience requirements of the NRC and the candidate meets the other conditions for taking the ABNM certification exam.
To be eligible for dual certification, a resident must seek American Board of Internal Medicine (ABIM) and ABNM approval of the proposed training program before beginning the combined program. The combined program consists of a total of four years of training in an accredited internal medicine and an accredited nuclear medicine training program and leads to admissibility to certification in both specialties. To meet eligibility for dual certification, the resident must satisfactorily complete 48 months of combined training that is verified by the directors of both training programs. It is strongly recommended that combined training occur in the same institution. Residents will be eligible for admission to the written certifying examination in internal medicine after successfully completing the R-3 year of training and for the nuclear medicine examination after the R-4 year. All training must be in ACGME-, RCPSP-, or PCPQ-accredited programs and approved by the director of each program.

Additionally, program directors must complete an Evaluation of Clinical Competence form to confirm that applicants from their program are competent in clinical nuclear medicine.

In June 2011, the ABNM published ABNM Position Statement: Nuclear Medicine Professional Competency and Scope of Practice to address the evolution of PET from a research methodology to a routine diagnostic imaging method for patients with malignant tumors or with cardiovascular or neurologic disease and changing requirements for ABNM-mandated maintenance of certification (MOC).

According to the statement, nuclear medicine specialists are expert in all aspects of diagnostic and therapeutic nuclear medicine services. They are qualified to interpret the entire range of diagnostic studies, including single-photon and positron-emitter radiopharmaceutical distributions obtained with planar and tomographic techniques and, when appropriate, hybrid tomographic data including coregistered anatomic (CT) and radiotracer (PET or SPECT) images. ABNM-certified nuclear medicine specialists are sufficiently expert to serve as directors of nuclear imaging laboratories, with responsibility for establishing and reviewing imaging procedural protocols, supervising other nonspecialist nuclear image interpreting practitioners, and establishing and reviewing laboratory and physician quality metrics. They are competent to perform all radiopharmaceutical therapies.

According to the ABNM, an ABNM-certified nuclear medicine physician must be able to:

➤ Obtain a pertinent history and perform an appropriate physical examination
➤ Select the most appropriate nuclear medicine examination to address the clinical problem, and perform diagnostic and therapeutic procedures in a manner that is safe to the patient, the staff, and the public
Interpret the results; arrive at a reasonable diagnosis through correlation of all available clinical, laboratory, and other imaging information; and issue a timely report

Recommend further study or treatment as appropriate

Assume responsibility for patient management or be an active participant in the management team when nuclear medicine therapy is indicated

Communicate effectively and promptly with patients and referring physicians in both written and verbal reports

Develop and supervise programs for quality assurance and quality control

Provide expert consultation on the most appropriate and cost-effective examinations, both in nuclear medicine and in complementary imaging modalities

Participate in lifelong education and development of new skills

The practice of nuclear medicine requires special knowledge in the following areas:

Physical science, including:
- Structure of matter
- Modes of radioactive decay, the emissions accompanying radioactive decay, and the biologic implications of these emissions
- Interaction of radiation with matter and its biologic implications
- Single-photon planar imaging, SPECT, PET, attenuation and scatter corrections, and CT
- Basic principles of dual-energy x-ray absorptiometry, MRI and spectroscopy, ultrasonography, digital autoradiography, and optical bioluminescence and fluorescence imaging (because some of these techniques are becoming increasingly important molecular imaging tools)

Instrumentation, including:
- Principles of radiation detection and detectors
- Imaging instrumentation such as g-cameras and SPECT, PET, CT, SPECT/CT, and PET/CT systems
- Nonimaging instrumentation such as the g-well counter, the scintillation probe, the liquid scintillation counter, radiation monitoring devices, the dose calibrator, and surgical g- and b-probes
- Collimation for the various types of radiation detectors
- Electronic instrumentation for nuclear counting and imaging such as pulse amplifiers, pulse-height analyzers, scalers, and counting-rate meters
- Image production and display technology, including reconstruction techniques and digital display
- Quality control principles and procedures

Mathematics and statistics, including:
- Fundamental concepts of mathematics as they apply to nuclear medicine
- Fundamental concepts of statistics, including probability distributions, parametric and nonparametric statistics, and counting statistics
- Principles of medical decision making, including Bayes’ theorem, receiver-operating-characteristic analysis, comparative accuracy of diagnostic tests,
outcomes analysis, cost-effectiveness, comparative effectiveness of therapeutic procedures, and principles of clinical study design and analysis.

- Mathematic models of biologic systems, including tracer compartmental analysis and quantification of organ radiotracer uptake and handling

➤ Computer and information science, including:
  - Basic aspects of computer structure, function, and programming
  - Principles of computer applications, with emphasis on digital image acquisition, image filters, quantitative analyses, image processing and enhancement, tomographic reconstruction, and display and recording of findings
  - Principles of data transport and storage, image transport, picture archiving, image fusion, and telecommunication systems
  - Word processing, medical information systems, database technology, and spreadsheet analysis
  - Medical knowledge databases and information search-and-retrieval strategies
  - Analyses of scientific reports (quality of evidence) and evidence-based practice guidelines

➤ Radiation biology, patient safety, and regulatory knowledge, including:
  - Biologic effects of radiation exposure, with emphasis on the effects of low-level exposure
  - Knowledge of radiation doses received by patients for nuclear medicine and alternative diagnostic procedures
  - Administrative and technical means of reducing unnecessary radiation exposure (as low as reasonably achievable) to patients, personnel, the public, and the environment
  - Système International d’Unités and appropriate conversions
  - Calculation of radiation dose from internally administered radionuclides
  - Diagnosis, evaluation, decontamination, and clinical management of patients exposed to radiation or radioactive materials
  - Governmental regulations regarding limits of radiation exposure, handling of radioactive patients, and disposal of radioactive wastes (Nuclear Regulatory Commission)
  - Establishment of radiation safety programs in accordance with federal and state regulations
  - Governmental regulations regarding drug safety and testing (Food and Drug Administration) and evaluation and approval of tests and interventions for reimbursement (Centers for Medicare and Medicaid Services)

➤ Radiotracer production, biochemistry, and clinical physiology, including:
  - Production of radionuclides by reactors, cyclotrons, and other particle accelerators and the use of radionuclide generators
  - Formulation and labeling of radiotracers; quality control procedures, including sterility and apyrogenicity; and familiarity with good manufacturing practice
Nuclear medicine

- Biochemistry, physiology, molecular biology, and pharmacokinetics of radiotracers and mechanisms of localization in normal and abnormal physiologic states.
- Role of regulatory bodies and regulations applicable to the use of radiotracers and other tracers in nuclear medicine practice and research

➤ In vivo diagnostic use of radiopharmaceuticals and other tracers, including:
- In vivo imaging or body function measurements of the central nervous system, endocrine system, salivary glands, bone marrow and hematologic system, respiratory system, cardiovascular system, gastrointestinal tract, hepatobiliary system, lymphatic system and spleen, musculoskeletal system, and genitourinary system and multiorgan oncologic imaging
- Use of imaging for quantification of physiologic functions such as renal clearance, gastric emptying, and cardiac and gallbladder ejection fraction
- Kinetics, absorption, excretion, and dilution analyses using radiopharmaceuticals and other tracers
- Nonimaging quantitative studies such as measurement of glomerular filtration rate, red cell mass and plasma volume, and intraoperative use of scintillation detectors
- Relationships between, and correlations of, nuclear medicine procedural results and other pertinent imaging modalities including general radiology, mammography, angiography, ultrasonography, CT, MRI, and spectroscopy.
- Relationships between, and correlations of, nuclear medicine procedural results and other pertinent nonimaging studies such as thyroid function tests, renal function tests, blood glucose level, and tumor markers
- Patient monitoring, with special emphasis on electrocardiographic interpretation and cardiopulmonary resuscitation during interventional tests such as exercise and pharmacologic stress myocardial perfusion studies and management of acute allergic reactions
- Pharmacology of drugs and radiotracers used in nuclear medicine
- Diagnostic applications of labeled antibodies, antibody fragments, peptides, metabolic substrates, and cells
- Interventional studies in nuclear medicine, including pharmacologic interventions in cardiac, renal, and hepatobiliary studies

➤ Normal cross-sectional anatomy and alterations in disease, including:
- Normal CT anatomy of the head and neck, thorax, abdomen, pelvis, and extremities (this experience should include studies both with and without intravenous iodinated contrast material)
- The range of diagnostic CT protocols, including strengths and weaknesses for specific applications and potential effects on data representation
- Types and applications of x-ray contrast materials and medical management of contrast reactions
- Critical and important anatomic findings requiring further action
- Comparison of anatomic findings with prior datasets for significant interval change
- Recommendations for appropriate imaging followup of indeterminate or nondiagnostic findings
- Interpretation of hybrid molecular/anatomic imaging (PET/CT or SPECT/CT) and identification of features related to specific imaging protocols

➤ New molecular imaging probes and approaches under preclinical assessment, including:
- Approaches to identification of targets for molecular imaging
- Development of new molecular imaging probes and strategies
- Testing and validation of new imaging tracers for molecular targets
- Reporter gene strategies
- Regulatory requirements for clinical translation of new molecular imaging agents

➤ Therapeutic uses of radionuclides, including:
- Patient selection, including the diagnostic procedures necessary to establish the need for and safety of radionuclide therapy, the indications and contraindications for the use of radionuclide therapeutic procedures, and the effectiveness of these procedures in relation to other therapeutic approaches
- Absorbed radiation dose, including calculation of absorbed radiation dose to the target area, to the surrounding tissue, to other organ systems, and to the total body
- Patient care during radionuclide therapy, including understanding potential early and late adverse reactions, additive toxicity when combined with other therapy, the timing and parameters of anticipated response, and follow-up care and evaluation.
- Potential adverse effects of radiation, including carcinogenic, teratogenic, and mutagenic effects and doses to family members and to the general public.
- Specific therapeutic applications, including radioiodine in hyperthyroidism and thyroid carcinoma, radionuclides for the pain of metastatic bone disease, radiolabeled antibody therapy, intraarterial radiolabeled microspheres for therapy of liver metastases, and radiolabeled peptide therapy

Regarding licensure, the ABNM requires that applicants who plan to practice medicine in the United States must pass the United States Medical Licensing Examination 3 before their application to take the certification examination will be accepted. Applicants must possess a valid, unrestricted license to practice medicine in a state, territory, possession, or province of the country they will practice in. If an applicant does not possess an unrestricted license at the time of application for the certification examination, the ABNM may allow the applicant to take the examination provided that the applicant is applying for and is expected to obtain an unrestricted license. The results of the certification examination will not be released until the applicant provides the ABNM with a copy of the
unrestricted license. If the applicant does not obtain a license by the ABNM deadline (December 31 of the year of the exam), the results of the examination will be null and void.

Applicants who are still in training or who will practice medicine at a teaching institution at the time of the exam may take the exam with an institutional license.

**AOBNM**

The American Osteopathic Board of Nuclear Medicine (AOBNM) no longer grants initial board certification for nuclear medicine physicians. However, the AOBNM does offer an examination for maintenance of certification (MOC).

According to the AOBNM, nuclear medicine MOC is a voluntary exam process for physicians board certified in nuclear medicine prior to January 1995. However, MOC is a mandatory exam process for nuclear medicine physicians with a certificate dated in January 1995 or thereafter.

To be eligible to take the MOC exam, the physician must have AOA membership in good standing for a continuous period, with documentation of at least 120 continuing medical education (CME) hours per three-year AOA cycle. A minimum of 50 hours must be obtained in the primary specialty area.

**ABR**

The American Board of Radiology (ABR) grants subspecialty certification in nuclear radiology to candidates who are certified in diagnostic radiology and pass the ABR nuclear radiology oral examination. Candidates must successfully complete one year of fellowship training in a nuclear radiology program accredited by the ACGME or the RCPSC, which must be documented by a letter from the program director. Candidates must also provide evidence of a current state medical license with an expiration date. Certificates are valid for 10 years.

The ABR also offers an alternate pathway to certification in nuclear radiology. A diplomate of the ABR may attain subspecialty certification without taking an accredited fellowship in nuclear radiology if he or she is on the subspecialty faculty at an institution with an ACGME-accredited fellowship in that discipline. The candidate must serve on the subspecialty faculty at a single institution for two consecutive years with at least a 0.75 FTE in that discipline, or for three consecutive years with at least a 0.50 FTE in that discipline, to qualify to take the initial subspecialty examination.
Positions of societies, academies, colleges, and associations

SNM/ANCP/ACNM

The Practice Standards Committee of the SNM issues joint statements on credentialing and delineation of privileges in conjunction with the American College of Nuclear Physicians (ACNP), the American College of Nuclear Medicine (ACNM), and the ABNM. Statements cover various areas of nuclear medicine regarding the training required to perform, supervise, interpret, and report nuclear medicine procedures, as well as related correlative imaging studies. These joint statements recommend meeting the training criteria listed for each of the following privileges for clinical nuclear medicine:

➤ Cardiovascular CT (CCT)
- The physician must interpret 150 CCT studies with intravenous contrast material under the supervision of a qualified physician
- The physician must complete two months of training in CCT (a minimum of 35 hours per week, of which four weeks must represent supervised laboratory time)
- Physicians need to participate in MOC as required by the ABNM, with evidence of continuing competence in the interpretation and reporting of 50 CCT examinations per year

➤ Cardiac PET
- Certification by the ABNM, the ABR with subspecialty certification in nuclear radiology, or the ABIM including certification in cardiovascular disease, and by the Certification Board of Nuclear Cardiology (CBNC)
- Completion of training in cardiovascular nuclear medicine level II or equivalent, including a minimum of four months of training or experience in cardiovascular nuclear medicine, with interpretation of 300 cases under the supervision of a qualified physician
- Physicians need to participate in MOC as required by the specialty board, with evidence of continuing competence in the interpretation and reporting of 50 cardiac PET or cardiac PET/CT examinations per year

➤ CT performed in conjunction with body PET or SPECT
- Training in ACGME-approved residency in nuclear medicine to include the physics of diagnostic radiology and interpretation of the CT examinations of 500 patients, including a reasonable distribution of CT of the neck, chest, abdomen, and pelvis, under the supervision of a qualified diagnostic radiologist
- Physicians need to participate in MOC as required by the specialty board, with evidence of continuing competence in the interpretation and reporting of 100 PET/CT and/or SPECT/CT examinations per year

➤ Body PET
- Certification by the ABNM or the ABR
- Completion of training must be documented and include 1) interpretation of the PET and/or PET/CT examinations of a minimum of 150 patients
under the direct supervision of an ABNM-certified nuclear physician or an
ABR-certified diagnostic radiologist who has interpreted 500 PET and/or
PET/CT examinations, and 2) eight hours of CME in PET and/or PET/CT
for physicians with ABNM certification and ABR certification with subspe-
cialty certification in nuclear radiology, or 35 hours of CME in PET and/or
PET/CT for physicians with ABR certification
– Physicians need to participate in MOC as required by the specialty board,
with evidence of continuing competence in the interpretation and report-
ing of 100 PET and/or PET/CT examinations per year
➤ Therapeutic procedures using radiopharmaceuticals
– Certification by the ABNM or the ABR
– Nuclear Regulatory Commission (NRC) requirements for authorized user
status for use of therapeutic radionuclides
– ACGME program requirements for therapeutic procedures using
radiopharmaceuticals
– Training and experience including review of the request form and patient
medical record, review of relevant laboratory values (including pregnancy
testing, if appropriate), review of imaging studies as appropriate, interview
of the patient to obtain history, examination of the patient as appropriate,
full explanation of the procedure answering all patient questions (includ-
ing risks and radiation safety precautions) and obtaining informed consent,
calculation of the dose to be administered, supervision of administration of
the dose to the patient, and arrangement for appropriate follow-up
– Physicians need to participate in MOC as required by the specialty board,
with evidence of continuing competence in the safe supervision and effec-
tive administration of therapeutic procedures using radiopharmaceuticals

When delineating privileges to practice nuclear medicine for an individual
physician, the following criteria should be considered:
➤ Graduation from a LCME-approved medical school or school of osteopathy
or graduation from a foreign medical school with possession of an ECFMG
certificate score acceptable for medical licensure in the state of medical
practice. Training in an ACGME-approved residency program in nuclear
medicine or the equivalent should also be considered. For therapeutic pro-
cedures using radiopharmaceuticals, satisfactory completion of an approved
training program in nuclear medicine, nuclear radiology, radiation oncol-
ogy, diagnostic radiology, or the equivalent, plus clinical experience is also
recommended.
➤ Clinical competence, appropriate for medical practice. Malpractice insurance
may be required. Current competency may be demonstrated by one of the
following:
– Documentation of certification by the appropriate ABMS-recognized spe-
cialty board and evidence of recertification as required; where applicable,
documentation of certification by the CBNC for ABIM diplomates with
subspecialty certification in cardiovascular disease
MOC as required by the appropriate ABMS-recognized specialty board or CNBC, if applicable

- A method of review for regular delineation of privileges, required by individual institutions annually
- A definition of which individual procedure or category of procedures may be performed by each physician

**ACGME**

In its *Program Requirements for Graduate Medical Education in Nuclear Medicine* (effective July 1, 2011), the ACGME states that residents must be able to provide patient care that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health. With regard to patient care, residents completing the NM1 year must demonstrate competency in:

- Initial patient evaluation to include pertinent patient information relevant to the requested procedure using patient interview, chart and computer database review, the performance of a focused physical examination as indicated, and communication with the referring physician
- Selection of appropriate nuclear medicine procedures in bone, thyroid, hepatobiliary, and cardiac imaging
- Supervision of the performance of nuclear medicine procedures in bone, thyroid, hepatobiliary, and cardiac imaging, as well as the preliminary review and interpretation of the resulting images
- Therapeutic administration of radioiodine for benign thyroid disease, including patient selection, evaluating risks and benefits, determining the administered dose, patient identity verification, obtaining informed consent, documenting pregnancy status, using administrative controls to prevent a medical event, complying with federal and state regulations regarding medical use of radiopharmaceuticals, counseling patients and their families about radiation safety issues, and scheduling and performing post-therapy follow-up

After completing the NM2 year, residents must demonstrate competency in:

- Selection of appropriate procedure(s) based on the referring physician’s request and the patient’s history
- Selection of the appropriate radiopharmaceutical, dose, imaging technique, data analysis, basic supervisory skills, image presentation, and preliminary interpretation in the performance of parathyroid, gastrointestinal, infection, pulmonary, urinary tract procedures, and PET studies
- Interpretation of PET studies performed for oncologic indications
- Preparation of radiopharmaceuticals, including preparing patient doses and performing quality control measures
- Therapeutic administration of radioiodine for thyroid malignancy, including patient selection, evaluating risks and benefits, determining the administered dose, patient identity verification, obtaining informed consent, documenting pregnancy status, using administrative controls to prevent a medical event,
complying with federal and state regulations regarding the medical use of radiopharmaceuticals, counseling patients and their families about radiation safety issues, and scheduling and performing post-therapy follow-up

After completing the NM3 year, residents must demonstrate competency in:
➤ Recommending, planning, conducting, supervising, interpreting, and reporting diagnostic and therapeutic nuclear medicine procedures appropriate for the clinical problem or condition
➤ Correlating the nuclear medicine procedure with clinical information, laboratory, and other procedural or imaging studies
➤ Interpreting PET studies performed for non-oncologic indications
➤ Therapeutic administration of radiopharmaceuticals, including patient selection, evaluating risks and benefits, determining the administered dose, patient identity verification, obtaining informed consent, documenting pregnancy status, using administrative controls to prevent a medical event, complying with federal and state regulations regarding the medical use of radiopharmaceuticals, counseling patients and their families about radiation safety issues, and scheduling and performing post-therapy follow-up

Residents completing the NM3 year must also be able to interpret the following:
➤ Musculoskeletal studies for benign and malignant disease.
➤ Myocardial perfusion imaging with treadmill and pharmacologic stress, including patient monitoring, with special emphasis on electrocardiographic interpretation.
➤ ECG-gated ventriculography for evaluation of ventricular performance.
➤ Endocrinologic studies, including thyroid and parathyroid. Thyroid studies must include measurement of iodine uptake and dosimetry calculations for radioiodine therapy.
➤ Gastrointestinal studies, including transit studies, liver and hepatobiliary, bleeding, and Meckel’s diverticulum.
➤ Infection studies, including gallium, labeled leukocytes, and bone marrow imaging.
➤ Oncology studies, including sentinel node localization, fluorodeoxyglucose, adrenal, somatostatin-receptor imaging and other agents as they become available.
➤ Neurologic studies, including cerebral perfusion, cerebral metabolism and cerebrospinal fluid. This should include studies of dementia, epilepsy, and brain death.
➤ Pulmonary studies, including perfusion and ventilation for pulmonary embolus, right-to-left shunts, and quantitative assessment of perfusion and ventilation.
➤ Urinary tract studies, including renal perfusion, function and cortical imaging, renal scintigraphy with pharmacologic interventions, and renal transplant evaluation.
Cross-sectional imaging of the brain, head and neck, thorax, abdomen, and pelvis with CT in the context of SPECT/CT and PET/CT.

Residents at all levels must:
- Demonstrate compliance with radiation safety rules and regulations, including NRC or agreement state rules, local regulations, and the ALARA (as low as reasonably achievable) principle for radiation protection
- Have certification in both basic and advanced cardiac life support

According to the ACGME, residents must also demonstrate knowledge of established and evolving biomedical, clinical, epidemiological, and social-behavioral sciences, as well as the application of this knowledge to patient care. With regard to medical knowledge:
- Residents completing the NM1 year should demonstrate basic knowledge of radiation safety; nuclear medicine instrumentation, including quality control; nuclear medicine procedures, including bone scans, thyroid uptake and scans; radioiodine therapy for hyperthyroidism; hepatobiliary scans; myocardial perfusion; and gated ventriculography
- Residents completing the NM2 year should demonstrate basic knowledge in radiopharmacy; nuclear medicine procedures, including parathyroid, gastrointestinal, infection, pulmonary, and urinary tract; radioiodine therapy for thyroid malignancy; PET for oncologic indications; and cross-sectional imaging of the thorax, abdomen, and pelvis with CT in the context of SPECT/CT and PET/CT
- Residents completing the NM3 year should demonstrate competence in their knowledge of all topics included in the didactic curriculum

Positions of accreditation bodies

**CMS**

CMS has no formal position concerning the delineation of privileges for nuclear medicine. However, CMS’ *Conditions of Participation (CoP)* define a requirement for a criteria-based privileging process in §482.22(c)(6) stating, “The bylaws must include criteria for determining the privileges to be granted to individual practitioners and a procedure for applying the criteria to individuals requesting privileges.”

§482.12(a)(6) states, “The governing body must assure that the medical staff bylaws describe the privileging process. The process articulated in the bylaws, rules or regulations must include criteria for determining the privileges that may be granted to individual practitioners and a procedure for applying the criteria to individual practitioners that considers:
- Individual character
- Individual competence
- Individual training
The governing body must ensure that the hospital’s bylaws governing medical staff membership or the granting of privileges apply equally to all practitioners in each professional category of practitioners.”

Specific privileges must reflect activities that the majority of practitioners in that category can perform competently and that the hospital can support. Privileges are not granted for tasks, procedures, or activities that are not conducted within the hospital, regardless of the practitioner’s ability to perform them.

Each practitioner must be individually evaluated for requested privileges. It cannot be assumed that every practitioner can perform every task, activity, or privilege specific to a specialty, nor can it be assumed that the practitioner should be automatically granted the full range of privileges. The individual practitioner’s ability to perform each task, activity, or privilege must be individually assessed. CMS also requires that the organization have a process to ensure that practitioners granted privileges are working within the scope of those privileges.

CMS’ CoPs include the need for a periodic appraisal of practitioners appointed to the medical staff/granted medical staff privileges (§482.22[a][1]). In the absence of a state law that establishes a time frame for the periodic appraisal, CMS recommends that an appraisal be conducted at least every 24 months. The purpose of the periodic appraisal is to determine whether clinical privileges or membership should be continued, discontinued, revised, or otherwise changed.

The Joint Commission

The Joint Commission has no formal position concerning the delineation of privileges for nuclear medicine. However, in its Comprehensive Accreditation Manual for Hospitals, The Joint Commission states, “The hospital collects information regarding each practitioner’s current license status, training, experience, competence, and ability to perform the requested privilege” (MS.06.01.03).

In the introduction for MS.06.01.03, The Joint Commission states that there must be a reliable and consistent system in place to process applications and verify credentials. The organized medical staff must then review and evaluate the data collected. The resultant privilege recommendations to the governing body are based on the assessment of the data.

The Joint Commission introduces MS.06.01.05 by stating, “The organized medical staff is responsible for planning and implementing a privileging process.” It goes on to state that this process typically includes:
➤ Developing and approving a procedures list
➤ Processing the application
➤ Evaluating applicant-specific information
➤ Submitting recommendations to the governing body for applicant-specific delineated privileges
➤ Notifying the applicant, relevant personnel, and, as required by law, external entities of the privileging decision
➤ Monitoring the use of privileges and quality-of-care issues

MS.06.01.05 further states, “The decision to grant or deny a privilege(s) and/or to renew an existing privilege(s) is an objective, evidence-based process.”

The EPs for standard MS.06.01.05 include several requirements as follows:
➤ The need for all licensed independent practitioners who provide care, treatment, and services to have a current license, certification, or registration, as required by law and regulation
➤ Established criteria as recommended by the organized medical staff and approved by the governing body with specific evaluation of current licensure and/or certification, specific relevant training, evidence of physical ability, professional practice review data from the applicant’s current organization, peer and/or faculty recommendation, and a review of the practitioner’s performance within the hospital (for renewal of privileges)
➤ Consistent application of criteria
➤ A clearly defined (documented) procedure for processing clinical privilege requests that is approved by the organized medical staff
➤ Documentation and confirmation of the applicant’s statement that no health problems exist that would affect his or her ability to perform privileges requested
➤ A query of the NPDB for initial privileges, renewal of privileges, and when a new privilege is requested
➤ Written peer recommendations that address the practitioner’s current medical/clinical knowledge, technical and clinical skills, clinical judgment, interpersonal skills, communication skills, and professionalism
➤ A list of specific challenges or concerns that the organized medical staff must evaluate prior to recommending privileges (MS.06.01.05, EP 9)
➤ A process to determine whether there is sufficient clinical performance information to make a decision related to privileges
➤ A decision (action) on the completed application for privileges that occurs within the time period specified in the organization’s medical staff bylaws
➤ Information regarding any changes to practitioners’ clinical privileges, updated as they occur

The Joint Commission further states, “The organized medical staff reviews and analyzes information regarding each requesting practitioner’s current licensure
status, training, experience, current competence, and ability to perform the requested privilege” (MS.06.01.07).

In the EPs for standard MS.06.01.07, The Joint Commission states that the information review and analysis process is clearly defined and that the decision process must be timely. The organization, based on recommendations by the organized medical staff and approval by the governing body, develops criteria that will be considered in the decision to grant, limit, or deny a request for privileges. The criteria must be consistently applied and directly relate to the quality of care, treatment, and services. Ultimately, the governing body or delegated governing body has the final authority for granting, renewing, or denying clinical privileges. Privileges may not be granted for a period beyond two years.

Criteria that determine a practitioner’s ability to provide patient care, treatment, and services within the scope of the privilege(s) requested are consistently evaluated.

The Joint Commission further states, “Ongoing professional practice evaluation information is factored into the decision to maintain existing privilege(s), to revise existing privileges, or to revoke an existing privilege prior to or at the time of renewal” (MS.08.01.03).

In the EPs for MS.08.01.03, The Joint Commission says there is a clearly defined process facilitating the evaluation of each practitioner’s professional practice, in which the type of information collected is determined by individual departments and approved by the organized medical staff. Information resulting from the ongoing professional practice evaluation is used to determine whether to continue, limit, or revoke any existing privilege.

**HFAP**

The Healthcare Facilities Accreditation Program (HFAP) has no formal position concerning the delineation of privileges for nuclear medicine. The bylaws must include the criteria for determining the privileges to be granted to the individual practitioners and the procedure for applying the criteria to individuals requesting privileges (03.01.09).

Privileges are granted based on the medical staff’s review of an individual practitioner’s qualifications and its recommendation regarding that individual practitioner to the governing body. It is also required that the organization have a process to ensure that practitioners granted privileges are working within the scope of those privileges.

Privileges must be granted within the capabilities of the facility. For example, if an organization is not capable of performing open-heart surgery, no physician should be granted that privilege.
In the explanation for standard 03.01.13 related to membership selection criteria, HFAP states, “Basic criteria listed in the bylaws, or the credentials manual, include the items listed in this standard. (Emphasis is placed on training and competence in the requested privileges.)”

The bylaws also define the mechanisms by which the clinical departments, if applicable, or the medical staff as a whole establish criteria for specific privilege delineation.

Periodic appraisals of the suitability for membership and clinical privileges is required to determine whether the individual practitioner’s clinical privileges should be approved, continued, discontinued, revised, or otherwise changed (03.00.04). The appraisals are to be conducted at least every 24 months.

The medical staff is accountable to the governing body for the quality of medical care provided, and quality assessment and performance improvement (03.02.01) information must be used in the process of evaluating and acting on re-privileging and reappointment requests from members and other credentialed staff.

**DNV**

Det Norske Veritas (DNV) has no formal position concerning the delineation of privileges for nuclear medicine. MS.12 Standard Requirement (SR) #1 states, “The medical staff bylaws shall include criteria for determining the privileges to be granted to individual practitioners and a procedure for applying the criteria to those individuals that request privileges.”

The governing body shall ensure that under no circumstances is medical staff membership or professional privileges in the organization dependent solely upon certification, fellowship, or membership in a specialty body or society.

Regarding the Medical Staff Standards related to Clinical Privileges (MS.12), DNV requires specific provisions within the medical staff bylaws for:

- The consideration of automatic suspension of clinical privileges in the following circumstances: revocation/restriction of licensure; revocation, suspension, or probation of a DEA license; failure to maintain professional liability insurance as specified; and noncompliance with written medical record delinquency/deficiency requirements
- Immediate and automatic suspension of clinical privileges due to the termination or revocation of the practitioner’s Medicare/Medicaid status
- Fair hearing and appeal

The Interpretive Guidelines also state that core privileges for general surgery and surgical subspecialties are acceptable as long as the core is properly defined.
DNV also requires a mechanism (outlined in the bylaws) to ensure that all individuals provide services only within the scope of privileges granted (MS.12, SR.4).

Clinical privileges (and appointments or reappointments) are for a period as defined by state law or, if permitted by state law, not to exceed three years (MS.12, SR.2).

Individual practitioner performance data must be measured, utilized, and evaluated as a part of the decision-making for appointment and reappointment. Although not specifically stated, this would apply to the individual practitioner’s respective delineation of privilege requests.

*Note:* Institutions should meet the CoPs and any accreditation standards specific to nuclear medicine/nuclear radiology as well.

**CRC draft criteria**

The following draft criteria are intended to serve solely as a starting point for the development of an institution’s policy regarding nuclear medicine. The core privileges and accompanying procedures list are not meant to be all-encompassing. They define the types of activities, procedures, and privileges that the majority of practitioners in this specialty perform. Additionally, it cannot be expected or required that practitioners perform every procedure listed. Instruct practitioners that they may strikethrough or delete any procedures they do not wish to request.

**Minimum threshold criteria for granting core privileges in nuclear medicine**

*Basic education:* MD or DO

*Minimal formal training:* Successful completion of an ACGME- or AOA-accredited residency in nuclear medicine and/or current certification or active participation in the examination process (with achievement of certification within [n] years) leading to certification by the ABNM or the AOBNM; or successful completion of an ACGME- or AOA-accredited fellowship in nuclear radiology and/or current certification or active participation in the examination process (with achievement of certification in [n] years) leading to certification in nuclear radiology by the ABR.

*Required current experience:* Applicants for initial appointment must be able to demonstrate the successful performance of at least [n] nuclear medicine procedures including 50 CCT examinations; 50 cardiac PET or cardiac PET/CT examinations; 100 CT performed in conjunction with body PET or SPECT examinations; and 100 body PET and/or PET/CT examinations.

**References**

If the applicant is recently trained, a letter of reference should come from the director of the applicant’s training program. Alternatively, a letter of reference
may come from the applicable department chair and/or clinical service chief at the facility where the applicant most recently practiced.

**Core privileges in nuclear medicine**

Core privileges for nuclear medicine include consultation, performance, and interpretation of all routine and nonroutine nuclear medicine procedures to make diagnostic evaluations, by both in vivo and in vitro techniques, of the anatomic and/or physiologic conditions of the body and to provide therapy with unsealed radioactive sources. The core privileges in this specialty include the procedures listed below and such other procedures that are extensions of the same techniques and skills:

- Performance of history and physical exam
- Interpretation of the results of diagnostic examinations of patients using unsealed radionuclides and radiopharmaceuticals
- Performance of radioimmunoassay examinations and management of radioactively contaminated patients and facilities
- Supervision of the preparation, administration, and the use of unsealed radionuclides and radiopharmaceuticals for diagnostic examinations of patients
- Supervision of the preparation, administration, and use of unsealed radionuclides for therapeutic purposes
- Diagnosis, evaluation, clinical management, treatment, monitoring, decontamination, and subsequent control of patients experiencing radiation overexposure in any form

**Reappointment**

Reappointment should be based on unbiased, objective results of care according to a hospital’s quality assurance mechanism.

To be eligible to renew privileges in nuclear medicine, the applicant must demonstrate current competence and an adequate volume of experience ([n] nuclear medicine procedures) including 100 CCT examinations; 100 cardiac PET or cardiac PET/CT examinations; 200 CT performed in conjunction with body PET or SPECT examinations; and 200 body PET and/or PET/CT examinations with acceptable results, reflective of the scope of privileges requested, for the past 24 months based on results of ongoing professional practice evaluation and outcomes. Evidence of current physical and mental ability to perform privileges requested is required of all applicants for renewal of privileges.

In addition, continuing education related to nuclear medicine should be required.
For more information

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