**Fellowship Core Curriculum**
**Nuclear Radiology**
**Last revised 7/1/2021**

The Nuclear Radiology Core Curriculum is designed to provide the Nuclear Radiology fellow with a foundation for developing advanced expertise in clinical nuclear radiology including cardiac nuclear medicine and radionuclide therapy. The structured training provides the base for preparation for certification in Nuclear Radiology by the American Board of Radiology and for the clinical or academic practice of nuclear radiology, including eligibility for Authorized User status by the Nuclear Regulatory Commission or State (if the fellow practices in an agreement state).

General Goals: The specific goals include objectives required for every level and focused area of training, with graduated levels of supervision and responsibility. All aspects of nuclear medicine imaging and therapy are incorporated into the fellowship including cardiac nuclear medicine and radionuclide therapy. During every training rotation, the fellow will read the required material and study the teaching cases. Over time, the fellow will become progressively more knowledgeable about normal scintigraphic anatomy and scintigraphic physiology and about the scintigraphic appearance of disease processes. Fellows will gain competence in interpreting dynamic and static nuclear imaging (planar, SPECT, SPECT/CT and PET-CT). Fellows will gain competence in the utilization and handling of radiopharmaceuticals for diagnostic and therapeutic purposes and quality control of nuclear imaging instruments and radiopharmaceuticals. In addition, the fellow will increasingly understand disease entities, their clinical presentations, and current modes of treatment. The fellow will know how to supervise and perform radionuclide image-guided procedures at the completion of the final rotation. The fellow will know how to function as an NRC Authorized User of radioisotopes for diagnostic use and for therapies involving administered doses <33 mCi I-131, administered doses <33 mCi I-131, and parenteral administration of any beta emitter, or a photon-emitting radionuclide with a photon energy less than 150 keV, for which a written directive is required, and/or parenteral administration of any other radionuclide, for which a written directive is required. Teaching and consultation skills will be practiced and honed during the fellowship.

The structured training provides the base for preparation for certification by the ABR and for the clinical and academic practice of Nuclear Radiology.

Note: Current ABR requirements are different for AU-eligiblity for DR and IR/DR versus AU-eligibility for Nuclear Radiology special competency, as below.

https://www.theabr.org/diagnostic-radiology/initial-certification/abr-training-nuclear-medicine-compliance-nrc-regulations

AU-eligibility for DR and IR/DR residents and those in alternate pathway

1. Administering to patients or human research subjects dosages that include at least **three** cases involving the oral administration of ≤ 33 mCi and at least **three** cases involving the administration of > 33 mCi of sodium iodide $^{131}$I.

AU-eligiblity for Nuc Rad special competency

1. Administering to patients or human research subjects dosages that include at least **10** cases involving the oral administration of ≤ 33 mCi and **five** cases involving the administration of > 33 mCi of sodium iodide $^{131}$I.
2. Administering to patients or human research subjects dosages that include at least **five** cases involving the parenteral administration of any beta emitter, or a photon-emitting radionuclide with a photon energy less than 150 keV, for which a written directive is required, and/or parenteral administration of any other radionuclide, for which a written directive is required.

Note:
Eligibility for Nuc Rad special competency for those in ABR alternate pathway requires a 12 month Nuc Rad fellowship + additional 4 months of NM.

## FELLOW DAILY WORK RESPONSIBILITIES

Overall Benchmarks/Objectives

### During routine work hours

1. The fellow assigned to clinical responsibilities will be available in the respective area (typically NM reading room) for consultations with technologists, clinicians, and other health care providers, except during previously planned conference and meeting times or approved leave.
2. At the start of every working day, the fellow will be familiar with the patient schedule and anticipate timing of any procedures or consultations.
3. At the start of every working day, the fellow will coordinate with residents on NM service to ensure MD coverage of the reading room for times when a trainee will be away (ex. lunch, conference, medical appointment, etc) .
4. The fellow will check the day's worklist to identify uncommon procedures in order to participate.
5. The fellow will refer his/her questions to the supervising faculty covering the clinic at the time and will understand the need to accept graded responsibility.
6. The fellow will perform a quality check on nuclear medicine exams as required before the technologist allows the patient to leave, to ensure that the exam is complete; the fellow may request additional views or imaging techniques, or repeat imaging when necessary.
7. The fellow will review of one or more cases with the supervising faculty in a timely fashion during the day to keep an efficient workflow and timely final signage of reports. Cases should not be held by the resident to be "bulk read" in one setting as that will negatively affect productivity parameters.
8. All examinations reviewed by the fellow will be dictated by the end of every working day.
9. The fellow will check and sign his/her reports prior to final verification by supervising faculty.
10. The fellow will serve as a secondary consultant to referring physicians regarding nuclear medicine. This will strengthen the confidence of the fellow in the very important role every radiologist must perform throughout his/her career as a consultant to clinicians.
11. The fellow will teach and share knowledge with medical students, radiologic and nuclear technologist students, radiology residents and residents and fellows outside Radiology.

12. The fellow will participate in the preparation and presentation at the Interesting Case conferences as assigned.
13. The fellow will participate in, and make presentations at noon conference for Radiology residents as assigned.
14. The fellow must be familiar with the operation of all nuclear medicine equipment.

**During and after routine work hours**

1. The fellow must acquire knowledge of radiation protection and ways to reduce radiation exposure to both patients and hospital personnel. The fellow will be supervised to assure that safe practices are followed.
2. The fellow will learn the techniques for performing high quality, state-of-the art diagnostic examinations.
3. The fellow must become proficient at detecting abnormalities on imaging procedures and be able to generate meaningful differential diagnosis.
4. The fellow will become knowledgeable about the use of different radiopharmaceutical agents (including indications, contraindications, dosages, and side effects/complications).
5. The fellow will acquire an understanding of the proper preparation of patients for examinations and appropriate follow-up if needed.
6. The fellow will do in-depth reading and study along with a review of reputable teaching cases to become knowledgeable about the utilization and utility of nuclear medicine procedures and to gain an understanding of the disease entities, their clinical presentations and management.
7. The fellow will undertake preparation to pass the ABR certifying examination in Nuclear Radiology or to pass the certifying examination in DR or DR/IR, based on eligibility.

**Additional Requirements during the Fellowship**

1. Completion of Radiation Safety module, UVA intranet, once/year of residency
2. Completion of required radionuclide therapy experience per ABR guidelines to support AU eligibility
3. Satisfactory completion of 10 SA-CME courses available online through RSNA, with documentation of passing score. After each module, the fellow will be assigned to present the material to the NM group The first 7 modules listed are required topics; the fellow may select the other 3 to complete for a total of 10.

4. Complete presentations at Interesting Case Conference for Rad residents, as assigned
5. Complete presentations at Noon Conference for Rad residents, as assigned
6. Participate in and serve as NM moderator in tumor boards, as assigned
7. The fellow will teach nuclear medicine procedures and supervise rotating medical students and radiology residents

Supervising Faculty Responsibilities:

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

**Educational Goals and Objectives for General Nuclear Medicine Rotation I (excludes PET-CT)**

Patient Care:

1. Protocol procedures in EPIC in advance of the patient appointment to assure that the requested procedure is appropriate, and that all needed materials and equipment will be available.
2. 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 imaging when necessary.
3. Be able to adequately explain each examination to the patient in compassionate, appropriate, and effective manner, in order to ensure that the patient feels comfortable.
4. 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.
5. Understand the indications and contraindications of the commonly used diagnostic radiopharmaceuticals and be able to monitor administration
6. Understand the indications and contraindications for use of therapeutic radiopharmaceuticals and be able to monitor administration.
7. Recognize and know how to treat reactions to commonly used radiopharmaceuticals or scan-associated medications (ex. Lasix, Sincalide, regadenoson, etc.), and be able to monitor administration of ancillary drugs.
8. Understand the preparation and aftercare required for the common examinations, including instructions to the patient.
9. 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.
10. Recognize the need to report significant findings to the referring physician in a timely manner (in accordance with hospital/Radiology guidelines), and fulfill and document your actions in the medical record.
11. Demonstrate the ability to recommend additional nuclear or non-nuclear imaging studies as appropriate to patient management based on the imaging and clinical information available.
12. Understand the preparation and aftercare required for all radionuclide treatments including instructions to the patient. Recognize the need for actively participating in consultations with the attending nuclear medicine physician, timely dictations of the consultation sessions.

Medical Knowledge:

1. Understand concepts of nuclear tracers, nuclear imaging, and equipment.
2. Know and discuss radiopharmaceutical preparation.
3. Know and discuss nuclear medicine physics and instrumentation.
4. Understand the principles and rational for using different radiopharmaceuticals.
5. Know the energies and half-lives of clinical radioisotopes.
6. Understand the difference between physical and biological half-life of commonly used radiotracers.
7. Know how to supervise the acquisition and processing, and know how to interpret commonly performed nuclear medicine exams involving gamma-emitters: ex. bone (whole body, three phase, SPECT), lung (ventilation using DTPA aerosol or xenon gas perfusion for VQ scan, quantitative perfusion), thyroid scan and uptake, renal (MAG3, DMSA), GI bleeding, meckels, gastric emptying and brain death.
8. Know how to supervise the acquisition and processing, and know how to interpret less commonly performed nuclear medicine exams involving gamma-emitters: including I-123 MIBG, In-111 WBC, Tc-99m WBC, Tc-99m sulfur colloid marrow scan, CSF leak, CSF cisternography, Leveen shunt, liver-lung shunt, right to left shunt, VCUG, RBC hemangioma scan, parathyroid scan, Tc-99m labeled perfusion brain SPECT.
9. Know the methods of radionuclide cell labeling applicable to leukocytes and red cells.
10. Know how to supervise the acquisition and processing of myocardial perfusion SPECT studies, and know how to interpret them.
11. Know how to supervise the acquisition and processing of FDG PET/CT scans for oncologic indications, and know how to interpret them.
12. Know how to supervise the acquisition and processing of FDG PET/CT scans for neurologic indications, and know how to interpret them.
13. Know how to supervise the acquisition and processing of N-13 ammonia PET/CT scans for cardiac indications, and know how to interpret them.
14. Know how to supervise the acquisition and processing of FDG PET/CT scans for cardiac indications, and know how to interpret them.
15. Know how to supervise the acquisition and processing of FDG PET/CT scans for cardiac indications, and know how to interpret them.
16. Know how to supervise the acquisition and processing of all other FDA-approved PET tracers (ex. F-18 bone, Ga-68 dotatate, F-18 Axumin, etc), and know how to interpret the scans.

17. Understand the biodistribution and kinetics of the radiotracers used for nuclear medicine procedures, itemized above.
18. Understand, discuss, and interpret procedures performed in the hot lab.
19. Use a systematic approach to identify abnormalities on nuclear medicine exams, itemized above
20. Develop a thorough knowledge of normal and abnormal anatomy and physiology as demonstrated on nuclear medicine studies, itemized above.
21. Demonstrate the ability to recognize and describe abnormalities depicted on nuclear medicine imaging studies, itemized above.
22. Discuss common types of pathology (and/or indications) for nuclear medicine exams, itemized above.
23. Develop a knowledge of the differential diagnoses for common and uncommon abnormalities demonstrated on the exams, itemized above.
24. Know how to perform a quality check on 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.
25. Understand the risk factors for allergic reaction to drugs and radiopharmaceuticals used in nuclear medicine.

Practice-Based Learning and Improvement:

1. Show evidence of independent study using materials from the reading list and recognized websites.
2. Demonstrate appropriate follow up of interesting and/or challenging cases.
3. Research interesting cases as directed by faculty.
4. Identify, rectify, and learn from personal errors.
5. Incorporate feedback into improved performance.
6. Efficiently use electronic and print sources to access medical information and increase knowledge base.

Interpersonal and Communication Skills:

1. Communicate with the patient at any point before, during, or after the examination to ensure that patient remains comfortable.
2. Communicate effectively with all members of the health care team (technologists, medical students, fellows, residents, allied health providers, support staff, and attending physicians in radiology, inside and outside referring clinicians.

3. Call results as appropriate, and document communication, to the referring physicians and show ability to interact with referring physicians.
4. Interact with clinicians when reviewing cases and show ability to provide preliminary readings, follow up with attending radiologists, formulate and discuss a plan for complex cases, and communicate any changes to referring clinicians.
5. Recognize limitations in knowledge and skills for making competent decisions.
6. Participate in case check-outs with appropriate NM attending and dictate most cases.
7. Participate in tumor boards and other inter-departments conferences as assigned. In a graded experience the fellow will take a primary role in case presentation in tumor boards.

Professionalism:

1. Demonstrate respect for patients, families, and all members of the healthcare team.
2. Explain the impact of the nuclear examinations or findings on patient care, including what imaging studies may/may not be appropriate.
3. Respect patient confidentiality at all times; understand HIPAA requirements.
4. Present oneself as a professional in appearance, mannerisms, and communication.
5. Demonstrate a responsible work ethic with regard to work assignments.
6. Demonstrate promptness and availability at work.

System-Based Practice:

1. Be able and willing to 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.
2. In a graded experience the fellow will take on a primary role in case presentation in tumor boards.
3. Demonstrate knowledge of the ACR practice guidelines and technical standards for nuclear medicine.
4. Demonstrate knowledge of ACR appropriateness criteria and cost effective imaging evaluation of common and less common disorders.
5. Show ability appropriate to the level of training to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical questions.

6. Review equipment and quality assurance with assigned technologist once a week or as required.
7. Make suggestions to improve methods and systems utilized in nuclear medicine and radiology whenever appropriate.
8. Understand the mechanisms by which the Nuclear Medicine section maintains internal records in order to comply with NRC/state regulations.

Monitoring and Assessment of Fellow Performance

1. Fellows are provided with evaluations quarterly by faculty. The fellow's progress will be monitored by the faculty on the service. Toward the end of each quarter, the fellow will receive an evaluation of performance from each attending through New Innovations.
2. Deficiencies or substandard performance will be discussed personally and privately with the fellow and will be brought to the attention of the Residency Program Director by the attending radiologist.
3. Fellow 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 for PET-CT Rotation**

The Educational Goals and Objectives for PET-CT Rotation that follow are specific to this rotation.
However, it assumes completion and further advancement in mastery of the Educational Goals and Objectives for General Nuclear Medicine Rotation I above.

Patient Care:

1. Understand the physics of radiation protection and how to apply it to PET-CT studies
2. Develop a knowledge of the preparation and aftercare required for more complex procedures
3. Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the fellow will effectively communicate with the patient and referring physician until clarified)
4. Protocol cases, in consultation with the attending, to assure that the examination is appropriate to the clinical question
5. Obtain consent for more complex procedures when needed, and answer all questions the patient may have
6. Perform a quality check on PET-CT 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
7. Continue to improve skills for supervising and performing PET-CT examinations, and tailor examinations to answer the questions being asked by the clinician; anticipate other pertinent clinical questions
8. Be familiar with available medical records and how to access them for the purposes of patient care
9. Review all studies with the supervising faculty attending
10. 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 fellow will notify the referring clinician immediately)

Medical Knowledge:

1. Comprehend basic concepts of FDG PET-CT imaging of body and brain for oncologic indications and artifacts, and know how to interpret the scans
2. Comprehend advanced concepts of FDG PET-CT of body and brain for oncologic indications, and know how to interpret the scans
3. Comprehend basic concepts of f FDG PET/CT scans of the brain or neurologic indications, and artifacts, and know how to interpret the scans
4. Comprehend basic concepts of N-13 ammonia PET/CT scans for cardiac indications, and artifacts, and know how to interpret the scans
5. Comprehend advanced concepts of N-13 ammonia PET/CT scans for cardiac indications, and know how to interpret the scans
6. Comprehend basic concepts of FDG PET/CT scans for cardiac indications, and artifacts (ex. Viability) and know how to interpret the scans
7. Comprehend advanced concepts of FDG PET/CT scans for cardiac indications, and artifacts (ex. Sarcoidosis) and know how to interpret the scans
8. Comprehend advanced concepts of each of the other FDA-approved PET tracers (ex. F-18 bone, Ga-68 dotatate, F-18 Axumin, etc.), and know how to interpret the scans
9. Understand the biodistribution and kinetics of the radiotracers used for nuclear medicine procedures, itemized above.
10. Demonstrate the ability to recognize and describe abnormalities depicted on nuclear medicine imaging studies itemized above when presenting to the attending, and demonstrate improvement skills compared to the prior rotation
11. Be familiar with imaging findings of common acute and chronic diseases on studies above
12. Be able to develop meaningful differential diagnoses for findings on imaging studies itemized above
13. Understand the clinical management of the conditions diagnosed on imaging studies itemized above
14. Correlate nuclear medicine studies with other imaging modalities and pathology when available
15. Understand the relative strengths and limitations of each scan type and other available imaging and non-imaging options
16. 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

17. Comprehend QC procedures, camera performance, and specific imaging techniques including PET acquisition and processing, and wet lab procedures
18. Divide time between supervision and interpretation, thereby developing more advanced skills and acquiring new skills concerning the scans enumerated above for this rotation
19. Be able to develop appropriate differential diagnoses of a advanced, rather than basic, level for scans itemized above
20. Act as a consultant to the clinical services

Practice-Based Learning and Improvement:

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

Interpersonal and Communication Skills:

1. Appropriately obtain informed consent
2. Produce clear, concise reports that include all relevant information
3. Be able to effectively convey the findings of examinations through accurate description during case check-out
4. Communicate effectively with all members of the healthcare team
5. 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)
6. Effectively convey the findings of examinations through accurate descriptions during case check-outs
7. Participate in inter-departments conferences

Professionalism:

1. Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers)
2. Respect patient confidentiality at all times
3. Present oneself as a professional in appearance, manner, and communication
4. Demonstrate a responsible work ethic in regard to work assignments
5. Explain the nature of the procedure or findings to patients and their families when needed
6. Observe ethical principles when recommending further work-up
7. Demonstrate promptness and availability with regard to work assignments
8. Dress appropriately for work

Systems-Based Practice:

1. Show ability appropriate to the level of training to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical questions
2. Demonstrate knowledge of ACR practice guidelines and technical standards for PET and PET-CT
3. Demonstrate knowledge of ACR appropriateness criteria and cost-effective imaging evaluations
4. Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations
5. Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
6. Make thorough dictations, with inclusion of indications, techniques, findings, and conclusions (impressions), for accuracy in reporting and compliance with billing guidelines
7. Dictate and correct reports in a timely fashion to avoid delay in patient disposition
8. Make suggestions to improve methods and systems utilized in nuclear medicine and radiology whenever appropriate
9. Review equipment and quality assurance with assigned technologist once/week or as required
10. Monitoring and Assessment of Fellow Performance
11. The fellow's progress will be monitored by the faculty on the service. Toward the end of each rotation (quarterly), the fellow will receive an evaluation of performance from each attending through New Innovations. Deficiencies or substandard performance will be discussed personally and

privately with the fellow and will be brought to the attention of the Residency Program Director by the attending radiologist. Fellows are evaluated quarterly by faculty. Fellow 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 for Endocrine Disorders and Radionuclide Therapy Rotation

The Educational Goals and Objectives for Endocrine Disorders and Radionuclide Therapy Rotation that follow are specific to this rotation. However, it assumes completion and further advancement in mastery of the Educational Goals and Objectives for General Nuclear Medicine Rotation I above.

Patient Care:

1. Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the fellow will effectively communicate with the patient or referring physician until clarified)
2. Be familiar with available medical records and how to access them for the purposes of patient care
3. 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
4. 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
5. Review all studies with the supervising faculty attending
6. 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 fellow will notify the referring clinician immediately)
7. Participate in Evaluation and Management (E/M) office visits, consultations (both econsult and in-person consult sessions) in conjunction with attending for any patient referred for radionuclide therapy. This includes but is not limited to: obtain history and perform physical exams, make assessment, develop management plan and complete note in EPIC (medical record). Engagement with the referring MD may be included in this process.
8. Participate in outpatient and inpatient radionuclide therapies, including but not limited to; assist/supervise radionuclide administration, coordinate with clinical service if inpatient therapy, explain required radiation safety measures to patient, obtain informed consent.

Medical Knowledge:

1. Be able to distinguish between normal and abnormal anatomy and physiology on imaging concerning endocrine disorders, especially thyroid diseases, and recognize artifacts
2. Be able to relate the imaging findings to the clinical condition, its pathology and pathophysiology
3. Be able to present and discuss laboratory and imaging findings at an advanced level when presenting to the attending, and demonstrate improvement over time
4. Be able to develop appropriate differential diagnoses of a advanced, rather than basic, level for commonly performed nuclear scans addressing endocrine disorders especially thyroid diseases
5. Develop a deeper understanding of the clinical management of thyroid disorders
6. Know the indications and dosage regimens for radionuclide therapy with I-131 for hyperthyroidism
7. Know the indications and dosage regimens for radionuclide ablation with I-131for thyroid cancer
8. Know the indications and dosage regimens for radionuclide therapy with I-131 for metastatic thyroid cancer
9. Be able to discuss and explain the patient preparations for I-131 therapies for indications enumerated above
10. Know the mechanism of action, risks and benefits, side effects and side effect management for I-131 therapy
11. Understand, discuss, perform, and interpret procedures performed in the hot lab relevant to I-131 radionuclide therapies
12. Know the proper preparation of patients for diagnostic and therapeutic procedures and the appropriate follow-up afterward, if warranted
13. Act as a consultant in nuclear medicine to the clinical services
14. Review equipment and quality assurance with assigned technologist once a week or as required
15. Competently recommend appropriate nuclear and non-nuclear radiologic workup for clinical presentation
16. Develop an understanding of the clinical management of patients with castration resistant prostate cancer metastatic to bone.
17. Be familiar with all the FDA-approved radionuclide therapy agents for painful bone metastasis, including Radium-223 (Xofigo), samarium-153 lexidronam (Quadramet), 89Srchloride-89 (Metastron), 32P-sodium phosphate, including relative advantages and disadvantages

18. Know the indications, dosage regimens, mechanism of action, and side effects for radionuclide therapy agents used at UVA for prostate cancer patients, including Radium-223 (Xofigo).
19. Be familiar with the indications, dosage regimens, mechanism of action, and side effects for Y-90 Zevalin therapy for non-Hodkin's lymphoma.
26. Understand the biodistribution and kinetics of the radionuclides used for therapy, itemized above.
20. Know the mechanism of action, risks and benefits, side effects and side effect management strategies for each FDA-approved radionuclide therapy agent used at UVA
21. Comprehend quality control procedures, camera performance, and specific imaging techniques including SPECT acquisition, processing, and wet lab procedures
22. Understand the physics and principles of radiation protection and how to apply it to the radionuclide therapy setting
23. Acquire knowledge and comprehension of regulations of nuclear imaging and radiation safety by the NRC, State, and Hospital (JCAHO)
24. Divide time between supervision and scan interpretation (as in Rotation 1 and 2) and therapy procedures, thereby developing more advanced skills in earlier components and acquiring new skills.

Practice-Based Learning and Improvement:

1. Identify, rectify, and learn from personal errors
2. Incorporate feedback to improve performance
3. Demonstrate evidence of independent reading and learning through use of printed and electronic resources
4. Follow up on abnormal or interesting cases through personal communication with the referring physician, patient, or patient medical records
5. Be 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:

1. Appropriately and effectively communicate with the patient (and family, when appropriate) during the consultation and radionuclide therapy procedure and followup
2. Appropriately communicate results to patients and clinicians whenever needed (for emergent studies, this will be done in a timely manner)

3. Communicate effectively with all members of the healthcare team
4. Assist with supervision and teaching of medical students, radiologic and nuclear technologist students, and radiology residents

Professionalism:

1. Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers)
2. Respect patient confidentiality at all times
3. Present oneself as a professional in appearance and communication
4. Demonstrate a responsible work ethic in regard to work assignments
5. Be able to explain the nature of the examination and findings in an examination to patients and their families when needed
6. Observe ethical principles when recommending further work-up for cases
7. Demonstrate promptness and availability with regard to work assignments
8. Dress appropriately when reporting to work

Systems-Based Practice:

1. Show ability appropriate to the level of training during interaction with clinicians regarding cost effective and streamlined evaluations for differing clinical questions
2. Demonstrate knowledge of ACR practice guidelines and technical standards for nuclear medicine
3. Demonstrate knowledge of ACR appropriateness criteria and cost effective imaging practices in nuclear medicine
4. Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations
5. Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
6. Produce thorough dictations with indications, techniques, findings, and conclusions
7. Dictate and correct reports in a timely fashion to avoid delay in patient disposition
8. Make suggestions to improve methods and systems utilized in nuclear medicine and radiology whenever appropriate

Monitoring and Assessment of Fellow Performance

1. Fellows are provided with evaluations quarterly by faculty. The fellow's progress will be monitored by the faculty on the service. Toward the end of each quarter, the fellow will receive an evaluation of performance from each attending through New Innovations.
2. Deficiencies or substandard performance will be discussed personally and privately with the fellow and will be brought to the attention of the Residency Program Director by the attending radiologist.
3. Fellow 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 for Cardiac Nuclear Medicine Rotation**

Educational Goals and Objectives for Cardiac Nuclear Medicine Rotation that follow are specific to this rotation. However, it assumes completion and further advancement in mastery of the Educational Goals and Objectives for General Nuclear Medicine Rotation I above.

Patient Care:

1. Demonstrate knowledge of indications for the examinations requested (when the reason for the examination is not clear, the fellow will effectively communicate with the patient or referring physician until clarified)
2. Protocol cases, in consultation with the attending, to assure that the examination is appropriate to address the clinical concerns of the patient and referring physician
3. Be facile with use of available electronic medical records and how to access them for the purposes of patient care
4. Perform a quality check on nuclear medicine exams as warranted, before the technologist allows the patient to leave, to ensure that the exam is complete, and request additional views or repeat imaging when necessary
5. Review all studies with the supervising faculty attending
6. 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 fellow will notify the referring clinician immediately)

Medical Knowledge:

1. Understand, discuss, and interpret nuclear radiology and nuclear cardiology procedures
2. Be able to distinguish between normal and abnormal anatomy and physiology with excellent accuracy appropriate to the level of training when presenting to the attending, and demonstrate improvement compared to the prior rotation
3. Be able to develop advanced differential diagnoses for common and uncommon findings on all types of cardiac nuclear scans, including SPECT and PET.
4. Know the indications and patient preparations for Tc myocardial perfusion SPECT, Tc pyrophosphate amyloid SPECT, N-13 myocardial perfusion

PET, FDG myocardial PET-CT, procedures scans for possible valve/graft infection.

5. Understand the biodistribution and kinetics of the radiotracers used for cardiac nuclear medicine procedures, itemized above.
6. Be able to address complicated patient circumstances (ex. broken arm in cast, diabetic patient). Know when and how to modify scan technique, if possible, to accommodate patient circumstances (ex. Patient can't lie flat).
7. Be able to interpret the scans and recognize common and uncommon artifacts
8. Use a systematic approach to identify abnormalities on cardiac scans and generate an advanced differential diagnosis
9. Be able to relate the imaging findings to the clinical condition, its pathology and pathophysiology, as well as correlative imaging.
10. Be able to explain the methods of radionuclide cell labeling for leukocytes and red cells
11. Be able to develop appropriate differential diagnoses at an advanced level for all types of nuclear cardiology exams
12. Develop a deeper understanding of the clinical management of the medical conditions encountered in routine practice
13. Understand, perform, and/or explain procedures performed in the hot lab
14. Know how to supervise equipment and quality assurance monitoring performed by technologist staff
15. Act as a consultant in nuclear medicine to the clinical services
16. Competently recommend appropriate workup for clinical presentations
17. Finalize understanding and knowledge regarding regulations of nuclear imaging by the NRC, State, and Hospital (JCAHO)
18. Complete final preparations to pass the certifying examination of the American Board of Radiology

Practice-Based Learning and Improvement:

1. Identify, rectify, and learn from personal errors
2. Incorporate feedback into improve performance
3. Demonstrate evidence of independent reading and learning through use of printed and electronic resources
4. Follow up on abnormal or interesting cases through personal communication with the referring physician or patient medical records
5. 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

6. Attend lectures/conferences, expand concepts, applications, and comparisons with other diagnostic methods
7. Review cardiac teaching file

Interpersonal Skills:

1. Appropriately communicate results to patients and clinicians whenever needed (for emergent studies, this will be done in a timely manner)
2. Produce clear, concise reports that include all relevant information and
3. Be able to effectively convey the findings of examinations through accurate description during case check-out
4. Communicate effectively with all members of the healthcare team
5. Assist with supervision and teaching of medical students, radiologic and nuclear technologist students, and radiology residents.

Professionalism:

1. Demonstrate respect for patients and all members of the healthcare team (technologists, nurses, and other healthcare workers)
2. Respect patient confidentiality at all times
3. Present oneself as a professional in appearance and communication
4. Demonstrate a responsible work ethic in regard to work assignments
5. Be able to explain the nature of the examination of findings in an examination to patients and their families when needed
6. Observe ethical principles when recommending further work-up for cases
7. Demonstrate promptness and availability with regard to work assignments
8. Dress appropriately when reporting to work

Systems-Based Practice:

1. Show ability appropriate to the level of training to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical questions
2. Demonstrate knowledge of ACR practice guidelines and technical standards for nuclear medicine
3. Demonstrate knowledge of ACR appropriateness criteria and cost effective imaging practices in nuclear medicine
4. Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations

5. Use appropriate language in communicating to clinicians through reports or consultations so proper management decisions can be made
6. Produce thorough dictations with indications, techniques, findings, and conclusions
7. Dictate and correct reports in a timely fashion to avoid delay in patient disposition
8. Make suggestions to improve methods and systems utilized in nuclear medicine and radiology whenever appropriate

Monitoring and Assessment of Fellow Performance

1. Fellows are provided with evaluations quarterly by faculty. The fellow's progress will be monitored by the faculty on the service. Toward the end of each quarter, the fellow will receive an evaluation of performance from each attending through New Innovations.
2. Deficiencies or substandard performance will be discussed personally and privately with the fellow and will be brought to the attention of the Residency Program Director by the attending radiologist.
3. Fellow 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.

**Daily Work Expectations**

See sub-section, below, for specific details regarding a portion of the Nuclear Cardiology experience.

Description below applies generally to the fellowship.

The vast majority of your time will be spent in the clinical Nuclear Medicine area of the Cancer Center, and primarily in the NM reading room. The first rotation will be spent learning about and reviewing/dictating commonly performed diagnostic scans. During this rotation and subsequent NM rotations, you will protocol exams in EPIC on the MD worklist in advance of the appointment, and check scans to let the patient leave the department. You will also have the opportunity to observe and participate in scan acquisition and processing in conjunction with the NM technologists. (If you are male, use common sense about patient contact. If the patient is in a gown, have a chaperone. This is for your protection as well as the patient.) You will inform the patient and doctor of scan results as warranted. You will see patients referred for radionuclide therapy in NM clinic in consultation and

collaborate with the NM attending to determine appropriate patient management. You will document the E&M visit in EPIC. You will serve as a consultant to other physicians and health care providers in the reading room, by phone, and outside the NM Division.

The second rotation will be spent learning about and reviewing/dictating less commonly performed diagnostic scans. You will also learn about and review/dictate PET-CT cases. You will develop management skills for using radionuclide therapies.

The third rotation will be spent learning about and reviewing/dictating uncommonly performed diagnostic scans, and advancing your skills to review/dictate PET-CT cases.

The fourth rotation will be spent finalizing your 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, according to priority, although all cases should be read in a timely fashion.

1. Emergency studies, inpatient and emergency department (to be continuously distributed as they come in and to be read as first priority)
2. “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)
3. 9 a.m.: any unread studies that appear from prior day(s), regardless of how they got overlooked or where they came from
4. 4 p.m.: check for studies from the day that slipped through and have not been read
5. Outpatient studies (to be continuously distributed as they come in)

Distribution of work:

1. General nuclear studies are to be split between the fellow, first-year Radiology resident and more advanced Radiology residents, with distribution based on level of training.
2. Early in the fellowship, the trainee is reading simpler cases and has a slightly lower workload compared to later in the training year.

3. The other Radiology residents and the Nuclear Radiology fellow share the cases, both in terms of numbers and degree of difficulty.
4. In general PET-CT studies to be split between the fellow and more advanced Radiology residents, with distribution based on level of training. Note: a prior CT rotation is required for Radiology resident to read hybrid nuclear studies involving CT (eg. SPECT/CT, PET/CT).
5. All studies assigned to the fellow must be dictated by the end of that working day.
6. Assignment of patients for Consultation (for radionuclide therapy evaluation) are to be split between the fellow, first-year Radiology resident and more advanced Radiology residents, (and occasionally, visiting Radiation Oncology resident) with distribution based on level of training and need for training experience.
7. The fellow will participate in, and make presentations on nuclear medicine topics at noon conference for Radiology residents, as assigned.
8. The fellow will make presentations at morning Interesting Case conference for Radiology residents, as assigned.

Daily Work-Cardiac Rotation only
Fellow Experience in Nuclear Cardiology Procedure area

You will be assigned to one of the Nuclear Cardiology clinics on specific dates, with your schedule coordinated with Cardiology, to observe and participate. The clinics are located in the Nuclear Cardiology wing (hospital 2nd floor) and Fontaine. When you arrive, identify yourself to the NM staff. Mike Sobczak, CNMT, (main hospital) and Chris Rababy, CNMT, (Fontaine Cardiology), are the respective Chief Technologists in Nuclear Cardiology, who can direct you to where the action is taking place at that time.

The majority of your day will be spent in the Nuclear Cardiology area where you will be observe and participate in the stress procedures, scan acquisition, image processing and scan review. During slack time between cases, you can review scans and participate in read-out sessions as they occur.

In addition, at all times during your fellowship you will also be able to review SPECT nuclear cardiology scans using the hospital intranet connection to Cardiology PACS.

Cardiac PET scans are able to be reviewed on Carestream PACS.

Reporting of cardiac SPECT and PET is shared between Nuclear Medicine and Nuclear cardiology. On Tuesdays, and alternate Weds and alternate Fridays, the SPECT scans are interpreted and reported by a Nuclear Medicine attending. The schedule is available on Qgenda, and may change upon availability of staff.

Official reporting of Nuclear Cardiology SPECT procedures is done through EPIC using CUPID. Become familiar with this computer based reporting.

Official reporting on PET Cardiac scans is done through Carestream PACS, like other Radiology procedures.

PET Cardiac scans are reported by Nuclear Medicine and Cardiology. The schedule available on Qgenda, and may change upon availability.

The fellow should be prepared to present, review, and discuss the cases with the NM attending on days they are reporting. Contact the NM attending for the readout times for their assigned reading days.

On the other work days when NM attending is not the reading physician, the cardiac SPECT scans are interpreted and reported by Nuclear Cardiology faculty. You can ask about their read out times and attend readout session for those days, depending on the read-out time and your availability.

**Schedule Expectations and Time-Off Clinical Service**

1. Qgenda is the official schedule regarding assignments for NM fellow and faculty.
2. The fellow is 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 attending to explain the reason of their being late.
3. The fellow should be on duty from 8:00 a.m.to 5:00, or until the work is completed if later.
4. When the fellow is assigned to see a patient in consultation for radionuclide therapy, that fellow should review the case in advance of the patient appointment, and be ready to discuss the patient with the attending before the designated appointment time.
5. Notify the attending before leaving the Nuclear Medicine section in the Cancer Center (unless paged away for contrast reaction).
6. Also the fellow cannot leave the reading-room for any appreciable period before the official end of their shift without the permission of the attending. (Ex. Meetings, appointments)
7. There are 15 vacation days, per GME and Rad department policy (link); see Appendix. During the academic year (July-June), at least seven days of vacation must be taken prior to January 1, and at least seven days taken after January 1 to avoid staffing issues. Residents are not permitted to take more than five consecutive days of vacation *during any rotation*. When feasible, the fellow should take into account vacation time of other trainees, when making requests for time off to facilitate the clinical service as well as learning environment. Vacation time should be avoided during national meetings, unless presenting at the meeting. Vacation is first come/first served, but we will be as flexible as possible. This will maximize your experience and prepare you for practice as well as board examination.
8. Requests for vacation or other time away will be cut-off 3 weeks/21 days before the start of next Rad resident rotation, to ensure adequate resident coverage.
9. There are 14 sick days per GME policy (link); see Appendix.
10. There is a fellow allotment file on Radiology intranet (link). For details, see Appendix.

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

## 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 Topics

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. Liver and hepatobiliary imaging including biliary atresia
5. Bone imaging, including three phase and SPECT
6. Brain SPECT
7. CNS and brain death imaging
8. GI bleeding scans
9. GU scintigraphy: DMSA, MAG3, radionuclide retrograde VCUG
10. Infection imaging: gallium, indium WBC, technetium WBC
11. Lung scans for pulmonary embolism, evaluation of right to left shunt, quantification of regional perfusion
12. Lymphoscintigraphy- breast CA, melanoma, lymphedema
13. Tumor imaging: Parathyroid, MIBG, OctreoScan, breast specific gamma imaging (BSGI) with MIBI
14. PET-CT for cancer, including body and brain
15. PET-CT of brain, including dementia and epilepsy
16. Quality assurance in nuclear medicine
17. Radiation safety in nuclear medicine
18. Radiobiology including application to radionuclide therapy

19. Radionuclide therapy for palliation of bone pain
20. Thyroid imaging
21. Thyroid cancer imaging
22. Radionuclide therapy for treatment of hyperthyroidism
23. Radionuclide therapy for treatment of thyroid cancer
24. Tc-99m myocardial perfusion tracers
25. Cardiac SPECT technique, processing, interpretation and common artifacts
26. Evaluation of ventricular function employing EKG gating using cardiac SPECT and MUGA
27. Cardiac stress procedures used in conjunction with nuclear imaging
28. PET radiotracers and PET procedures applicable for cardiac imaging

Nuclear Radiology Fellow Nuclear Radiology Program Director

Name:

Signature

Date