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ABNM Position Statement: Nuclear Medicine Professional Competency and Scope of Practice

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The purpose of this position statement is to define the scope of nuclear medicine practice and the professional competencies required now and for the future. Medical practice will change dramatically over the coming decades in ways no one can predict. The methodologies, technology, and radiotracers will certainly change. However, the core concepts and knowledge that were first required for nuclear medicine board certification in 1971 still hold true and will guide and sustain us into the future. The American Board of Nuclear Medicine (ABNM) is one of the 24 primary boards of the American Board of Medical Specialties (ABMS). This organizational structure provides an infrastructure that promotes transparency and accountability for all the member boards.

CHANGES SINCE THE PRIOR ABNM POSITION STATEMENT

Since the last time an ABNM position statement was published in *The Journal of Nuclear Medicine* (*J Nucl Med.* 2003;44:988–990), there have been significant changes in the scope of nuclear medicine and in the residency training requirements. One major change has been the evolution of PET from a research methodology with limited clinical application to a routine diagnostic imaging method for evaluation of patients with malignant tumors or with cardiovascular or neurologic disease. Imaging with hybrid PET/CT scanners is now the standard for oncology indications. Although ^{18}F-FDG is the only oncologic PET radiopharmaceutical currently approved by the U.S. Food and Drug Administration, others will likely become available. Hybrid SPECT/CT has emerged in parallel with PET/CT and is being rapidly incorporated into diagnostic imaging protocols. Hybrid PET/MRI is under development and may soon be deployed in the clinical setting.

An additional change has been the way in which a physician's competence is viewed. In the past, the board's efforts were focused primarily on assessing the medical knowledge of trainees and diplomates. The evolutionary changes in the practice of nuclear medicine, like all medical specialties, require that all diplomates be engaged in systematic lifelong learning that is credible to the public. The ABNM is no longer merely a specialty certification board that determines the competencies of physicians at the time that they complete their training. Lifetime certificates and even 10-y certifications with recertification are a thing of the past. Lifelong learning must now be documented annually as defined by the ABMS-mandated Maintenance of Certification (MOC) requirements.

The mandated ABMS MOC program consists of 4 parts:

I. Professional standing. The ABNM now automatically receives a report of all disciplinary actions taken by state medical licensing boards, reviews these actions, and formulates an appropriate response according to the severity of the offense.
II. Lifelong learning and self-assessment. The ABNM now monitors continuing medical education activities. Self-assessment activities are now required for continuing medical education.
III. Cognitive expertise. The ABNM certification and MOC examination are now computer-based and are given at over 200 centers in the United States and around the world.
IV. Practice performance assessment. Diplomates are now required to participate in quality improvement activities that involve data from their own practices.

All recent diplomates (since 1992) are required to participate in MOC to maintain their certificates. Diplomates with lifetime certificates are expected to participate.

The concepts of molecular imaging and therapy are guiding our vision of the future. Nuclear medicine is defined by the core knowledge required to apply the tracer principle to study physiologic, biochemical, and molecular processes in humans; it is not defined merely by the technical aspects of how the signal of interest is detected. Molecular imaging, with and without radioactive tracers, is central to how nuclear medicine is practiced today and how it will be practiced in the future.

Therapy using radiopharmaceuticals has always been an important part of nuclear medicine and will likely increase over time because of advances in targeted therapy using radioimmunotherapy and radiopeptides. For example, since the 2003 position statement, therapy for non-Hodgkin

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lymphoma using ^{90}Y- or ^{131}I-labeled monoclonal antibodies has become a routine part of many clinical practices. Treatment of liver metastasis with ^{90}Y-microsphere therapy (SIR-Spheres [Sirtex] or TheraSphere [Nordion]) is also Food and Drug Administration–approved, and its clinical use is growing.

In July 2007, the Nuclear Medicine Residency Review Committee of the American College of Graduate Medical Education (ACGME) implemented revised training requirements that increased residency length from 2 to 3 y (not including the required preparatory clinical year) in response to the expanding scope and increased knowledge required for nuclear medicine practice. Because hybrid-imaging devices have become standard, nuclear medicine physicians now must be knowledgeable about 3-dimensional anatomy and the interpretation of these images.

SCOPE OF NUCLEAR MEDICINE SPECIALIST PRACTICE

On the basis of training and experience, ABNM 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 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. Specialist practitioners devote a substantial fraction of their clinical practice to nuclear medicine to maintain broad competency in diagnostic and therapeutic radionuclide procedures. It is expected that a substantial portion of their ABMS-mandated MOC will be devoted to nuclear medicine and closely related areas of practice.

Physicians completing a training path resulting in eligibility for ABNM certification are qualified nuclear medicine specialist practitioners. Current training requirements include any of the following 3 alternatives: a minimum of 12 mo in an ACGME-accredited nuclear medicine residency after completion of a 4-y diagnostic radiology residency (a total of 16 mo of dedicated nuclear medicine training), a minimum of 24 mo in an ACGME-accredited nuclear medicine residency after completion of another ACGME residency (e.g., internal medicine, surgery, or neurology), or a minimum of 36 mo in an ACGME-accredited nuclear medicine residency after completion of a preparatory postgraduate clinical year. A proposed 4-y combined diagnostic radiology and nuclear medicine residency (which includes 16 mo of dedicated nuclear medicine training) will also result in eligibility for ABNM certification.

NUCLEAR MEDICINE CORE COMPETENCY AREAS

The nuclear medicine physician is a physician first and foremost. Patient contact and interaction are vital parts of what nuclear medicine physicians do. This requires commitment to the 6 core competencies defined by the ABMS (http://www.abms.org/Maintenance_of_Certification/MOC_competencies.aspx):

I. Patient care.
II. Medical knowledge.
III. Interpersonal and communication skills.
IV. Professionalism.
V. Systems-based practice.
VI. Practice-based learning and improvement.

An ABNM-certified nuclear medicine physician must be able to:

I. Obtain a pertinent history and perform an appropriate physical examination.
II. 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.
III. Interpret the results; arrive at a reasonable diagnosis through correlation of all available clinical, laboratory, and other imaging information; and issue a timely report.
IV. Recommend further study or treatment as appropriate.
V. Assume responsibility for patient management or be an active participant in the management team when nuclear medicine therapy is indicated.
VI. Communicate effectively and promptly with patients and referring physicians in both written and verbal reports.
VII. Develop and supervise programs for quality assurance and quality control.
VIII. Provide expert consultation on the most appropriate and cost-effective examinations, both in nuclear medicine and in complementary imaging modalities.
IX. Participate in lifelong education and development of new skills.

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

I. Physical science.
   a. Structure of matter.
   b. Modes of radioactive decay, the emissions accompanying radioactive decay, and the biologic implications of these emissions.
   c. Interaction of radiation with matter and its biologic implications.
   d. Single-photon planar imaging, SPECT, PET, attenuation and scatter corrections, and CT.
   e. 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).

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

III. Mathematics and statistics.
   a. Fundamental concepts of mathematics as they apply to nuclear medicine.
   b. Fundamental concepts of statistics, including probability distributions, parametric and nonparametric statistics, and counting statistics.
   c. 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.
   d. Mathematic models of biologic systems, including tracer compartmental analysis and quantification of organ radiotracer uptake and handling.

IV. Computer and information science.
   a. Basic aspects of computer structure, function, and programming.
   b. 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.
   c. Principles of data transport and storage, image transport, picture archiving, image fusion, and telecommunication systems.
   d. Word processing, medical information systems, database technology, and spreadsheet analysis.
   e. Medical knowledge databases and information search-and-retrieval strategies.
   f. Analyses of scientific reports (quality of evidence) and evidence-based practice guidelines.

V. Radiation biology, patient safety, and regulatory knowledge.
   a. Biologic effects of radiation exposure, with emphasis on the effects of low-level exposure.
   b. Knowledge of radiation doses received by patients for nuclear medicine and alternative diagnostic procedures.
   c. Administrative and technical means of reducing unnecessary radiation exposure (as low as reasonably achievable) to patients, personnel, the public, and the environment.
   d. SI units (Système International d'Unités) and appropriate conversions.
   e. Calculation of radiation dose from internally administered radionuclides.
   f. Diagnosis, evaluation, decontamination, and clinical management of patients exposed to radiation or radioactive materials.
   g. Governmental regulations regarding limits of radiation exposure, handling of radioactive patients, and disposal of radioactive wastes (Nuclear Regulatory Commission).
   h. Establishment of radiation safety programs in accordance with federal and state regulations.
   i. 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).

VI. Radiotracer production, biochemistry, and clinical physiology.
   a. Production of radionuclides by reactors, cyclotrons, and other particle accelerators and the use of radionuclide generators.
   b. Formulation and labeling of radiotracers; quality control procedures, including sterility and apyrogenicity; and familiarity with good manufacturing practice.
   c. Biochemistry, physiology, molecular biology, and pharmacokinetics of radiotracers and mechanisms of localization in normal and abnormal physiologic states.
   d. Role of regulatory bodies and regulations applicable to the use of radiotracers and other tracers in nuclear medicine practice and research.

VII. In vivo diagnostic use of radiopharmaceuticals and other tracers.
   a. 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.
   b. Use of imaging for quantification of physiologic functions such as renal clearance, gastric emptying, and cardiac and gallbladder ejection fraction.
   c. Kinetics, absorption, excretion, and dilution analyses using radiopharmaceuticals and other tracers.

d. Nonimaging quantitative studies such as measurement of glomerular filtration rate, red cell mass and plasma volume, and intraoperative use of scintillation detectors.
e. Relationships between, and correlations of, nuclear medicine procedural results and other pertinent imaging modalities including general radiology, mammography, angiography, ultrasonography, CT, MRI, and spectroscopy.
f. 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.
g. 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.
h. Pharmacology of drugs and radiotracers used in nuclear medicine.
i. Diagnostic applications of labeled antibodies, antibody fragments, peptides, metabolic substrates, and cells.
j. Interventional studies in nuclear medicine, including pharmacologic interventions in cardiac, renal, and hepatobiliary studies.

VIII. Normal cross-sectional anatomy and alterations in disease.
a. 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).
b. The range of diagnostic CT protocols, including strengths and weaknesses for specific applications and potential effects on data representation.
c. Types and applications of x-ray contrast materials and medical management of contrast reactions.
d. Critical and important anatomic findings requiring further action.
e. Comparison of anatomic findings with prior datasets for significant interval change.
f. Recommendations for appropriate imaging follow-up of indeterminate or nondiagnostic findings.
g. Interpretation of hybrid molecular/anatomic imaging (PET/CT or SPECT/CT) and identification of features related to specific imaging protocols.

IX. New molecular imaging probes and approaches under preclinical assessment.
a. Approaches to identification of targets for molecular imaging.
b. Development of new molecular imaging probes and strategies.
c. Testing and validation of new imaging tracers for molecular targets.
d. Reporter gene strategies.
e. Regulatory requirements for clinical translation of new molecular imaging agents.

X. Therapeutic uses of radionuclides.
a. 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.
b. 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.
c. 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.
d. Potential adverse effects of radiation, including carcinogenic, teratogenic, and mutagenic effects and doses to family members and to the general public.
e. 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.

SUMMARY

This document is not meant to be an all-inclusive list of everything that encompasses the field of nuclear medicine, which is ever changing, nor is it a list of topics and knowledge required to pass a certification or MOC examination. Nuclear medicine program requirements and the ABNM examination content manual are available on the ACGME Web site (http://www.acgme.org/acWebsite/RRC_200/200_prIndex.asp) and the ABNM Web site (http://www.abnm.org/contmanual.pdf), respectively. New requirements for ACGME nuclear medicine program residency go into effect on July 1, 2011. The ABNM uses these as reference guides; however, the ABNM examinations are written by the 12 experts who make up the ABNM and have years of different experiences in academic and community practices. To take the certification examination, the physician's program director must first document that a resident has successfully completed the residency training. The certification examination emphasizes basic science and the clinical knowledge and understanding acquired during residency that allow one to be prepared to competently practice nuclear medicine. The MOC examination is similar except that it emphasizes present-day clinical practice. Future MOC examinations may be modular so that practitioners can be tested in the areas of nuclear medicine that are most relevant to their clinical practice—for example, general nuclear medicine, hybrid imaging, cardiovascular nuclear medicine, and therapy.