

# NUCLEAR CARDIOLOGY LABORATORY AND CONSULTATION SERVICE

## Mission Statement

“Nuclear cardiology methods provide important diagnostic and prognostic information with which all modern cardiologists should be conversant.”

Task force for Training in Nuclear Cardiology  
The American College of Cardiology<sup>1</sup>.

The mission of the UPMC Nuclear Cardiology Laboratory and teaching program is (1) to optimize the accurate, safe and cost effective management of patients with known or suspected heart disease; (2) to stimulate professional growth of trainees by providing them with clinical and investigative expertise in the performance, interpretation and clinical application of cardiovascular nuclear medicine studies in the assessment of diagnosis, prognosis, as well as assessment of therapeutic efficacy or toxicity of medical and surgical interventions; and (3) to stimulate research and further the contributions of the discipline to the field of cardiovascular medicine.

## Statement of Educational Goals

The curriculum is designed to promote six broad goals based on the six ACGME core competencies:

1. Medical Knowledge: exposure to a broad range of acute and chronic cardiovascular problems including both through direct patient management and in a consultative role to other services. Many formal and informal didactic teaching sessions are used as well.
2. Patient Care: accurate, physiologically-reasoned diagnosis, at the bedside, in the emergency department and in the ambulatory setting; expert selection of diagnostic tests and referrals for intervention, restrained by considerations of risk, benefit and cost; formulation of a management plan sensitively tailored to the unique medical and life circumstances of each patient. This plan must include rehabilitative and preventive measures.
3. Professionalism: effective, mutually satisfying communication with patients, families and other physicians and allied health care personnel. Working with other allied health care team professionals to provide patient focused care. This is especially important in the consultative role the resident will undertake on this service. Maintaining highest ethical standards and strict privacy when discussing patient case plans with other providers.
4. Interpersonal and Communication skills: Most importantly this will be critical in the new role the resident will assume as a consultant. Effective communication with other non-cardiology physicians, nurses and allied professions in working with them to develop a plan of care for patients for whom the consultation resident does not assume primary care responsibilities. Being able to explain the

necessity of cardiac evaluations clearly and concisely using verbal and written communication will be of paramount importance. In addition, since you are not the patient's longterm primary physician, rapidly developing a rapport with patients and families in a limited time period through good listening and communication skills will be critically important to learning the role of an effective consultant as well.

5. Practice Based Learning: Using information technology, literature sources and other available resources to practice evidence based medicine based on sound medical principles, guidelines and best practices, while being still able to individualize this for a particular patient's circumstances.
6. Systems Based Learning: during interaction with other medical services and providers in your primary role as a consultant, it will be important to learn how their care delivery systems work (eg. surgical OR schedules and flow, pre-operative evaluation clinics and techniques and where, how and by whom most post-operative care is delivered ). Understanding this will be critical to your ability to getting consultative recommendations implemented in a timely manner.

#### Statement of Educational Objectives for Fellows

Goals of this service will be achieved by participation on rotations in nuclear cardiology devoted to the diagnosis and prognosis of patients with known or suspected cardiovascular disease in both hospitalized and ambulatory patients. Fellows/Residents will be expected to play an active role in all aspects of patient care in the nuclear cardiology laboratory and interact directly with faculty members and referring health care professionals on this rotation to communicate the findings and clinical significance of the findings of the nuclear cardiology examination. The goals of this rotation include developing performance adequacy in the field of nuclear cardiology which includes both technical skills, interpretation skills, and clinical integration skills. The cardiology faculty/staff member(s) assigned to the Nuclear Cardiology Laboratory and Consultation service will have direct responsibility for fellow/resident education.

#### **General Statement of Educational Objectives for Fellows**

The training program in Nuclear Cardiology at the University of Rochester advocates the general goals of Task Force 5 report of the American Society of Nuclear Cardiology (ASNC) and American College of Cardiology (ACC) (<http://www.asnc.org/yourpractice/nctraining.cfm>).

The training program seeks to provide trainees technical and professional experiences that will facilitate their professional growth. The cardiology fellow benefits from interaction in a very modern laboratory with highly trained laboratory personnel as well as other trainees in both technical and professional spheres. The first year cardiology rotation in Nuclear Cardiology is designed by Dr. Ronald Schwartz, Director of Nuclear

Cardiology, to fulfill a significant portion of the first level of training recommended by the American College of Cardiology<sup>1</sup>. These guidelines specify that training for cardiology fellows should be divided into three levels:

1. *General training* (2 months) for all cardiology fellows is designed to make the fellow conversant with the field of nuclear cardiology (level 1).

Note current assignment of cardiology trainees to one month full time training meets 50% of this requirement. It is the responsibility of the fellow to ensure a minimum of one additional month is spent during the entire fellowship training experience in nuclear cardiology to satisfy the ASNC / ACC guideline criteria.

2. *Specialized training* (4 to 6 months) for fellows who wish to have special expertise in clinical nuclear cardiology and practice nuclear cardiology (level 2). As part of the revised COCATS requirements, fellows will also be able to attend an on-site 200 hour course given in July of each year, which will satisfy the nuclear radiation safety training requirements for nuclear cardiology certification and licensure.

3. *Advanced training* (1 year) for trainees who wish to pursue an academic direction in nuclear cardiology, including patient care, teaching and research (level 3).

Fellows are encouraged to review carefully the guidelines of the ACC for training in Nuclear Cardiology as they plan their training program. Fellows are responsible for documenting their adherence to these guidelines. Fellows are expected to develop a sufficient fund of knowledge to permit clinical application of nuclear cardiology and to perform the testing procedures safely and effectively. Participation in a minimum of 80 hours of active participation in daily radionuclide study interpretation with the Director of Nuclear Cardiology is required. Knowledge and appreciation of radiation safety as it relates to administration and handling of radiopharmaceuticals is also required, and certification by the Radiation Safety Unit of the Medical Center is highly recommended (<http://intranet.urmc.rochester.edu/radiationsafety/rshpage.htm>.)

Fellows are expected to gain experience with Nuclear Cardiology Procedures and training components as outlined in the following Tables.

**Table 1: Classification of Nuclear Cardiology Procedures**

1. Standard nuclear cardiology procedures
  - a. Myocardial perfusion imaging
    - i. Single photon emission computed tomography (SPECT) with technetium agents and thallium
    - ii. Planar with technetium agents and thallium
    - iii. Electrocardiographic (ECG) gating of perfusion images for assessment of global and regional ventricular function
    - iv. Imaging protocols
    - v. Stress protocols
  6. Exercise stress
  7. Pharmacologic stress
    - Viability assessment including reinjection and delayed imaging of thallium and metabolic imaging where available
    - b. Equilibrium gated blood pool or "first pass" radionuclide angiography at rest and during exercise or pharmacologic stress
    - c. Qualitative and quantitative methods of image display and analysis
2. Less commonly used nuclear cardiology procedures
  - a. Metabolic imaging using single photon and/or positron emitting radionuclides
  - b. Myocardial infarct imaging
  - c. Cardiac shunt studies
  - d.

General Cardiology Training Background

To have an adequate understanding of the clinical applications of nuclear cardiology and to perform tests safely, the cardiology trainee must acquire knowledge and proficiency in the following areas of general cardiology:

1. Coronary angiography and physiology
2. Cardiac physiology and pathophysiology

3. Rest and exercise electrocardiography
4. Exercise physiology
5. Pharmacology of standard cardiovascular drugs
6. Cardiopulmonary resuscitation and treatment of other cardiac emergencies
7. Pharmacology and physiology of commonly used stress agents, such as dipyridamole, adenosine and dobutamine
8. Clinical outcomes assessment

### Overview of Nuclear Cardiology Training

Training in nuclear cardiology at all levels should provide an understanding of the indications for specific nuclear cardiology tests, the safe use of radionuclides, basics of instrumentation and image processing, methods of quality control, image interpretation, integration of risk factors, clinical symptoms and stress testing and the appropriate application of the resultant diagnostic information for clinical management. The depth of understanding will vary with each of the three Levels of training. Training in nuclear cardiology is best acquired in Accreditation Council for Graduate Medical Education (ACGME) approved training programs in cardiology, nuclear medicine or radiology. An exception to this ACGME requirement is the didactic and laboratory training in radiation safety and radioisotope handling that may be provided by qualified physicians/scientists in a non-ACGME program when such a program is not available as part of the clinical ACGME training program.

Nuclear cardiology training consists of the components shown in Table 2. Didactic, clinical case experience and hands-on training hours require documentation in a logbook, having the trainee's name appear on the clinical report or having some other specific record. The hours need to be monitored and verified by the nuclear cardiology training preceptor. For the advanced trainee, specialized training and research can be derived as part of an established program in either cardiology or a division of nuclear medicine. The person(s) responsible for the didactic, clinical and hands-on training and experience are responsible for evaluating the competence of the trainee in nuclear cardiology upon completion of the program. This can be accomplished by observing the daily performance of the fellow, a formal testing procedure, or both. The preceptor for specialized or advanced training should have Level 3 (or the equivalent) training in nuclear cardiology.

### **Table 2: Nuclear Cardiology Training Components**

1. Didactic Program
  - a. Lectures and self-study
  - b. Radiation safety

2. Interpretation of Clinical Cases
3. Hands-On Experience
  - a. Clinical cases
  - b. Radiation safety

#### Didactic Program

Lectures and self-study. This component is composed of lectures on the basic aspects of nuclear cardiology and parallel self-study material consisting of reading and viewing cases on video or CD. The lectures and reading should provide the fellow with an understanding of the clinical applications of nuclear cardiology, including imaging with positron emitting radionuclides. The material covered should include radiopharmaceuticals, instrumentation, nuclear cardiology diagnostic tests and procedures/protocols, general cardiology as it relates to image interpretation, risk stratification, myocardial perfusion imaging, ventricular function imaging and assessment of myocardial viability. Specificity, sensitivity, diagnostic accuracy, utility in assessing prognoses and interventions, costs, indications and pitfalls in interpretation and clinical application must be emphasized for each patient subset.

This program may be scheduled over a 12- to 24-month period, concurrent with other fellowship assignments. Some of the information can be effectively transmitted as part of a weekly noninvasive or invasive cardiology conference with presentation and discussion of nuclear cardiology image data.

Radiation safety. The second component of the didactic program should provide the fellow with an understanding of radiation safety as it relates to patient selection and administration of radiopharmaceuticals. Fellows seeking Level 2 or Level 3 training will require greater in-depth knowledge as well as hands-on practical experience. These are detailed for each level.

#### Interpretation of Clinical Cases

During training, fellows should actively participate in daily nuclear cardiology study interpretation under the direction of a qualified preceptor in nuclear cardiology. For all studies in which angiographic or hemodynamic data are available, such information should be correlated with the nuclear cardiology studies. Although experience in all aspects of nuclear cardiology is recommended, some procedures may not be available-or may be performed in low volume-in some training programs. Under such circumstances, an adequate background for general fellowship training can be satisfied with appropriate reading or review of case files. Training in nuclear cardiology needs to include extensive experience with the standard nuclear cardiology procedures and as much exposure as possible with the less commonly performed procedures. The training program needs to provide a teaching file consisting of perfusion and ventricular function studies with angiographic/cardiac catheterization documentation of disease.

## **Hands-On Experience**

**Clinical cases.** Fellows should have hands-on supervised experience in an appropriate number of the standard procedures (e.g., myocardial perfusion imaging and radionuclide angiography) and as many of the less commonly performed procedures as possible. Such experience should include pretest patient evaluation; radiopharmaceutical preparation-measuring the dose, administration and experience with relevant radionuclide generators; operation and quality control of planar and SPECT gamma camera systems; setup of the imaging computer; utilization of ECG gating; performing treadmill, bicycle and pharmacologic stress testing techniques; processing the data for display; interpreting the study; and generating a clinical report. Complete nuclear cardiology studies should be performed under the supervision of qualified personnel. **IT IS ALSO EXPECTED, ESPECIALLY DURING THE FIRST YEAR OF FELLOWSHIP, THAT FELLOWS WILL ACTIVELY PARTICIPATE IN THE STRESS PORTION OF THE TEST, DIRECTLY PARTICIPATING IN TREADMILL AND PHARMOCOLOGIC PROTOCOLS. THESE SHOULD BE DOCUMENTED BY THE FELLOW TO TRACK THE NUMBER OF STRESS TESTS DIRECTY SUPERVISED DURING THEIR TRAINING.**

**Radiation safety.** Fellows need to be familiar with radiation biology and the regulations governing the use of radioactive materials for performing diagnostic nuclear cardiology studies. This knowledge includes details for protecting patients, the public and the user from the effects of radiation.

### **General Training-Level 1 (Minimum of Two Months)**

The trainee is exposed to the fundamentals of nuclear cardiology for a minimum period of two months during training. This two-month experience provides familiarity with nuclear cardiology technology and its clinical applications in the general clinical practice of adult cardiology, but it is not sufficient for the specific practice of nuclear cardiology. The three components of training include a didactic program that includes lectures, self-study, radiation safety and regulations, interpretation of nuclear cardiology studies and hands-on experience.

### **Didactic Program**

**Lectures and self-study.** This component consists of lectures on the basic aspects of nuclear cardiology and parallel self-study material consisting of reading and viewing case files. The material presented should integrate the role of nuclear cardiology into total patient management. Such information can be included within a weekly noninvasive or invasive cardiology conference, with presentation and discussion of nuclear cardiology image data as part of diagnostic and therapeutic management.

**Knowledge and appreciation of radiation safety.** The didactic program should include reading and practical experience with the effects of radiation and provide the fellow with an understanding of radiation safety as it relates to patient selection and administration of radiopharmaceuticals.

### **Interpretation of Nuclear Cardiology Studies**

During the two-month rotation, fellows should actively participate in daily nuclear cardiology study interpretation (minimum of 80 h). Experience in all the areas listed in Table 1 is recommended. If some procedures are not available or are performed in low volume, an adequate background for general fellowship training can be satisfied by appropriate reading or review of case files. The teaching file should consist of perfusion and ventricular function studies with angiographic/cardiac catheterization documentation of disease.

### **Hands-On Experience**

Fellows should perform complete nuclear cardiology studies alongside a qualified technologist or other qualified laboratory personnel. They should, under supervision, observe and participate in a large number of the standard procedures and as many of the less commonly performed procedures as possible. Fellows should have experience in the practical aspects of radiation safety associated with performing clinical patient studies.

### **Specialized Training-Level 2 (Minimum of Four Months)**

Fellows who wish to practice the specialty of nuclear cardiology are required to have at least four months of training. This includes a minimum of 700 h of didactic, clinical study interpretation and hands-on clinical case and radiation safety training in nuclear cardiology. In training programs with a high volume of procedures, clinical experience may be acquired in as short a period as four months. In programs with a lower volume of procedures, a total of six months of clinical experience will be necessary to achieve Level 2 competency. The additional training required of Level 2 trainees is to enhance their clinical skills and qualify them to become authorized users of radioactive materials in accordance with the regulations of the Nuclear Regulatory Commission (NRC) and/or the Agreement States. Requirements do vary among Agreement States; therefore, those seeking licensure are advised to check the Agreement State/NRC website at <http://www.hsr.gov/nrc/asframe.htm>.

### **Didactic**

**Lectures and self-study.** The didactic training should include in-depth details of all aspects of the procedures listed in Table 1. This program may be scheduled over a 12- to 24-month period concurrent and integrated with other fellowship assignments.

**Radiation safety.** Classroom and laboratory training need to include extensive review of radiation physics, radiation protection, mathematics pertaining to the use and measurement of radioactivity, chemistry of byproduct material for medical use, radiation biology and radiopharmaceuticals. There should be a thorough review of regulations dealing with radiation safety for the use of radiopharmaceuticals.

### **Interpretation of Clinical Cases**

Fellows should participate in the interpretation of all nuclear cardiology imaging data for the four to six-month training period. It is imperative that the fellows have experience in correlating catheterization/angiographic data with radionuclide-derived data for a minimum of 30 patients. A teaching conference in which the fellow presents the clinical

material and nuclear cardiology results is an appropriate forum for such an experience. A total of 300 cases should be interpreted under preceptor supervision, either from direct patient studies or from a teaching file consisting of diverse types of procedures (Table 1).

### **Hands-On Experience**

**Clinical cases.** Fellows acquiring Level 2 training should have hands-on supervised experience with a minimum of 35 patients: 25 patients with myocardial perfusion imaging and 10 patients with radionuclide angiography. Such experience should include pretest patient evaluation, radiopharmaceutical preparation (including experience with relevant radionuclide generators), performance of the study, administration of the dosage, calibration and setup of the gamma camera, setup of the imaging computer, processing the data for display, interpretation of the studies and generating clinical reports. Radiation safety. This experience should be under the supervision of an authorized user who meets the NRC requirements of Part 35.290 or Part 35.390 or the equivalent Agreement State requirements, and should include:

- a. Ordering, receiving and unpacking radioactive materials safely and performing the related radiation surveys;
- b. Calibrating instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;
- c. Calculating, measuring and safely preparing patient or human research subject dosages;
- d. Using administrative controls to prevent a medical event involving the use of unsealed byproduct material;
- e. Using procedures to safely contain spilled radioactive material and using proper decontamination procedures;
- f. Administering dosages of radioactive material to patients or human research subjects; and
- g. Eluting generator systems appropriate for preparation of radioactive drugs for imaging and localization studies, measuring and testing the eluate for radionuclide purity, and processing the eluate with reagent kits to prepare labeled radioactive drugs.

### **Additional Experience**

The training program for Level 2 must also provide experience in computer methods for analysis. This should include perfusion and functional data derived from thallium or technetium agents and ejection fraction and regional wall motion measurements from radionuclide angiographic studies.

### **Advanced Training-Level 3 (Minimum of One Year)**

For fellows planning an academic career in nuclear cardiology or a career directing a clinical nuclear cardiology laboratory, an extended program is required. This may be part of the standard three-year cardiology fellowship. In addition to the recommended

program for Level 2, the Level 3 program should include advanced quality control of nuclear cardiology studies and active participation and responsibility in ongoing laboratory or clinical research. In parallel with participation in a research program, the trainee should participate in clinical imaging activities for the total training period of 12 months, to include supervised interpretative experience in a minimum of 600 cases. Hands-on experience should be similar to, or greater than, that required for Level 2 training. The fellow should be trained in most of the following areas:

- Qualitative interpretation of standard nuclear cardiology studies, including myocardial perfusion imaging, ECG gated perfusion studies, gated equilibrium studies, "first-pass" and any of the less commonly performed procedures available at the institution
- Quantitative analysis of perfusion and/or metabolic studies
- Quantitative radionuclide angiographic and gated perfusion analyses, including measurement of global and regional ventricular function
- SPECT perfusion acquisition, reconstruction and display
- ECG gated SPECT perfusion acquisition, analysis and display of functional data
- Imaging of positron emitting tracers using either dedicated positron emission tomography (PET) systems or SPECT-like systems equipped with either high photon energy collimators or coincidence detection

The requirements for Level 1-3 training in nuclear cardiology are summarized in Table 3.

**Table 3: Summary of Training Requirement for Nuclear Cardiology**

Level	Minimum Duration of Training	Total No. of Examinations
1	2 Months	80 h interpretative experience
2	4-6 Months	300*
3	12 Months	600*

\*A minimum of 35 cases with hands-on experience must be performed and interpreted under supervision. The remaining supervised interpretative experience can be obtained from a teaching file.

### **Specific Training in Cardiac Imaging of Positron Emitting Radionuclides**

Cardiac PET and imaging of positron emitting radionuclides is part of nuclear cardiology but technically different and not widely available. Nevertheless, at this time, for institutions that have positron imaging devices, training guidelines are appropriate. Training in this particular imaging technology should go hand-in-hand and may be concurrent with training in conventional nuclear cardiology. Such training should include those aspects that are unique or specific to the imaging of positron emitting radionuclides. Depending on the desired level of expertise, training in cardiac PET and imaging with positron emitting radionuclides should include knowledge of substrate metabolism in the normal and diseased heart; knowledge of positron emitting tracers for blood flow,

metabolism and neuronal activity, medical cyclotrons, radioisotope production and radiotracer synthesis; and principles of tracer kinetics and their in vivo application for the noninvasive measurements of regional metabolic and functional processes. The training should also include the physics of positron decay, aspects of imaging instrumentation specific to imaging of positron emitters, production of radiopharmaceutical agents, quality control, handling of ultra-short life radioisotopes, appropriate radiation protection and safety and regulatory aspects.

Consistent with the training guidelines for general nuclear cardiology, training should be divided into three classes.

### **General Training (Two Months)**

This level is for cardiology fellows who are associated with an institution where PET or positron imaging devices are available and who wish to become conversant with cardiac positron imaging. Training should therefore be the same as for Level 1 training in nuclear cardiology but should include aspects specific to cardiac positron imaging. The additional proficiency to be acquired by physician trainees includes background in substrate metabolism, patient standardization and problems related to diabetes mellitus and lipid disorders, positron emitting tracers of flow and metabolism and technical aspects of positron imaging. A didactic program should include the interpretation of cardiac PET studies of myocardial blood flow and substrate metabolism, the interpretation of studies combining SPECT for evaluation of blood flow with PET for evaluation of metabolism, the evaluation of diagnostic accuracy and cost-effectiveness of viability assessment of coronary artery disease detection, and the understanding of radiation safety as specifically related to positron emitters. Hands-on experience should include supervised observation and interpretation of cardiac studies performed with positron emitting radionuclides and positron imaging devices.

### **Specialized Training (Minimum of Four Months)**

This level of training is for fellows who wish to perform and interpret cardiac PET or positron imaging studies in addition to nuclear cardiology. This training should include all Level 1 and Level 2 training in nuclear cardiology (four to six months) as well as general training for cardiac PET. Specific aspects of training for PET and for using positron emitting radionuclides should include radiation dosimetry, radiation protection and safety, dose calibration, physical decay rates of radioisotopes, handling of large doses of high energy radioactive materials of short physical half-lives, quality assurance procedures and NRC safety and record-keeping requirements. This level of training requires direct patient experience with a minimum of 40 patient studies of myocardial perfusion or metabolism, or both.

### **Advanced Training (Minimum One Year)**

This level of training is intended for fellows planning an academic career in cardiac PET or who wish to direct a clinical cardiac PET laboratory. Similar to Level 3 training in nuclear cardiology, this training should include active participation in laboratory and clinical research in parallel with clinical activities.

In addition to the requirements for general and specialized cardiac PET training (including standard nuclear cardiology training, as previously described), advanced training should include the following:

1. Basic principles of cyclotrons, isotope production, radiosynthesis, tracer kinetic principles and tracer kinetic models, cardiac innervation and receptors, and methods for quantifying regional myocardial blood flow and substrate metabolism.
2. Imaging instrumentation including dedicated PET systems and SPECT-like positron imaging devices with high-energy photon collimators or coincidence detection. Image acquisition and processing to include review of sinograms, errors in image reconstruction, correction routines for photon attenuation, and patient misalignment.
3. Tissue kinetics of positron emitting tracers; in vivo application of tracer kinetic principles; tracer kinetic models, generation of tissue time activity curves and computer-assisted calculation of region of functional processes of the myocardium.
4. Computer-assisted data manipulation, quantitative image analysis and image display.

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<sup>+</sup>The issues of ongoing clinical competence and training or retraining of practicing cardiologists are beyond the scope of this document. The Certification Board of Nuclear Cardiology (CBNC) was established jointly by the ACC and ASNC and assesses knowledge and mastery in the areas of radiation safety and the technical and clinical performance of nuclear cardiology procedures. For additional information, contact CBNC at 9111 Old Georgetown Road, Bethesda, Maryland 20814, <http://www.cbnc.org>.

<sup>1</sup> Level 2 and Level 3 training meet eligibility criteria for taking the Certification Board of Nuclear Cardiology examination and NRC training and experience requirements to become an authorized user. The NRC establishes federal policy with regard to the medical use of nuclear reactor byproduct materials. Currently, there are 31 states that have applied and been approved by the NRC to self-regulate the use of radioactive materials, so called "Agreement States." The other 19 states are regulated by the federal policy. There is variation within the Agreement States in the training and experience requirements for physicians applying to become authorized users of radioactive materials for diagnostic testing. The NRC requires only that the Agreement State requirements be as stringent as the Federal NRC policy, but states have the authority to make the requirements more stringent. Some states require a greater number of total hours for the didactic, classroom and laboratory experience in radiation safety. Other states have restricted the acceptable programs or institutions where such training hours maybe acquired. Given this variability in training and experience requirements within the U.S., trainees are advised to contact the NRC and the Agreement States where they may seek to become authorized users of radioactive materials for the current rules and requirements. For details contact the Agreement States Homepage at <http://www.hsrdo.org/nrc/home.html> Click on Directory and then click on Directory

of Agreement States and Non-Agreement State Directors and State Liaison Officers. This will provide you with information on contacting the individual states and getting the specific licensure requirements.

## **CERTIFICATION ISSUES**

### **Becoming An Authorized User**

Under 10 CFR Part 35, Medical Use of Byproduct Material, published in the October 24, 2002 *Federal Register* cardiologists may complete requirements for authorized user status through two pathways. First, in NRC states, a cardiologist may complete a total of 700 hours divided into two categories: (1) classroom and laboratory training and (2) supervised work experience. The NRC dropped the 500 hour requirement for supervised clinical experience based on its decision to "remove itself completely from the practice of medicine." A preceptor (a physician who is a current authorized user) must certify a candidate's competency by signing a statement. For a list of both NRC and Agreement States, please consult [www.hsrdo.org/nrc/](http://www.hsrdo.org/nrc/)

#### ***Classroom and Laboratory Training***

The new rule contains no specific hour requirement for classroom training. It merely states that within the total of 700 hours the candidate must have classroom and laboratory training in the following areas:

1. radiation physics and instrumentation
2. radiation protection
3. mathematics pertaining to the use and measurement of radioactivity
4. chemistry of byproduct material for medical use
5. radiation biology.

For a list of organizations offering radiation safety courses please consult, [www.asnc.org/meetings/radioisotope.cfm](http://www.asnc.org/meetings/radioisotope.cfm)

#### ***Supervised Work Experience***

Within the total 700 hour requirement a candidate for authorized user status must complete supervised work experience under the auspices of an authorized user that includes the following specific procedures:

1. ordering, receiving, and unpacking RAM packages and performing radiation surveys
2. calibrating instruments used to determine the activity of dosages and performing checks for proper operation of survey meters
3. calculating, measuring, and safely preparing dosages

4. using administrative controls to prevent a medical event involving unsealed byproduct material
5. using procedures to contain spills of byproduct material and using property decontamination procedures
6. administering dosages of radioactive drugs to patients or human research subjects; and
7. Eluting generators systems appropriate for preparation of radioactive drugs for imaging and localization studies, measuring and testing the eluate for radionuclidic purity, and processing the eluate with reagent kits to prepare radioactive drugs.

For the Nuclear Regulatory Commission's rule text please consult, [www.nrc.gov/reading-rm/doc-collections/cfr/part035/part035-0290.html](http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/part035-0290.html)

### ***Role of the Agreement States***

In Agreement states physicians must apply to the appropriate state office for the authorized user license. For a list of the appropriate state officials, please consult [www.hsr.doe.gov/nrc/asdirectr.htm](http://www.hsr.doe.gov/nrc/asdirectr.htm) Under the new 10 CFR Part 35 the training and experience requirements for diagnostic authorized users in the Agreement states must be "essentially identical" to the NRC requirements. However, Agreement States have up to three years beginning October 24, 2002 to comply with the new compatibility requirement. Iowa, Maine, and North Dakota have already recognized the NRC standards. By October 24, 2005 all agreement states must have training and experience requirements that are "essentially identical" to the NRC standards.

The American Society of Nuclear Cardiology will be working with the agreement states through the mechanism of the Organization of Agreement States to get as many of these 32 states to comply with the new national standards as quickly as possible. The process will vary from state to state depending on whether the state has an Administrative Procedures Act that allows independent agencies to promulgate rules without legislative approval. In some states every new rule must be approved by the legislature, a process that will lengthen the time of compliance.

### ***Certification Board of Nuclear Cardiology (CBNC)***

Cardiologists now may utilize a second pathway to obtain authorized user status. In addition to the 700 hour preceptor certified pathway, physicians may be certified by a medical specialty board whose certification process has been recognized by the Nuclear Regulatory Commission. The CBNC has been recognized by the NRC. Please consult [www.nrc.gov/materials/miau/miau-reg-initiatives/spec-board-cert.html](http://www.nrc.gov/materials/miau/miau-reg-initiatives/spec-board-cert.html) For further information on CBNC requirements, please consult [www.cbnc.org](http://www.cbnc.org)

### **General Statement of Expectations of Fellows**

Fellows are expected to satisfy the goals of the program, as established by Dr. Ronald Schwartz, Director of Nuclear Cardiology, by (1) daily reading and consultation sessions with Dr. Schwartz, (2) daily participation in nuclear cardiologic perfusion, function and viability studies in the laboratory with the nursing and technical staff; (3) self-learning through the extensive teaching file of the Nuclear Cardiology Database System and extensive reading from the currently recommended nuclear cardiology reading list; (4) attendance and participation in all nuclear cardiology teaching conferences offered during the rotation; and (5) preparing and leading an in-depth teaching conference on a nuclear cardiologic topic of interest to the cardiology fellow. In addition, clinical, administrative or investigative activities may be assigned by the Director of Nuclear Cardiology. By the completion of the rotation, extensive experience in the performance and interpretation of exercise and pharmacologic nuclear cardiologic testing should be obtained. Cardiology fellows are responsible for maintaining an up-to-date log of all procedures in which they participate and interpret. This goal can be facilitated by the Nuclear Cardiology Database System which is networked throughout the Cardiology Unit in the medical center.

During this clinical experience the physician is expected to become directly involved in all aspects of operation of the nuclear cardiology laboratory relevant to need for the certification process, including the following: (1) interview and examine patients referred for nuclear cardiologic evaluation; (2) assess the indication and suitability of testing for the individual patient; (3) review the selection of suitable radiopharmaceutical and dose; (4) obtain certification of Radiation Safety Unit for radioisotope handling under the general license of the University of Rochester, (5) demonstrate the ability to administer radiopharmaceuticals using a syringe shield; and (6) collaborate with the attending nuclear cardiologist on a daily basis in the interpretation of the procedures and generation of study reports; and (7) demonstrate knowledge of the use of the interpretation of the nuclear cardiology studies in the management of patients.

The fellow in nuclear cardiology is expected to obtain supervised work experience in the nuclear cardiology laboratory to include (1) procedures for ordering, receiving and unpacking of radioactive materials. (2) Calibrating the dose calibrator and other instruments as well as checks for proper operation; (3) calculating and preparing patient dosages; (4) using administrative controls to prevent misadministration; and (5) review procedures to contain spills and decontamination procedures.

In addition, fellows are expected to work with the supervising laboratory technologists to gain familiarity with patient set up for scintigraphic studies, acquisition, and processing.

### **Integration of the nuclear cardiology expectations of fellows and six ACGME core competencies:**

Daily work in the nuclear cardiology laboratory, performance of testing, interpretation of studies, prioritizing appropriate, timely reporting of study findings to facilitate patient care and disposition decisions, communicating the significance of the results communication so that appropriate intervention is applied in the care of the patient, obtaining clinical follow-up information to assess the impact of the nuclear cardiology

testing and consultation process, and reviewing the nuclear cardiology database and references recommended provide the specific methods for supporting the six ACGME core competencies: (1) Medical Knowledge; (2) Patient Care; (3) Professionalism; (4) Interpersonal and Communication skills; (5) Practice Based Learning; and (6) Systems Based Learning.

### **Benchmarks of Competency in Nuclear Cardiology During Training**

Experience teaching nuclear cardiology has demonstrated fellows vary widely in the time it takes to achieve clinical competence in nuclear cardiology. Competence in this field requires integration of critical image interpretation skills, a substantial fund of knowledge in the fields of clinical and nuclear cardiology, prioritization and communication of the findings verbally and in standardized report format to enhance the care of the patient.

**By the end of year one, the cardiology fellow is expected to complete the above listed tasks consistent with Level I training in Nuclear Cardiology.**

The fellow is expected to have studied the recommended reference list and demonstrate familiarity with the literature of nuclear cardiology in his daily interactions with the attending cardiologist in the nuclear cardiology laboratory.

The fellow is expected to have directed or participated most of the recommended minimum of 35 stress tests, including at least 15 exercise tests, 15 vasodilator stress tests, and at least 5 dobutamine studies. The fellow should be able to recognize optimal stress protocols for particular clinical situations.

The fellow is expected to demonstrate familiarity with interpretation and categorization of the electrocardiographic data accompanying the stress tests satisfactorily, and to generate and / or review carefully and take responsibility for the interpretation of these data in the computerized NCDS (nuclear cardiology database system).

The fellow is expected to be able to demonstrate basic skills in the patient set up and acquisition and processing of planar and SPECT cardiac data.

The fellow is expected to demonstrate correct interpretation of SPECT and planar data perfusion and function data. Recognizing image artifacts which influence image interpretation.

The fellow is expected to be able to integrate the study indication, scintigraphic findings, diagnostic and prognostic assessments.

Identification of an area of special interest and a date for presentation at his/her nuclear cardiology noon luncheon conference.

Scheduling of a formal feedback review session with the director of nuclear cardiology during the last week of the rotation.

Make general and / or specific arrangements for completion of Level 1 training (2 months total).

By the end of the second year month-long rotation the cardiology fellow is expected to have accomplished the following:

The cardiology fellow will have completed 100% of the ACC Level 1 training for certification in nuclear cardiology.

The fellow is expected to have studied the recommended reference list and demonstrate substantial familiarity with the literature of nuclear cardiology in his daily interactions with the attending cardiologist in the nuclear cardiology laboratory.

The fellow is expected to have directed or participated in at least 35 stress tests, including at least 15 exercise tests 15 vasodilator stress tests, and at least 5 dobutamine studies. The fellow should be able to recognize optimal stress protocols for particular clinical situations, and know how to deal comfortably with common complications which may accompany stress testing.

The fellow is expected to demonstrate the ability to interpret and categorize the electrocardiographic data accompanying the stress tests satisfactorily, and to generate and / or review carefully and take responsibility for the interpretation of these data in the computerized NCDS (nuclear cardiology database system).

The fellow is expected to be able to set up, acquire and process planar and SPECT cardiac data. Familiarity with processing of first pass studies is expected.

The fellow is expected to demonstrate correct interpretation of SPECT and planar data perfusion and function data. Recognizing image artifacts which influence image interpretation.

The fellow is expected to demonstrate the ability to integrate the study indication, scintigraphic findings, diagnostic and prognostic assessments and compare the incremental information and limitations of information provided by nuclear cardiology techniques relative to other invasive and non-invasive techniques.

Completion of the nuclear cardiology seminar with an evaluation of "good" or better by the director of service.

Scheduling of a formal feedback review session with the director of nuclear cardiology during the last week of the rotation.

If desired, make general and / or specific arrangements for completion of Level 2 training (4 to 6 months total).

**By the end of year one, the cardiology fellow is expected to complete the above listed tasks consistent with Level I training in Nuclear Cardiology.**

**By the end of the Level 2 (year 2)** specialization training in nuclear cardiology the cardiology fellow is expected to have accomplished the following:

Completion of 4 to 6 months full time training or equivalent in nuclear cardiology.

Completion and in-depth maturation of steps 1-9 (listed above).

Maintenance and submission to the director of logs verifying stress studies actually completed and scans actually interpreted. Note: While NCDS may or may not contain this information, it is the responsibility of the cardiology fellow to maintain this log and provide it to the director of service to verify completion of service requirements.

**By the end of year two, the cardiology fellow is expected to complete the above listed tasks consistent with Level II training in Nuclear Cardiology.**

**By the end of the Level 3 (year 3)** advanced training in nuclear cardiology the cardiology fellow is expected to have accomplished the following:

Spend a full year of equivalent in training in nuclear cardiology

Participation in a research study, with acceptance and presentation at a regional, national or international meeting.

Publication of at least one manuscript in the field of nuclear cardiology in a peer-reviewed journal.

**By the end of year 3, the cardiology fellow is expected to complete the above listed tasks consistent with Level III training in Nuclear Cardiology.**

### **Specific Procedures**

Consults / Procedures during normal working hours

It is the responsibility of the fellow to preview, edit and present all clinical and electrocardiographic information on the Nuclear Cardiology Database System to the Director after blinded scintigraphic interpretation is performed, and to review and co-sign study reports at the daily reading and teaching sessions. Since laboratory volumes are high and the need for rapid reporting is recognized as a priority of patient care, normal working hours routinely go into the late afternoon and early evening hours on this rotation.

Cardiology fellows are expected to pursue vigorously independent reading in nuclear and clinical cardiology to supplement the didactic sessions and daily clinical experiences formally provided. Updated reference list of prioritized reading material in the field of nuclear cardiology will be provided by the Director. The fellow is expected to discuss any concerns or special interests in nuclear cardiology as well as the status of his/her literature review with the Director regularly.

Consideration and participation in research is strongly encouraged.

Participation in the University radiation health physics program is also required. Fellows are expected to be available during the operating hours of the laboratory (7 A.M. - 8 P.M. daily) for clinical assistance as requested.

Clinical or investigative duties may be assigned during the rotation at the discretion of the Director.

A mutual evaluation is discussed between Director and fellow at the end of each rotation following the fellow teaching conference.

Cardiology fellows are specifically not expected to function routinely in a service requirement performing exercise tests, although the opportunity to perform such tests is available to the fellow if it meets his/her professional training needs.

Fellow rotations usually involve participation in patient evaluations and laboratory activities during the morning hours, reading and ECG review in the afternoon, and clinical consultations and scintigraphic readings throughout the day with the Director.

Learning of technical acquisition skills and quality control procedures is also expected of the cardiology fellow.

In accordance with ACC guidelines for training in Nuclear Cardiology<sup>1</sup>, fellows are expected to evaluate patients and determine the indications for specific nuclear cardiology tests. The appropriate integration of clinical information and test results should guide the fellow to making appropriate prognostic and therapeutic decisions in the best interests of patient care.

### **After-hours consults / procedures**

Occasional requests for consultations and / or scan interpretations may be expected from the fellow on service. Fellows may be called upon to evaluate patients during the evenings and weekends at the discretion of the Director. Inpatient and emergent consultations are to be performed promptly when requested, and any concerns or questions about them are to be discussed with the Director or to the attending physician covering the laboratory.

## **Conferences**

Each fellow rotating through the Nuclear Cardiology Laboratory is expected to identify one area of special interest in the field and present a state-of-the-art teaching presentation to be given at the Cardiology Unit noontime luncheon conference.

It is the responsibility of the fellow to select this area, with the advice and input of the director of the service and to obtain written confirmation from of the date and time of the presentation.

## **Vacation**

Due to the brevity of the nuclear cardiology rotation, it is recommended that vacation be taken during other rotations in the first year. Any time away from the nuclear cardiology rotation must be approved by Dr. Schwartz in advance.

## **On-call Responsibilities**

On call responsibilities after hours and weekends are not routine on this service. Inpatient and emergent consultations may be requested occasionally, and are to be performed promptly when requested. Any concerns or questions about them are to be directed promptly to the director of the service or to the attending physician covering the laboratory.

## **Research Opportunities**

### **Clinical Research of the Director and Laboratory**

Detection of asymptomatic ischemia with cardiac SPECT imaging and assessment of its incremental prognostic value in diabetic patients and women

Acute cardiac imaging for rapid risk stratification and triage for chest pain in the Emergency Department and inpatient settings.

Monitoring beneficial effects of therapeutic lifestyle (diet and exercise) and medical therapy for coronary artery disease including statins, ACE inhibitors, A-II receptor blockers other antihypertensive agents and anti-oxidants with quantitative gated cardiac SPECT myocardial perfusion and function imaging.

Assessment of cardiovascular, metabolic and renal effects of a ketotic diet

Assessment of incremental prognostic value of assessment with quantitative and semi-quantitative techniques, including assessment of transient ischemic dilation.

Assessment of incremental prognostic value of SPECT nuclear cardiologic data relative to clinical endpoints

Assessment of anthracycline cardiotoxicity in adults and children

Assessment of myocardial viability

Radiation induced heart disease

Fuel substrate utilization of the myocardium

First pass and quantitative volumetric analysis or cardiac performance

Cost efficacy of combined radionuclide functional and perfusion imaging of the heart  
Mental stress testing and cardiac perfusion and performance  
Reproducibility of quantitative SPECT perfusion defect scores  
Clinical assessment of attenuation, scatter and motion correction algorithms with  
quantitative gated SPECT myocardial perfusion imaging.  
Imaging of cardiac sympathetic nervous system with MIBG

The nuclear cardiology laboratory is located in the Paul N. Yu Heart Center on the ground floor of the Ambulatory Center. The laboratory houses two SMV DST dual head, variable angle SPECT cameras with two dedicated computer network systems, color printers and fully digital color slide production capability, Capintec Vest for simultaneous ambulatory ECG and radionuclide left ventricular function data analysis, an IBM network featuring the Nuclear Cardiology Database System. The DST cameras are linked via electronic networks to remote computer stations in the Scan Reading Room, Director's office, computer room (former fellows room, current SP nurses' room), and exercise treadmill rooms in the Paul N. Yu Heart Center. Image processing, clinical interpretation and consultation are fully integrated in the Center. Fully functional telemedicine capability has been in operation since 1996 for remote study interpretation. This capability now includes remote access to and from the Strong Cardiology Associates office at Clinton Crossings and the Highland Hospital Nuclear Cardiology Laboratory.

## **References**

1. Ritchie JL. Gibbons RJ. Johnson LL. Maddahi J. Schelbert HR. Wackers FJ. Zaret BL. Guidelines for training in adult cardiovascular medicine. Core Cardiology Training Symposium (COCATS). Task Force 5: Training in nuclear cardiology. *Journal of the American College of Cardiology*. 25(1):19-23, 1995 Jan.
2. Guidelines for clinical use of cardiac radionuclide imaging: Report of the American College of Cardiology/American Heart Association Task Force on Assessment of Diagnostic and Therapeutic Cardiovascular Procedures (Committee on Radionuclide Imaging), developed in collaboration with the American Society of Nuclear Cardiology. *J. Am Coll Cardiol* 1995;25:521-47.
3. Iskandrian AS, Verani MS. *Nuclear Cardiac Imaging: Principles and Applications*. Edition 2. F.A. Davis Co., Philadelphia, 1996, 451 pages.
4. Beller GA. *Clinical Nuclear Cardiology* 1995. W.B. Saunders Company, 387 pages.
5. Zaret BL: *Nuclear Cardiology, State of the Art and Future Directions*, Mosby, 1993. 347 pages.
6. Schwartz RG. Beyond the Cholesterol Profile: Monitoring Therapeutic

Effectiveness of Statin Therapy. (Editorial) *Journal of Nuclear Cardiology* 2001;8:528-532.

7. Schwartz RG, and Pearson TA. Can Single Photon Emission Computed Tomography Myocardial Perfusion Imaging Monitor the Potential Benefit of Aggressive Treatment of Hyperlipidemia? *Journal of Nuclear Cardiology* 1997; 4:555-568. (Barry L. Zaret, M.D., Editor; Mosby).

Annual nuclear cardiology reference list. (Updated and provided by Dr. Schwartz).

American Society of Nuclear Cardiology: <http://www.asnc.org/>

Radiation Safety Unit, URMC:

<http://intranet.urmc.rochester.edu/radiationsafety/rshpage.htm>

### **Nuclear Cardiology Staff**

#### Medical Staff

	Beeper	Office	Home
Ronald G. Schwartz, M.S., M.D. (Director)	16-3021	273-4340	461-1216
James Eichelberger, M.D. (Director, Strong Cardiology Associates, Clinton Crossings)	16-2660	341-7704	385-7673
Hanna Mieszczanska M.D.	16- 2011	341-7744	
Michael Fong, MD	16-6078	273-3760	

### **Scheduling and Secretarial Staff**

	Beeper	Office	Home
Kelly Werner, Nuclear Cardiology Scheduler		275-6169	
TBN, Scheduler		275-6169	
Barbara Entz, Clinical Secretary		275-0026	

### **Nursing Staff**

	Beeper	Office	Home
Kathy Carnes, R.N.	16-7594	273-4050	
Lynn Reinhardt, R.N.	16-7594	27-34050	
Lynne Sculli, R.N.	16-7594	273-4050	
June Spratt, R.N.	16-7594	273-4050	
Judy Lacagnina, R.N.	16-7594	273-4050	
Rosa Kapus, R.N.	16-7594	273-4050	
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Theresa Davies, RN – SCA	16-1644	341-7750	
Janet Anthony, RN – SCA	16-4143	341-7750	
John Hughes, RN – SCA	16-6185	341-7750	

### **Technical Staff**

	Beeper	Office	Home
Maria Mackin, C.N.M.T., Chief Nuclear Cardiology Technologist	16-1900	275-1430	889-5269 Cell phone 355-0333
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Joe Saladzius, C.N.M.T.		275-1430	

Uyen Au, C.N.M.T.  
Eileen Hicks, ECG Technologist at  
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275-1430  
341-7730

## **Credentials of Medical Staff**

### Ronald G. Schwartz, M.D., M.S., F.A.C.C.

University of Rochester, B.A. with Distinction in Biology  
Columbia University, College of Physicians & Surgeons, Institute of Human Nutrition, M.S.  
University of Rochester, M.D. with Distinction in Research  
Internal Medicine Residency, Hennepin County Medical Center, University of Minnesota  
Cardiovascular Disease Fellowship, Yale University  
Nuclear Medicine Residency, Yale University

### James P. Eichelberger, M.D.

University of Rochester, B.A.  
University of Rochester, M.D.  
Internal Medicine Residency, University of Vermont  
Cardiology Fellowship, University of Rochester

### Hanna Mieszczanska M.D.

Cardiology Fellowship, Winthrop University Hospital, State University of New York at Stony Brook  
Internal Medicine Residency Program. University Hospital in Stony Brook and the Veterans Affairs Medical Center (VAMC) in Northport, New York  
Clinical rotating internship in Internal Medicine, Gynecology, Surgery and Pediatrics, Central Railway Hospital, Warsaw, Poland  
Warsaw University School of Medicine, M.D.  
Gen. Jankowski Lycee, Warsaw, Diploma.