Resident Core Curriculum

Nuclear Medicine

The Nuclear Radiology Core Curriculum combined with the Cardiac Nuclear Medicine Core Curriculum is designed to provide the radiology resident with a foundation for developing the necessary skills to become competent in clinical nuclear medicine. The structured training provides the base for preparation for certification in Diagnostic Radiology by the American Board of Radiology and for the clinical practice of nuclear medicine, including eligibility for Authorized User status by the Nuclear Regulatory Commission or State (if the resident later practices in an agreement state).

General Goals: The specific goals include objectives required for every level of training with graduated levels of supervision and responsibility. All aspects of nuclear medicine imaging are incorporated into the residency, including cardiac nuclear medicine. During every training rotation, the resident will read the required literature and study the teaching file in nuclear medicine. Over time, the resident will become progressively more knowledgeable about normal scintigraphic anatomy and physiology and about the scintigraphic appearance of disease processes. Residents will gain competence in interpreting dynamic and static nuclear imaging (planar, SPECT, and PET-CT) of physiologic and pathophysiologic processes, the utilization and handling of radiopharmaceuticals, and quality control of nuclear imaging instruments and radiopharmaceuticals. In addition, the resident will increasingly understand disease entities, their clinical presentations, and current modes of treatment. The resident will know how to supervise and perform radionuclide image-guided procedures at the completion of the final rotation. The resident will know how to function as an NRC Authorized User of radioisotopes for diagnostic use and for therapies involving $<33$ mCi and $>33$ mCi I-131 at the completion of the final rotation. The structured training provides the base for Board preparation and clinical practice of nuclear medicine.

Resident Daily Work Responsibilities (OVERALL BENCHMARKS/OBJECTIVES for Self-Evaluation)

1. Residents assigned to nuclear medicine will be available for consultations by technologists, clinicians, and other health care providers, except during conference times, when the attending faculty will cover.
2. Resident questions will be referred to the supervising faculty covering nuclear medicine.
3. Resident review of cases with the supervising faculty will be conducted as many times in the day as necessary to keep an efficient workflow.
4. All resident examinations will be dictated by the end of every working day.
5. Residents will check and sign reports prior to final verification by supervising faculty.
6. Residents must be familiar with the operation of all nuclear medicine equipment.
7. Residents must acquire knowledge of radiation protection and ways to reduce radiation exposure to both patients and hospital personnel. The resident will be supervised to assure that safe practices are followed.
8. Residents will learn the techniques for performing high quality, state-of-the art diagnostic examinations throughout the body.
9. Residents must become proficient at detecting abnormalities and be able to generate meaningful differential diagnosis.
10. Residents will become knowledgeable about the use of different radiopharmaceutical agents (including their indications, contraindications, dosages, and side effects/complications).
11. Residents will acquire an understanding of the proper preparation of patients for examinations and appropriate follow-up if needed.
12. Residents will be familiar with the patient schedule at the start of every working day and anticipate need for and timing of any procedures.
13. Residents will check requisitions for the next working day to evaluate for appropriateness of the requested procedure or if additional exams/protocols need to be performed. Absent clinical
14. Residents will perform a quality check on commonly performed nuclear medicine exams as required per protocol, before the technologist allows the patient to leave, to ensure that the exam is complete, and request additional views or repeat imaging when necessary.

15. Residents will do in-depth reading and study, along with a review of teaching file cases, to become knowledgeable about the utilization and utility of nuclear medicine procedures and gain a general understanding of the disease entities, their clinical presentations, and management.

16. Resident will serve as a secondary consultant to referring physicians regarding nuclear medicine. This will strengthen the confidence of the resident in the very important role every radiologist must perform throughout his/her career as a consultant to clinicians.

17. Residents will become prepared to pass the certifying examination of the American Board of Radiology.

18. Residents will teach and share knowledge to medical students, radiologic and nuclear technologist students, and junior residents.

19. Residents will participate in the preparation and presentation of imaging studies at the monthly Interesting Case Conference and as teaching files.

**Supervising Faculty Responsibilities:**

1. Supervising faculty will be available at all times for any questions or consultations needed by the resident.
2. Supervising faculty will review all cases with the residents before the end of the day.
3. Supervising faculty will provide the resident with constructive feedback in any problem areas encountered during the rotation.
4. Supervising faculty will verify resident-generated reports in a timely manner and inform the resident of any major changes made.

**Educational Goals and Objectives (First Rotation):**

**Patient Care:**

- Adequately explain each examination to the patient in order to ensure that the patient feels comfortable and provide patient care that is compassionate, appropriate, and effective
- Perform a quality check on commonly performed nuclear medicine exams as required per protocol, before the technologist allows the patient to leave, to ensure that the exam is complete, and request additional views or repeat imaging when necessary
- Understand the basic principles of radiation protection in order to reduce as much as possible the radiation dose to the patient and reduce exposure to healthcare providers
- Understand the indications for and contraindications to use of the commonly used diagnostic and therapeutic radiopharmaceuticals, and be able to monitor administration
- Recognize and treat reactions to commonly used radiopharmaceuticals or scan-associated medications (ex. Lasix, Sincalide), and be able to monitor administration of ancillary drugs
- Develop a knowledge of the preparation and aftercare required for the common examinations, including instructions to the patient
- Use the PACS, voice recognition systems, and hospital information systems to become proficient in dictating reports of significant findings in a concise and clear manner
- Demonstrate the ability to recommend additional nuclear or non-nuclear imaging studies as appropriate to patient management based on imaging and clinical information available
- Protocol procedures, in consultation with the attending, to assure that the requested procedure is appropriate

**Medical Knowledge:**

- Comprehend basic concepts of nuclear tracers, nuclear imaging, and equipment
• Describe basic radiopharmaceutical preparation
• Describe basic nuclear medicine physics and instrumentation
• Understand basic principles and rationale for using different radiopharmaceuticals
• Know the energies and half-lives of commonly used radioisotopes, biological half-life of commonly used radioisotopes
• Know how to supervise the acquisition and processing, and know how to interpret commonly performed nuclear medicine exams: bone (whole body, three phase, SPECT), lung (VQ, quantitative perfusion), thyroid scan and uptake, renal (MAG3, DMSA), GI bleeding, meckels, gastric emptying studies and brain death
• Describe the normal biodistribution of radiopharmaceutical for commonly performed nuclear medicine exams, itemized above
• Use a systematic approach to identify abnormalities on frequently performed nuclear medicine exams, itemized above, and generate a basic differential diagnosis
• Develop a knowledge of normal and abnormal anatomy as demonstrated on commonly performed nuclear medicine studies, itemized above
• Demonstrate the ability to recognize and describe abnormalities depicted on commonly performed nuclear medicine imaging studies, itemized above
• Discuss common types of pathology (and/or indications) for commonly performed nuclear medicine exams, itemized above
• Develop a knowledge of the differential diagnoses for the common abnormalities demonstrated on commonly performed exams, itemized above
• Know how to perform a quality check on commonly performed nuclear medicine exams, as required before the technologist allows the patient to leave to ensure that the exam is complete, and request additional views or repeat imaging when necessary
• Know how to participate in outpatient and inpatient radionuclide therapies, be able to obtain history and physicals, informed consent, supervise therapy, and perform rounds with inpatients until discharge
• Understand the risk factors for allergic reaction to drugs and radiopharmaceuticals used in nuclear medicine

Practice-Based Learning and Improvement:
• Show evidence of independent study using textbooks and material from reading list
• Demonstrate appropriate follow up of interesting cases
• Research interesting cases as directed by faculty
• Identify, rectify, and learn from personal errors
• Incorporate feedback into improved performance
• Efficiently use electronic and print sources to access information

Interpersonal and Communication Skills:
• Communicate with the patient at all times (ex. during the examination, during consultation, post-procedure) to ensure that patient remains comfortable
• Communicate effectively with all members of the health care team (technologists, medical students, fellows, residents, allied health providers, support staff, and attending physicians/radiologists, inside and outside referring clinicians)
• Recognize the need to report significant findings to the referring physician (according to hospital/Radiology guidelines), fulfill and document your actions, and show ability to interact with referring physicians
• Interact with clinicians when reviewing cases and show ability to provide preliminary readings, follow up with attending radiologists, formulate a plan of complex cases, and communicate any changes to referring clinicians
• Recognize limitations in knowledge and skills for making competent decisions
Participate in case check-outs and dictate most cases

Professionalism:
- Demonstrate respect for patients, families, and all members of the healthcare team
- Explain the impact of the nuclear examinations or findings on patient care, including what imaging studies may/may not be appropriate
- Respect patient confidentiality at all times; understand HIPAA requirements
- Present oneself as a professional in appearance and communication
- Demonstrate a responsible work ethic with regard to work assignments
- Promptness and availability at work are required of every resident

System-Based Practice:
- Participate in clinical conferences in which imaging studies are used to guide patient care/evaluations and be able to demonstrate understanding of how imaging relates to the clinical care of the patient
- Demonstrate knowledge of the ACR practice guidelines and technical standards for nuclear medicine
- Demonstrate knowledge of ACR appropriateness criteria and cost effective imaging evaluation of common disorders
- Show ability to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical entities appropriate to the level of training
- Review equipment and quality assurance with assigned technologist once a week or as required
- Understand the mechanisms by which the Nuclear Medicine section maintains internal records in order to comply with NRC/state regulations

Monitoring and Assessment of Resident Performance
The resident’s progress will be monitored by the faculty on the service. Toward the end of each rotation, the resident will receive an evaluation of performance from each attending. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist. Residents are evaluated monthly by faculty. Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case discussion, review of patient outcomes, and other performance evaluation methods as determined.

Educational Goals and Objectives (Second Rotation):

The objectives above as well as the following:

Patient Care:
- Understand the physics of radiation protection and how to apply it to routine studies
- Obtain consent for more complex procedures and answer all questions the patient may have
- Develop a knowledge of the preparation and aftercare required for more complex procedures
- Continue to improve skills for supervising and performing nuclear medicine examinations, and tailor examinations to answer all questions being asked by the clinician; anticipate other pertinent clinical questions
- Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the resident will effectively communicate with the patient and referring physician until clarified)
- Familiarity with available medical records and how to access them for the purposes of patient care
- Protocol cases, in consultation with the attending, to assure that the examination is appropriate
to the clinical question and of sufficient quality to address the clinical concerns of the patient and referring physician

- Review all studies with the supervisor faculty attending
- Provide preliminary reports to all referring clinicians if needed before the final review of cases (when there is a significant discrepancy between the preliminary reading and final reading, the resident will notify the referring clinician immediately)
- Perform a quality check on commonly performed nuclear medicine exams as required, before the technologist allows the patient to leave, to ensure that the exam is complete, and request additional views or repeat imaging when necessary

**Medical Knowledge:**

- Comprehend basic concepts of FDG PET and FDG PET-CT of the body, imaging, and commonly seen artifacts
- Know the indications and patient preparations for routine procedures and be able to interpret scan procedures, including In-111 Octreoscan, I-123 MIBG, In-111 WBC, Tc-99m WBC, Tc-99m sulfur colloid marrow scan, Tc-99m DMSA renal, Tc-99m labeled perfusion brain SPECT, FDG brain PET
- Demonstrate the ability to recognize and describe abnormalities depicted on nuclear medicine imaging studies itemized above appropriate to the level of training when presenting to the attending, and demonstrate improvement compared to the prior rotation
- Begin to develop meaningful differential diagnoses for findings on nuclear medicine imaging studies itemized above
- Understand the clinical management of the conditions commonly encountered
- Have basic knowledge to begin to recommend the appropriate therapy and therapy dose, based on the patient-specific details and clinical setting
- Understand the relative strengths and limitations of each scan type and other available imaging options
- Understand the risk factors for allergic reaction to drugs used in nuclear medicine, and know appropriate actions to prevent or mitigate side-effects and/or reactions
- Familiarity with imaging findings of common acute and chronic diseases evaluated with nuclear medicine
- Correlate nuclear medicine studies with other imaging modalities
- Participate in outpatient and inpatient radionuclide therapies; obtain history and physicals, informed consent, assisting/supervising therapy, and perform rounds with inpatients until discharge
- Comprehend QC procedures, camera performance, and specific imaging techniques including SPECT acquisition and processing and wet lab procedures
- Divide time between supervision and interpretation of commonly performed scans (as in Rotation 1), thereby developing more advanced skills and acquiring new skills concerning the scans enumerated above for this rotation
- Be able to develop appropriate differential diagnoses of a moderately advanced, rather than basic, level for commonly performed nuclear scans
- Act as a consultant to the clinical services

**Practice-Based Learning and Improvement:**

- Identify, rectify and learn from personal errors
- Incorporate feedback into improved performance
- Demonstrate evidence of independent reading and learning through use of printed and electronic resources
- Follow up on abnormal or interesting cases through personal communication with the referring physician or patient medical records
- Competent in using PACS, voice recognition systems, and the patient information systems in the daily accomplishment of the workload and instruct others in their use
- Attend lectures/conferences, expand concepts, applications, and comparisons with other diagnostic methods

**Interpersonal and Communication Skills:**
- Appropriately obtain informed consent
- Produce concise reports that include all relevant information
- Communicate effectively with all members of the healthcare team
- Communicate effectively the results of studies to referring clinicians whenever needed (for emergent studies, this will be accomplished in a timely manner, with documentation as per hospital and Radiology policy)
- Effectively convey the findings of examinations through accurate description and dictation of reports and participate in case check-outs

**Professionalism:**
- Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers)
- Respect patient confidentiality at all times
- Present oneself as a professional in appearance and communication
- Demonstrate a responsible work ethic in regard to work assignments
- Explain the nature of the examination or findings in an examination to patients and their families when needed
- Observe ethical principles when recommending further work-up
- Promptness and availability at work are required of every resident
- Dress appropriately for work

**Systems-Based Practice:**
- Demonstrate knowledge of ACR practice guidelines and technical standards for nuclear medicine
- Demonstrate knowledge of ACR appropriateness criteria and cost-effective imaging evaluations
- Show ability appropriate to the level of training to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical questions
- Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations
- Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
- Thorough dictations will be made with indications, techniques, findings, and conclusions (impressions), for accuracy in reporting and compliance with billing guidelines
- Dictate and correct reports in a timely fashion to avoid delay in patient disposition
- Make suggestions to improve methods and systems utilized in radiology whenever appropriate
- Review equipment and quality assurance with assigned technologist once/week or as required

**Monitoring and Assessment of Resident Performance**
The resident’s progress will be monitored by the faculty on the service. Toward the end of each rotation, the resident will receive an evaluation of performance from each attending. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist. Residents are evaluated monthly by faculty. Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case discussion, review of patient outcomes, and other performance
Educational Goals and Objectives (Third Rotation):

The above objectives as well as the following:

Patient Care:
- Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the resident will effectively communicate with the patient or referring physician until clarified)
- Familiarity with available medical records and how to access them for the purposes of patient care
- Protocol cases, in consultation with the attending, to assure that the examination is appropriate and of sufficient quality to address the clinical concerns of the patient and referring physician
- Perform a quality check on commonly performed nuclear medicine exams as required, before the technologist allows the patient to leave, to ensure that the exam is complete, and request additional views or repeat imaging when necessary
- Review all studies with the supervising faculty attending
- Provide preliminary reports to all referring clinicians if needed before the final review of cases (when there is a significant discrepancy between the preliminary reading and final reading, the resident will notify the referring clinician immediately)

Medical Knowledge:
- Develop appropriate differential diagnoses of an advanced, rather than basic, level for all types of nuclear scans for nuclear radiology and nuclear cardiology when presenting to the attending
- Distinguish between normal and abnormal anatomy with excellent accuracy according to the level of training when presenting to the attending and demonstrate improvement compared to the prior rotation
- Know the indications and patient preparations for routine FDG PET-CT procedures, be able to interpret them and recognize FDG PET-CT artifacts
- Know the indications and patient preparations for FDG PET-CT procedures complicated by patient circumstances (ex. broken arm in cast, diabetic patient), and be able to interpret the scans and recognize FDG PET-CT uncommon artifacts
- Use a systematic approach to identify common abnormalities on FDG PET-CT performed for common indications and generate an advanced differential diagnosis
- Be able to relate the imaging findings seen in FDG PET-CT performed for common clinical indications to the clinical condition, its pathology and pathophysiology
- Understand the physics and principles of radiation protection and how to apply it to the CT component of PET-CT
- Know how to perform and interpret less-commonly performed procedures, such as CSF leak, cisternography, Leveen shunt, liver-lung shunt, right to left shunt, VCUG, hemangioma, etc. for typical clinical indications, with appropriate basic differential diagnoses
- Know when and how to modify scan technique to accommodate patient circumstances (ex. patient cannot lie down)
- Know and be able to explain the methods of radionuclide cell labeling for leukocytes and red cells
- Understand, discuss, perform, explain, and interpret procedures performed in the hot lab
- Develop a thorough knowledge of the differential diagnosis of abnormalities encountered
- Develop a deeper understanding of the clinical management of the medical conditions encountered in routine practice
- Know the proper preparation of patients for diagnostic and interventional procedures and the
appropriate follow-up afterwards
- Act as a consultant in nuclear medicine to the clinical services
- Recommend appropriate radiologic workup for clinical presentations
- Know how to supervise equipment and quality assurance monitoring performed by technologist staff
- Understand, discuss, and interpret nuclear radiology and nuclear cardiology procedures
- Divide time between supervision and interpretation of scans (as in Rotation 1 and 2), thereby developing more advanced skills in earlier components and acquiring new skills concerning the scans enumerated for this rotation
- Competently recommend appropriate radiologic workup for clinical presentations
- Comprehend quality control procedures, camera performance, and specific imaging techniques including SPECT acquisition, processing, and wet lab procedures
- Finalize understanding and knowledge regarding regulations of nuclear imaging by the NRC, State, and Hospital (JCAHO)

Practice-Based Learning and Improvement:
- Identify, rectify, and learn from personal errors
- Incorporate feedback into improve performance
- Demonstrate evidence of independent reading and learning through use of printed and electronic resources
- Follow up on abnormal or interesting cases through personal communication with the referring physician or patient medical records
- Competent in using PACS, voice recognition systems, and the patient information systems in the daily accomplishment of the workload and instruct junior trainees in their use

Interpersonal Skills:
- Appropriately communicate results to patients and clinicians whenever needed (for emergent studies, this will be done in a timely manner)
- Produce concise reports that include all relevant information and be able to effectively convey the findings of examinations through accurate dictation of reports and participate in case check-outs
- Communicate effectively with all members of the healthcare team
- Assist with supervision and teaching of medical students, radiologic and nuclear technologist students, and junior residents

Professionalism:
- Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers)
- Respect patient confidentiality at all times
- Present oneself as a professional in appearance and communication
- Demonstrate a responsible work ethic in regard to work assignments
- Be able to explain the nature of the examination of findings in an examination to patients and their families when needed
- Observe ethical principles when recommending further work-up for cases
- Promptness and availability at work are required of every resident
- Dress appropriately when reporting to work

Systems-Based Practice:
- Demonstrate knowledge of ACR practice guidelines and technical standards for nuclear medicine
- Demonstrate knowledge of ACR appropriateness criteria and cost effective imaging practices in
nuclear medicine

- Complete final preparations to pass the certifying examination of the American Board of Radiology
- Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations
- Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
- Produce thorough dictations with indications, techniques, findings, and conclusions
- Dictate and correct reports in a timely fashion to avoid delay in patient disposition
- Make suggestions to improve methods and systems utilized in radiology whenever appropriate
- Show ability appropriate to the level of training to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical questions

**Monitoring and Assessment of Resident Performance**

The resident’s progress will be monitored by the faculty on the service. Toward the end of each rotation, the resident will receive an evaluation of performance from each attending. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist. Residents are evaluated monthly by faculty. Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case discussion, review of patient outcomes, and other performance evaluation methods as determined.

**Reading List for Each Rotation**

**First Rotation**


**Second Rotation**

5. Thomas L. Pope. *Aunt Minnie’s Atlas and Imaging-Specific Diagnosis.* Lippincott Williams &
Third Rotation

5. PET Clinics. Published quarterly, Elsevier, 2006. Clinical reviews on advances in the use of PET and combined PET/CT.
8. Faculty assigned supplemental reading list.

"Recommended" Reading All Years

**General Nuclear Medicine**


**Specialized Nuclear Medicine –Clinical**

2. PET Clinics. Published quarterly, Elsevier, 2006. Clinical reviews on advances in the use of PET and combined PET/CT.

**Specialized Nuclear Medicine -Physics and Radiopharmacy**

**Other Requirements**
1. Completion of Radiation Safety module, UVA intranet, once/year of residency
2. Completion of > 3 patients for I-131 therapy < 33mCi, including consultation, therapy planning and oversight of I-131 therapeutic dose administration
3. Completion of > 3 patients for I-131 therapy < 33mCi, including consultation, therapy planning and oversight of I-131 therapeutic dose administration

**Daily Work**

The vast majority of your time will be spent in the clinical Nuclear Medicine area in the Emily Couric Cancer Center, and primarily in the NM reading room.

First year will be spent learning about and reviewing/dictating commonly performed diagnostic scans. During this rotation and future NM rotations, the resident will protocol exams in advance of the appointment and check scans to let the patient leave the department. The resident will have the opportunity to observe and participate in scan acquisition and processing, in conjunction with the technologist. If you are male, use common sense about patient contact. If the patient is in a gown, have a chaperone. This is for resident protection as well as for the patient. The resident will inform the patient and doctor of results as warranted. The resident will see patients referred for radionuclide therapy in consultation and collaborate with the attending to determine appropriate management. Lastly, the resident will serve as a consultant to other physicians and health care professionals.

Third year will be spent learning about and reviewing/dictating less commonly performed diagnostic scans, and beginning to learn about and review/dictate PET-CT cases.

Fourth year will be spent learning about and reviewing/dictating uncommonly performed diagnostic scans, and advancing your skills to review/dictate PET-CT cases. It will also be spent finalizing the resident’s understanding of basic and complex nuclear medicine scans and procedures and therapies, and mastering the ability to dictate clear, concise reports.

**Cases to be Read**
- Emergency studies, inpatient and emergency department (to be continuously distributed as they come in and to be read as first priority)
- “Early read” or “STAT read” inpatient or outpatient requests (to be continuously distributed as they come in and to be read in priority after emergency studies)
• 9 a.m.: any unread studies that appear from prior day(s), regardless of how they got overlooked or where they came from
• 4 p.m.: check for studies from the day that slipped through and have not been read
• Outpatient studies (to be continuously distributed as they come in)

**Distribution of Work:**
- General nuclear studies to be split between the fellow, first-year resident and more advanced residents, with distribution based on level of training
- The first-year resident is reading simple cases and has a slightly lower workload compared to the more advanced residents
- The other residents and the Nuclear Radiology fellows share the remaining cases, both in terms of numbers and degree of difficulty.
- In general PET-CT studies to be split between the fellow and more advanced residents, with distribution based on level of training
- PET-CT studies concerning problems or diseases related to be split between the fellow and more advanced residents, with distribution based on level of training
- All resident examinations must be dictated by the end of every working day.
- Assignment of patients for Consultation (for radionuclide therapy evaluation) to be split between the fellow, first-year resident and more advanced residents, (and occasionally, visiting Radiation Oncology resident) with distribution based on level of training

**Vacation/Meeting Time**

**Schedule Expectations and Vacations:**
- All residents are expected to show up ON TIME at the beginning of the work day. If they foresee that they are going to be late, for whatever reason, they have to call the early attending to explain the reason of their being late.
- The resident should be on duty from 8:00 a.m. until the work is completed.
- When a resident is assigned to see a patient in consultation for radionuclide therapy, that resident should review the case in advance of the patient appointment, and be ready to see the patient at the designated appointment time.
- Attendance at noon conference is strongly recommended. Notify the attending before leaving for conference and before leaving for the day.
- Also, the residents cannot leave the reading-room for any appreciable period before the official end of their shift without the permission of the attending.
- Among the residents rotating through Nuclear Medicine, there can be only one resident on vacation at a given time. Vacation is first come/first served, but we will be as flexible as possible. Total allowable vacation/meeting time during all of your months of Nuclear Medicine is 4 weeks, per department policy. This will maximize your experience and prepare you for practice as well as written and oral boards.

We hope your rotation on the Nuclear Medicine service is educational, productive and enjoyable. We are always striving to improve the rotation. Please let us know if you have an idea for improvement.

**Core Knowledge Presentation Topics**

More than one lecture is needed in most areas. Some subjects (ex. quality assurance, artifacts, instrumentation, biodistribution) will be developed under multiple subject headings listed below.
- **Instrumentation.** An organized review of the equipment used in nuclear medicine, including quality control procedures needed to demonstrate acceptable function and meet regulatory requirements
- **Biologic handling and biodistribution of radiopharmaceuticals,** including quality control procedures
- **Review of regulatory agency requirements,** and good radiation safety practices
- **Liver and hepatobiliary imaging** including biliary atresia
- Bone imaging, including three phase and SPECT
- Brain SPECT
- CNS and brain death imaging
- GI bleeding scans
- GU scintigraphy: DMSA, MAG3, radionuclide retrograde VCUG
- Infection imaging: gallium, indium WBC, technetium WBC
- Lung scans for pulmonary embolism, evaluation of right to left shunt, quantification of regional perfusion
- Lymphoscintigraphy- breast CA, melanoma
- Tumor imaging: Parathyroid, MIBG, OctreoScan, ProstaScint, breast specific gamma imaging (BSGI) with MIBI
- PET-CT for cancer, body and brain
- PET-CT of brain, including dementia and epilepsy
- Quality assurance in nuclear medicine
- Radiation safety in nuclear medicine
- Radiobiology including application to radionuclide therapy
- Radionuclide therapy for palliation of bone pain
- Radionuclide therapy for treatment of hyperthyroidism
- Radionuclide therapy for treatment of thyroid cancer
- Thyroid imaging
- Thyroid cancer imaging
- Nuclear cardiology: MUGA, myocardial perfusion SPECT; PET

The Cardiac Nuclear Medicine Core Curriculum combined with the Nuclear Radiology Core Curriculum is designed to provide the radiology resident a foundation for developing the necessary skills to become competent in clinical nuclear medicine. The structured training provides the base for preparation for certification in Diagnostic Radiology by the American Board of Radiology and the clinical practice of nuclear medicine, including eligibility for Authorized User status by the Nuclear Regulatory Commission or State (if the resident later practices in an agreement state).

**Educational Goals and Objectives (Cardiac Nuclear Medicine: Upper Level Resident):**
The above objectives as well as the following:

**Patient Care:**
- Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the resident will effectively communicate with the patient or referring physician until clarified)
- Familiarity with available medical records and how to access them for the purposes of patient care
- Protocol cases, in consultation with the attending, to assure that the examination is appropriate and of sufficient quality to address the clinical concerns of the patient and referring physician
- Review all studies with the supervising faculty attending
- Provide preliminary reports to all referring clinicians if needed before the final review of cases (when there is a significant discrepancy between the preliminary reading and final reading, the resident will notify the referring clinician immediately)
- Perform a quality check on commonly performed nuclear medicine exams as required, before the technologist allows the patient to leave, to ensure that the exam is complete, and request additional views or repeat imaging when necessary

**Medical Knowledge:**
- Develop a thorough knowledge of the differential diagnosis of abnormalities encountered
- Relate the imaging findings to the clinical condition and its pathology and pathophysiology
• Understand the clinical management of the conditions encountered
• Familiarity with the anatomy of the heart and cardiovascular system
• Familiarity with imaging findings of common acute and chronic diseases evaluated with cardiac nuclear medicine
• Distinguish between normal and abnormal cardiac anatomy with excellent accuracy according to the level of training when presenting to the attending
• Development of appropriate differential diagnostic lists will be well advanced
• Know the proper preparation of patients for cardiac nuclear medicine and the appropriate follow-up afterwards
• Act as a consultant in cardiac nuclear medicine to the clinical services
• Comprehend imaging principles and imaging procedures including gated myocardial perfusion SPECT and gated blood pool studies
• Interpret nuclear cardiology studies, specifically gated myocardial perfusion SPECT and gated blood pool studies
• Understand and be knowledgeable regarding stress or pharmacologic tests, and know the appropriate management of complications and/or side effects of the exercise or medications used in the test
• Supervise daily clinical work with a degree of independence as determined by faculty
• Conduct SPECT acquisition and processing in conjunction with the technologist
• Know how to interpret cardiac nuclear medicine imaging studies with accuracy appropriateness to the level of training and make appropriate presentation to the attending
• Understand the underlying physiologic basis and procedure for cardiac PET
• Correlate procedures including cardiac catherization, echocardiography as well as CT and MRI of the heart with nuclear cardiology studies
• Develop appropriate differential diagnoses of a moderately advanced, rather than basic, level for commonly performed nuclear scans
• Review knowledge regarding regulations of nuclear imaging and radioisotope therapy by the NRC, State, and Hospital (JCAHO), as specifically applicable in the cardiology setting

Practice-Based Learning and Improvement:
• Identify, rectify, and learn from personal errors
• Incorporate feedback into improve performance
• Demonstrate evidence of independent reading and learning through use of printed and electronic resources
• Follow up on abnormal or interesting cases through personal communication with the referring physician or patient medical records
• Competent in using PACS, voice recognition systems, and the patient information systems in the daily accomplishment of the workload and instruct others in their use
• Attend lectures/conferences, expand concepts, applications, and comparisons with other diagnostic methods
• Review cardiac teaching file

Interpersonal Skills:
• Appropriately communicate results to patients and clinicians whenever needed (for emergent studies, this will be done in a timely manner)
• Produce concise reports that include all relevant information and be able to effectively convey the findings of examinations through accurate dictation of reports and participate in case check-outs
• Communicate effectively with all members of the healthcare team
• Assist with supervision and teaching of medical and radiologic and nuclear technologist students, and junior residents
• Be able to effectively convey the findings of examinations through accurate description during case
Professionalism:
- Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers)
- Respect patient confidentiality at all times
- Present oneself as a professional in appearance and communication
- Demonstrate a responsible work ethic in regard to work assignments
- Be able to explain the nature of the examination of findings in an examination to patients and their families when needed
- Observe ethical principles when recommending further work-up for cases
- Promptness and availability at work are required of every resident
- Dress appropriately when reporting to work

Systems-Based Practice:
- Demonstrate knowledge of ACR practice guidelines and technical standards for nuclear medicine
- Demonstrate knowledge of ACR appropriateness criteria and cost effective imaging practices in nuclear medicine
- Complete final preparations to pass the certifying examination of the American Board of Radiology
- Become familiar with departmental procedures, contrast safety, and sedation required in the performance of examinations
- Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
- Produce thorough dictations with indications, techniques, findings, and conclusions
- Dictate and correct reports in a timely fashion to avoid delay in patient disposition
- Make suggestions to improve methods and systems utilized in radiology whenever appropriate
- Review equipment and quality assurance with assigned technologist once a week or as required
- Show ability appropriate to the level of training to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical questions

Monitoring and Assessment of Resident Performance
The resident’s progress will be monitored by the faculty on the service. Toward the end of each rotation, the resident will receive an evaluation of performance from each attending. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist. Residents are evaluated monthly by faculty. Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case discussion, review of patient outcomes, and other performance evaluation methods as determined.

Reading List for Cardiac Nuclear Medicine

General Nuclear Medicine (sections on cardiac imaging)

Specialized Nuclear Medicine- Cardiac Nuclear Medicine
Specialized Nuclear Medicine - Physics and Radiopharmacy

Other Requirements/Expectations

**Daily Work**
The vast majority of the resident’s time will be spent in the NICV reading room, reviewing nuclear cardiology scans using the hospital intranet. Intranet connection to Cardiology PACS is available in NICV reading room, NM reading room, Nuclear Cardiology reading room (2nd floor), and Moss Auditorium.

During slack time between MRI cases, go to Nuclear Cardiology area (2nd floor) to observe the acquisition and processing of scans, as well as the performance of stress procedures. When arriving there, identify yourself to Mike Sobczak, the Chief Technologist in Nuclear Cardiology, who can direct the resident to where the action is taking place at that time. Also, identify yourself to Dr. Denny Watson, the Director of Nuclear Cardiology, and inform him of your availability to review scans and procedures.

On Mondays, Thursdays and some Fridays (as of 2010), the scans are interpreted and reported by the Nuclear Medicine attending, Drs. Rehm and Deng, respectively. Be prepared to present, review, and discuss the cases with the NM attending. Contact (page) each NM attending for the readout times for their assigned reading days.

On other days, the scans are interpreted and reported by Cardiology attendings. The resident can attend readout session for those days, depending on the resident’s availability.

**Lectures**
The lectures are not intended to be a substitute for a thorough reading and comprehension of appropriate
texts and lecture notes. Repetition of simple facts and characteristics contained in standard references is not the best use of lecture time. Rather lectures expand on concepts, applications, and comparisons with other diagnostic methods. A generous use of examples that demonstrate strengths and limitations of the procedures is encouraged, as well as a review of specific radiopharmaceuticals in each area.

**Core Knowledge Presentation Topics**

More than one lecture is needed in most areas. Some subjects (ex. quality assurance, artifacts, instrumentation, biodistribution) will be developed under multiple subject headings listed below.

1. Instrumentation. An organized review of the equipment used in nuclear medicine, including quality control procedures needed to demonstrate acceptable function and meet regulatory requirements
2. Biologic handling and biodistribution of radiopharmaceuticals, including quality control procedures
3. Review of regulatory agency requirements, and good radiation safety practices
4. Tc-99m myocardial perfusion tracers
5. Cardiac SPECT technique, processing, interpretation and common artifacts
6. Evaluation of ventricular function employing EKG gating using cardiac SPECT and MUGA
7. Cardiac stress procedures used in conjunction with nuclear imaging
8. PET radiotracers and PET procedures applicable for cardiac imaging