Florida Hospital Diagnostic Radiology Residency
Nuclear Medicine Goals and Objectives
Training Location: Orlando

Nuclear Medicine Curriculum

I. Introduction

The core of the Nuclear Medicine training is provided by daily interpretation of imaging studies under the direct supervision of the nuclear medicine faculty. This learning is supplemented by faculty lectures covering physics, radiation biology, radiation protection, protocols, imaging, and disease process. Additional training is acquired and reinforced by attending and presenting at conferences, studying of text books and journals, teaching and research. ACGME requires 700 hours of nuclear medicine during 4 years of Diagnostic Radiology Training.

II. Curriculum Content for 700 hours of training

Refer to: Appendix A

III. General ACGME six core competencies (6 categories) for 700 hours of Nuclear Medicine training

Refer to: Appendix B

IV. Resident responsibilities during Nuclear Medicine Rotations

Year 1

1) Learn radiotracer techniques and physiology, radionuclide pharmacology, radiation biology, radiation protection, decontamination procedures, ALARA, instrumentation, nuclear medicine instrumentation, imaging protocols, and biodistribution of isotopes.
2) Learn indications for, protocols of, imaging techniques of, and scintigraphic findings for the more commonly performed nuclear medicine procedures: Lung, bone, GI, and PET/CT.
3) Interpret studies under the guidance of nuclear medicine faculty.
4) Learn to use the dictation templates to provide an articulate and meaningful interpretation for referring physicians.
5) Acquire an appreciation for and knowledge of the operation of a Nuclear Medicine Department.
6) Develop the habit of always gathering appropriate clinical history and relevant anatomical studies in order to render a more useful interpretation.
7) Become familiar with ACR appropriateness criteria related to nuclear medicine.
8) Work in Nuclear Medicine pharmacy and hot lab in order to acquire knowledge and experience in the handling of radiopharmaceuticals (see appendices E,F,G)
9) Learn the procedures for and participate in treating patients using high-dose and low dose I-131. (see appendix D)
10) Observe in the imaging areas, the performance of selected nuclear medicine procedures.
11) At all times demonstrate respect and kindness for patients, their families, staff and peers:
    Patient and Professional needs supersede the self-interest.
12) Study Nuclear Medicine; Teaching files, cases, text books, journals.

**Year 2**

1) Learn biodistribution of, production of, and characteristics of all diagnostic isotopes and radiopharmaceuticals.
2) Learn indications for, protocols of, imaging techniques of, and the scintigraphic findings for all nuclear medicine procedures.
3) Interpret studies under the guidance of nuclear medicine faculty.
4) Learn to use all of the nuclear medicine work stations and software.
5) Begin interactions with technologists helping them solve problems they encounter in performing studies.
6) Interact with referring physicians regarding the results of and implications of studies.
7) Continue to acquire experience in treating thyroid disease with low-dose and high-dose I-131.
8) Continue to observe the performance of selected nuclear medicine procedures.
9) At all times demonstrate respect and kindness for patients and their families, staff, and peers: Patient and Professional needs supersede self-interest.
10) Study Nuclear Medicine:
    Journals:  JNMMI, EJNMMI, Clinical Nuclear Medicine

**Years 3 & 4**

1) Interpret studies with the guidance of nuclear medicine faculty.
2) Assume the role of the primary nuclear physician interacting with technologists and physicians to solve problems and obtain high quality studies.
3) Teach students and fellow residents.
4) Present cases at conference.
5) Complete I-131 therapy requirements if needed.
6) Reinforce knowledge of nuclear medicine procedures by spending time in imaging areas, helping technologists studying the physics of instrumentation, interpreting studies, and teaching others.
7) Acquire knowledge of state and national regulations pertaining to the regulation of distribution of, use of, and administration of isotopes and radiopharmaceutical.
8) At all times demonstrate respect and kindness for patients and their families, staff, and peers. Patient and Professional needs supersede self-interest.
9) Study textbooks and journals.
    Book: Nuclear medicine and PET/CT PE Christian and KM Waterstram-Rich
    Book: PET and PET/CT:  RL Wahl
V. Goals and Objectives of Nuclear Medicine Rotations

A. Year 1

1) Can completely use the nuclear medicine work stations
2) Utilize electric medical health record to gather patient information
3) Understands the fundamentals of nuclear medicine imaging
4) Knows biodistribution of isotopes
5) Provides appropriate interpretations using templates
6) Communicates well with physicians and staff
7) Responds appropriately to constructive criticism
8) Demonstrates appropriate professional behavior
9) Completes and submits to physicist the required information pertaining to the time spent in nuclear pharmacy and in the imaging areas

B. Year 2

1) Can competently use all nuclear medicine stations
2) Knows protocols of all nuclear medicine procedures
3) Knows production of, biodistribution of, and characteristics of diagnostic isotopes and the radiopharmaceuticals
4) Is able to assist technologists with problems they encounter in performing studies
5) Demonstrates appropriate professional behavior

C. Years 3 and 4

1) Can competently direct all nuclear studies and render an appropriate interpretation
2) Has completed all I-131 therapies
   Documentation of:
   Radiation physics and instrumentation
   Radiation protection
   Mathematics, statistics and computer sciences pertaining to the use and measurement of radioactivity
   Radiation biology
   Radiopharmaceutical chemistry
   3 of I-131>33 mCi
   3 of I-131<33 mCi
3) Has knowledge of nuclear medicine journals
4) Can competently discuss all aspects of nuclear medicine: physics, instrumentation, isotopes, imaging protocols, pathophysiology and radiation exposure.
5) Demonstrates appropriate professional behavior


NM APPENDIX A

Nuclear Medicine Curriculum based on the ABR Core Exam

1) Breast
   a) Benign neoplasm
      i) Radiopharmaceuticals (f-18 fdg)
      ii) Imaging techniques (pet)
      iii) Indications: breast lesion
   b) Malignant neoplasm, primary
      i) Radiopharmaceuticals (f-18 fdg)
      ii) Imaging techniques (pet)
      iii) Indications: breast lesion
   c) Malignant neoplasm, metastatic
      i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 NaF, F-18 FDG)
      ii) Imaging techniques (planar, SPECT; PET)
      iii) Indications: staging disease, treatment strategy
   d) Lymphatic mapping/sentinel lymph node (SLN)
      i) Radiopharmaceuticals (Tc-99m SC)
      ii) Injection techniques
      iii) Imaging and localization techniques (planar, SPECT, gamma probe)
      iv) Indications: identification and localization of SLN for intraoperative gamma probe
   e) Infection & inflammation
      i) Radiopharmaceuticals (Ga-67 citrate, In-111 WBCs; F-18 FDG)
      ii) Imaging techniques (planar, SPECT; PET)
      iii) Indications: breast abscess, inflammation
   f) Normal & other
      i) Radiopharmaceuticals (all of above)
      ii) Imaging techniques (all of above)
      iii) Indications: all of above, miscellaneous
   g) Artifacts & quality control
      i) Patient issues: patient preparation, motion, positioning, contamination
      ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
      iii) Technical issues: instrumentation, acquisition & processing, quantitation (SUV)

2) Cardiac
   a) Perfusion imaging, coronary artery disease
      i) Stress protocols (exercise, pharmacologic)
ii) Radiopharmaceuticals (Tc-99m MIBI/tetrofosmin, Tl-201 chloride; Rb-82)
iii) Imaging techniques (SPECT, ECG-gated SPECT; PET)
iv) Quantitative analysis (LVEF, EDV, ESV, TID)
v) Indications: perfusion, function, wall motion, ischemia vs. infarction

b) Perfusion Imaging, non-Coronary Artery Disease
i) Radiopharmaceuticals (Tc-99m MIBI/tetrofosmin, Tl-201 chloride; Rb-82)
ii) Imaging techniques (SPECT, ECG-gated SPECT; PET)
iii) Quantitative analysis (LVEF, EDV, ESV)
iv) Indications: perfusion, function, wall motion, cardiomyopathy

c) Metabolism & viability
i) Radiopharmaceuticals (TI-201 chloride; F-18 FDG)
ii) Imaging techniques (SPECT; PET)
iii) Indications: hibernating myocardium, pre-operative evaluation

d) Function: multigated acquisition (muga) & first-pass studies
i) Radiopharmaceuticals (Tc-99m RBCs, Tc-99m DTPA)
ii) Imaging techniques (ECG-gated planar)
iii) Quantitative analysis (LVEF)
iv) Indications: baseline function, cardiotoxicity, valvular disease (e.g., aortic insufficiency)

e) Shunts
i) Radiopharmaceuticals (Tc-99m MAA, Tc-99m DTPA)
ii) Imaging techniques (planar, SPECT)
iii) Quantitative analysis (QpQs)
iv) Indications: right-to-left shunt, left-to-right shunt

f) Infection & inflammation
i) Radiopharmaceuticals (Ga-67 citrate, In-111 WBCs; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: pericarditis, myocardial/valvular abscess, sarcoidosis

g) Normal & other
i) Radiopharmaceuticals (all of above)
ii) Imaging techniques (all of above)
iii) Indications: all of above, miscellaneous

h) Artifacts & quality control
i) Patient issues: patient preparation, motion, positioning, contamination
ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
iii) Technical issues: instrumentation, acquisition & processing, ECG-gating, quantitation (LVEF)

3) Gastrointestinal
a) Liver & spleen
i) Radiopharmaceuticals (Tc-99m SC, damaged Tc-99m RBCs, Tc-99m MAA)
ii) Imaging techniques (planar, SPECT)
iii) Indications: cirrhosis, hepatic masses (FNH), accessory spleen/splenosis, ascites shunt patency

b) Biliary
i) Radiopharmaceuticals (Tc-99m IDA)
ii) Imaging techniques (planar, SPECT)
iii) Pharmacologic protocols (morphine, CCK)
iv) Quantitative analysis (GBEF)
v) Indications: acute cholecystitis, chronic acalculous cholecystitis, common bile duct obstruction, bile leak, postoperative complications, biliary ectasia

c) Bowel: gastrointestinal bleeding
i) Radiopharmaceuticals (Tc-99m RBCs, Tc-99m pertechnetate)
ii) Imaging techniques (planar, SPECT)
iii) Indications: active GI bleeding site, varices, Meckel diverticulum

d) Bowel: gastrointestinal motility
i) Radiopharmaceuticals (Tc-99m SC solid meal/liquid meal)
ii) Imaging techniques (planar)
iii) Quantitative analysis (T'A, geometric mean)
iv) Indications: gastroparesis, gastroesophageal reflux, aspiration

e) Benign neoplasm
i) Radiopharmaceuticals (Tc-99m SC, Tc-99m IDA, Tc-99m RBCs; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: liver mass (FNH, cavernous hemangioma)

f) Malignant neoplasm, primary
i) Radiopharmaceuticals (Ga-67 citrate; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: hepatocellular cancer, biliary/esophageal/gastric/pancreatic/colorectal cancer, GI stromal tumor

g) Malignant neoplasm, metastatic
i) Radiopharmaceuticals (F-18 FDG)
ii) Imaging techniques (PET)
iii) Indications: staging disease, treatment strategy

h) Infection & inflammation
i) Radiopharmaceuticals (Ga-67 citrate, In-111 WBCs, Tc-99m pertechnetate; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: abscess, inflammatory bowel disease, sialadenitis
iv) Non-imaging techniques (C-14 urea breath test for H. pylori)
i) Normal & other
i) Radiopharmaceuticals (all of above)
ii) Imaging techniques (all of above)
iii) Indications: all of above, miscellaneous

j) Artifacts & quality control
i) Patient issues: patient preparation, motion, positioning, contamination
ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution

iii) Technical issues: instrumentation, acquisition & processing, quantitation (GBEF, T'A; SUV)

4) Musculoskeletal

a) Benign neoplasm
   i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 NaF, F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: osteoid osteoma, exostosis, other imaging

b) Malignant neoplasm, primary
   i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 NaF, F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: osteosarcoma, Ewing sarcoma, multiple myeloma

c) Malignant neoplasm, metastatic
   i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 NaF, F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: staging disease, monitoring therapeutic response

d) Therapy
   i) Radiopharmaceuticals (Sm-153, Sr-89)
   ii) Patient preparation, consent & instructions
   iii) Indications: painful metastases

e) Tumor-like conditions
   i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 NaF, F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: fibrous dysplasia

f) Metabolic & vascular abnormalities
   i) Radiopharmaceuticals (Tc-99m HDP/MDP, Tc-99m SC; F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: hyperparathyroidism (“superscan”/renal osteodystrophy), Paget disease, avascular necrosis, myelofibrosis

g) Trauma
   i) Radiopharmaceuticals (Tc-99m HDP/MDP)
   ii) Imaging techniques (planar, SPECT)
   iii) Indications: stress fracture, heterotopic bone

h) Infection & inflammation
   i) Radiopharmaceuticals (Ga-67 citrate, In-111 WBCs; Tc-99m SC; F-18 FDG)
   ii) Imaging techniques (three-phase, planar, SPECT; PET)
   Indications: osteomyelitis, cellulitis, synovitis/septic joint, arthritis

i) Extra-skeletal processes
   i) Radiopharmaceuticals (Tc-99m HDP/MDP)
   ii) Imaging techniques (planar, SPECT)
   iii) Findings: benign (lung in hypercalcemia, myocardial infarction/ myocarditis/ pericarditis, cardiac amyloidosis) vs. malignant (breast carcinoma, liver metastases from colon cancer, pleural effusion in lung cancer), renal anomalies

j) Bone mineral density (BMD) (dual-energy absorptiometry, DEXA)
   i) Imaging techniques
ii) Quantitative analysis & pitfalls (T-score, Z-score, ROIs, artifacts)
iii) Indications: osteoporosis vs. osteopenia, fracture risk, serial evaluations on medication

k) Normal & other
i) Radiopharmaceuticals (all of above)
ii) Imaging techniques (all of above)
iii) Indications: all of above, miscellaneous

l) Artifacts & quality control
i) Patient issues: patient preparation, motion, positioning, contamination
ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
iii) Technical issues: instrumentation, acquisition & processing, quantitation (SUV; T-score)

5) Neuro
a) Brain death
i) Radiopharmaceuticals (Tc-99m ECD/HMPAO, Tc-99m DTPA/GH)
ii) Imaging techniques (planar, SPECT)
iii) Indications: confirmation of clinical brain death

b) Dementias & behavioral disorders
i) Radiopharmaceuticals (Tc-99m ECD/HMPAO; F-18 FDG)
ii) Imaging techniques (SPECT; PET)
iii) Indications: Alzheimer disease, Lewy body-associated, Pick disease, multi-infarct, senility, depression

c) Seizure
i) Radiopharmaceuticals (Tc-99m ECD/HMPAO; F-18 FDG)
ii) Imaging techniques (SPECT; PET)
iii) Stress protocols (injection during active seizure)
iv) Indications: localization of seizure focus, interictal vs. ictal study

d) Stroke, cerebrovascular disease & vascular reserve
i) Radiopharmaceuticals (Tc-99m ECD/HMPAO; F-18 FDG)
ii) Imaging techniques (SPECT; PET)
iii) Stress protocols (Wada test, Diamox challenge, balloon occlusion)
iv) Indications: ischemia vs. infarct, vascular reserve

e) Benign neoplasm
i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: meningioma

f) Malignant neoplasm, primary
i) Radiopharmaceuticals (Tc-99m MIBI, TI-201 chloride; F-18 FDG)
ii) Imaging techniques (SPECT; PET)
iii) Indications: glioblastoma, astrocytoma, lymphoma

g) Malignant neoplasm, metastatic
i) Radiopharmaceuticals (Tc-99m MIBI, TI-201 chloride; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: staging disease, treatment strategy, tumor viability
h) Infection & inflammation
   i) Radiopharmaceuticals (Ga-67 citrate, In-111 WBCs; F-18 FDG)
   ii) Imaging techniques (SPECT; PET)
   iii) Indications: abscess, encephalitis, toxoplasmosis
       (immunocompromised), radionecrosis
i) Cerebrospinal fluid (CSF)
   i) Radiopharmaceuticals (In-111/Tc-99m DTPA)
   ii) Imaging techniques (planar, SPECT)
   iii) Indications: normal pressure hydrocephalus, leak, V-P shunt patency
j) Normal & other
   i) Radiopharmaceuticals (all of above)
   ii) Imaging techniques (all of above)
   iii) Indications: all of above, miscellaneous
k) Artifacts & quality control
   i) Patient issues: patient preparation, motion, positioning, contamination
   ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
   iii) Technical issues: instrumentation, acquisition & processing, quantitation (SUV)

6) Pediatrics
a) Brain & cerebrospinal fluid (CSF)
   i) Radiopharmaceuticals (Tc-99m ECD/HMPAO; F-18 FDG; In-111/Tc-99m DTPA)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: seizure, neoplasm, V-P shunt patency, hydrocephalus
b) Cardiac
   i) Radiopharmaceuticals (Tc-99m RBCs, Tc-99m MIBI/tetrofosmin, TI-201 chloride)
   ii) Imaging techniques (ECG-gated planar, SPECT, ECG-gated SPECT)
   iii) Quantitative analysis (LVEF, QpQs, RVEF)
   iv) Indications: congenital heart disease, left-to-right shunt
c) Thoracic
   i) Radiopharmaceuticals (Tc-99m MAA, Xe-133 gas, Tc-99m DTPA aerosol)
   ii) Imaging techniques (planar, SPECT)
   iii) Indications: pulmonary artery atresia, right-to-left shunt, cystic fibrosis, Swyer-James
d) Gastrointestinal tract & hepatobiliary system
   i) Radiopharmaceuticals (Tc-99m SC, Tc-99m IDA, Tc-99m pertechnetate)
   ii) Imaging techniques (planar, SPECT)
   iii) Pharmacologic protocols (phenobarbital, cimetidine)
   iv) Quantitative analysis (gastric emptying T 1/2)
   v) Indications: biliary atresia, gastroesophageal reflux, aspiration, Meckel diverticulum
e) Musculoskeletal
   i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: osteoid osteoma, fracture, avascular necrosis, osteomyelitis
f) Endocrine
   i) Radiopharmaceuticals (I-123 NaI, Tc-99m pertechnetate)
   ii) Imaging techniques (planar)
III) Indications: lingual thyroid, agenesis, organification defect, hyperthyroidism

g) Infection & inflammation
i) Radiopharmaceuticals (Ga-67 citrate, In-111 WBCs; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: osteomyelitis/septic joint, lung inflammation, inflammatory bowel disease, abscess

h) Neoplasm
i) Radiopharmaceuticals (Tc-99m HDP/MDP, I-123 MIBG, I-131 NaI; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: osteosarcoma/Ewing sarcoma, histiocytosis/eosinophilic granuloma, neuroblastoma, thyroid cancer, lymphoma

i) Urinary tract
i) Radiopharmaceuticals (Tc-99m DMSA, Tc-99m MAG3, Tc-99m pertechnetate/SC)
ii) Imaging techniques (planar, SPECT)
iii) Indications: multicystic dysplastic kidney, hydronephrosis, vesicoureteral reflux, anuria, pyelonephritis, pre-nephrectomy assessment

j) Normal & other
i) Radiopharmaceuticals (all of above)
ii) Imaging techniques (all of above)
iii) Indications: all of above, miscellaneous

k) Artifacts & quality control
i) Patient issues: patient preparation, motion, positioning, contamination; dosimetry
ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
iii) Technical issues: instrumentation, acquisition & processing, quantitation (T1/2, SUV)

7) Reproductive/endocrine

a) Thyroid gland
i) Radiopharmaceuticals (I-123 NaI, Tc-99m pertechnetate)
ii) Imaging techniques (planar, SPECT)
iii) Quantitative techniques (uptake probe for radioiodine uptake)
iv) Indications: goiter (in situ, substernal), benign thyroid nodules, thyroiditis, multinodular gland, Graves

b) Thyroid cancer
i) Radiopharmaceuticals (I-123/I-131 NaI, Tc-99m MIBI, Tl-201 chloride, In-111 OctreoScan; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: malignant thyroid nodules, thyroid bed remnant, staging disease/metastases for papillary, follicular & medullary cancers

c) Therapy
i) Radiopharmaceuticals (I-131 NaI), dose selection/calculation (benign vs. malignant)
ii) Preparation, patient consent & instructions (benign vs. malignant)
iii) Indications: hyperthyroidism, thyroid cancer (remnant vs. metastases)

d) Adrenal
i) Radiopharmaceuticals (I-123 MIBG, In-111 Octreoscan)
ii) Imaging techniques (planar, SPECT)
iii) Indications: pheochromocytoma, cortical adenoma

e) Neuroendocrine
i) Radiopharmaceuticals (In-111 Octreoscan)
ii) Imaging techniques (planar, SPECT)
iii) Indications: carcinoid, islet cell tumors, medullary thyroid cancer, pheochromocytoma/paraganglioma/ neuroblastoma

f) Parathyroid gland
i) Radiopharmaceuticals (Tc-99m MIBI/pertechnetate, I-123 NaI)
ii) Imaging techniques (planar, SPECT)
iii) Indications: hyperparathyroidism (adenoma, hyperplasia, ectopic)

g) Female reproductive system neoplasms
i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: staging disease, treatment strategy

h) Pregnancy Issues
i) Special considerations in nuclear radiology: patient preparation, instructions & dosimetry; dose reduction; breastfeeding; occupational rules & policies

i) Male reproductive system neoplasms
i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: staging disease, treatment strategy

j) Normal & other
i) Radiopharmaceuticals (all of above)
ii) Imaging techniques (all of above)
iii) Indications: all of above, miscellaneous

k) Artifacts & quality control
i) Patient issues: patient preparation, motion, positioning, contamination
ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
iii) Technical issues: instrumentation, acquisition & processing, quantitation (uptake; SUV)

8) Thoracic
a) Thromboembolic disease
i) Radiopharmaceuticals (Tc-99m MAA, Xe-133 gas, Tc-99m DTPA aerosol)
ii) Imaging techniques (planar, SPECT)
iii) Indications: acute or chronic pulmonary embolism

b) Non-thrombotic disease
i) Radiopharmaceuticals (Tc-99m MAA, Xe-133 gas, Tc-99m DTPA aerosol)
ii) Imaging techniques (planar, SPECT)
iii) Quantitative techniques: regional/split lung function
iv) Indications: fat emboli, hilar mass, vasculitis, pre-pulmonectomy & pulmonary transplant evaluation

c) Chronic obstructive airways disease (COPD) & airways disease
   i) Radiopharmaceuticals (Tc-99m MAA, Xe-133 gas, Tc-99m DTPA aerosol)
   ii) Imaging techniques (planar, SPECT)
   iii) Quantitative techniques: regional/split lung function
   iv) Indications: COPD, asthma, cystic fibrosis, mucus plug, pre-bullectomy evaluation

d) Benign neoplasm/mass
   i) Radiopharmaceuticals (F-18 FDG)
   ii) Imaging techniques (PET)
   iii) Indications: hamartoma, granuloma

e) Malignant neoplasm, primary
   i) Radiopharmaceuticals (Tc-99m MIBI, TI-201 chloride, In-111 OctreoScan; F-18 FDG)
   ii) Imaging techniques (SPECT; PET)
   iii) Quantitative techniques (differential/split lung analysis)
   iv) Indications: esophageal cancer, lung cancer, carcinoid, thymoma, mediastinal tumor, lymphoma

f) Malignant neoplasm, metastatic
   i) Radiopharmaceuticals (HDP/MDP; F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: staging disease, treatment strategy

g) Trauma
   i) Radiopharmaceuticals (Tc-99m HDP/MDP, Tc-99m MAA, Xe-133 gas, Tc-99m DTPA aerosol)
   ii) Imaging techniques (planar, SPECT)
   iii) Indications: rib fractures, pneumothorax, hemothorax, bronchopleural fistula

h) Infection & inflammation
   i) Radiopharmaceuticals (Ga-67 citrate, In-111 WBCs; F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: sarcoidosis, occupational lung disease, pneumonia, abscess, tuberculosis, MAI, pneumocystis pneumonia (PCP), histoplasmosis

i) Normal & other
   i) Radiopharmaceuticals (all of above)
   ii) Imaging techniques (all of above)
   iii) Indications: all of above, miscellaneous

j) Artifacts & quality control
   i) Patient issues: patient preparation, motion, positioning, contamination
   ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
   iii) Technical issues: instrumentation, acquisition & processing, quantitation (split lung; SUV)

9) Urinary
   a) Perfusion & function
   i) Radiopharmaceuticals (Tc-99m MAG3)
ii) Imaging techniques (planar)
iii) Quantitative analysis (relative function: peak time, $T_{1/2}$, 2-3 minute activity)
iv) Indications: renal dysfunction/failure, renal artery occlusion, renal vein thrombosis

b) Diuretic studies
i) Radiopharmaceuticals (Tc-99m MAG3)
ii) Imaging techniques (planar)
iii) Stress protocols (furosemide [Lasix])
iv) Quantitative analysis (relative function, $T'A$)
v) Indications: obstructive vs. non-obstructive hydronephrosis, stent function

c) Angiotensin converting enzyme inhibitor (ace-i) studies
i) Radiopharmaceuticals (Tc-99m MAG3)
ii) Imaging techniques (planar)
iii) Stress protocols (captopril, enalapril)
iv) Quantitative analysis (relative function, peak time, $T'A$, compared with baseline)
v) Indications: renovascular hypertension/renal artery stenosis

d) Cortical
i) Radiopharmaceuticals (Tc-99m DMSA/GH)
ii) Imaging techniques (planar, SPECT)
iii) Indications: relative function, Column of Bertin, scarring, ectopia, horseshoe kidney

e) Transplant
i) Radiopharmaceuticals (Tc-99m MAG3)
ii) Imaging techniques (planar)
iii) Quantitative analysis (peak time, $T'A$)
iv) Indications: acute tubular necrosis, rejection, drug toxicity (cyclosporine), complications (obstruction, infection, infarction, lymphocele/urinoma)

f) Leak
i) Radiopharmaceuticals (Tc-99m MAG3)
ii) Imaging techniques (planar, SPECT)
iii) Indications: urinoma, leak after transplant/other surgery, instrumentation, trauma

g) Benign Neoplasm
i) Radiopharmaceuticals (F-18 FDG)
ii) Imaging techniques (PET)
iii) Indications: angiomyolipoma, complex cystic mass

h) Malignant neoplasm, Primary
i) Radiopharmaceuticals (Ga-67 citrate; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: lymphoma, renal cell cancer
i) Malignant neoplasm, metastatic
i) Radiopharmaceuticals (Tc-99m HDP/MDP; F-18 FDG)
ii) Imaging techniques (planar, SPECT; PET)
iii) Indications: staging disease, treatment strategy
j) Infection & inflammation
   i) Radiopharmaceuticals (Tc-99m DMSA, Ga-67 citrate, In-111 WBCs; F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: pyelonephritis, abscess
k) Normal & other
   i) Radiopharmaceuticals (all of above)
   ii) Imaging techniques (all of above)
   iii) Indications: all of above, miscellaneous
l) Artifacts & quality control
   i) Patient issues: patient preparation, motion, positioning, contamination
   ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
   iii) Technical issues: instrumentation, acquisition & processing quantitation (T 1/2; SUV)

10) Vascular
   a) Patency
      i) Radiopharmaceuticals (Tc-99m pertechnetate, Tc-99m RBCs)
      ii) Imaging techniques (planar)
      iii) Indications: pre-operative evaluation, postoperative evaluation, deep venous thrombosis
   b) Malignant neoplasm, primary
      i) Radiopharmaceuticals (F-18 FDG)
      ii) Imaging techniques (planar, SPECT; PET)
      iii) Indications: sarcoma
   c) Malignant neoplasm, metastatic
      i) Radiopharmaceuticals (Tc-99m sulfur colloid; F-18 FDG)
      ii) Imaging techniques (planar; PET)
      iii) Indications: lymphatic mapping/sentinel lymph node (SLN); staging disease, treatment strategy
d) Infection & inflammation
   i) Radiopharmaceuticals (Ga-67 citrate, In-111 WBCs; F-18 FDG)
   ii) Imaging techniques (planar, SPECT; PET)
   iii) Indications: vasculitis, atherosclerotic disease, vascular graft infection, catheter/line infection
e) Normal & other
   i) Radiopharmaceuticals (all of above)
   ii) Imaging techniques (all of above)
   iii) Indications: all of above, miscellaneous
f) Artifacts & Quality Control
   i) Patient issues: patient preparation, motion, positioning, contamination
   ii) Radiopharmaceutical issues: dose preparation, dosing technique, altered biodistribution
   iii) Technical issues: instrumentation, acquisition & processing
1) Medical Knowledge:

Residents Must:
- Acquire knowledge of the physics, radiation safety, radiation biology, physiology, imaging equipment, imaging protocols, and disease processes pertaining to nuclear medicine and the relevant complimentary and competing modalities.
- Apply and reinforce this knowledge through the analysis of, interpretation of, and communication of results of nuclear studies.
- Apply and reinforce this knowledge through teaching others; presenting at conferences, meetings, journal clubs; and communicating with other members of the health and imaging teams.

2) Patient Care:

Residents Must:
- Provide compassionate, appropriate, and effective care and therapy for a patient's health problem.
- Communicate effectively and efficiently the results of imaging studies in a timely manner to physicians and other members of healthcare team.
- Provide imaging that is quality controlled,
- Ensure that diagnostic studies and procedures are safe for patient, adhering to best practices concerning radiation safety, administration of radiopharmaceuticals, and use of imaging equipment.
- Be able to perform and interpret all studies in nuclear medicine.
- Perform at least six therapies involving the oral administration of $^{131}$I: three with amounts of $^{131}$I equal to or less than 33 MCI, and three with amounts of $^{111}$In greater than mG must be an advocate for patient safety and high quality patient care.
- Gather appropriate clinical and historical information about patient in order to maximize analysis of a study or to provide effective therapy.
- Communicate compassionately and appropriately with patient and families.

3) Professionalism:

Residents Must:
- Recognize that patient and professional needs supersede self-interest.
- Demonstrate compassion, and respect for patients, staff, and colleagues.
- Demonstrate ability to maintain all of their professional responsibilities with respect to their colleagues, the hospital staff, their patients, and their community.
- Adhere to high ethical principles.
- Respect patient privacy and autonomy.
- Be accountable to patients, community, and profession.
- Be sensitive to the needs of a diverse population of patients, families, and professionals.
- Attend and participate in conferences, lectures, and meetings.
- Be actively available for helping technologists, colleagues, and referring physicians.

4) Practice-Based Learning and Improvement:

Residents Must:
- Demonstrate ability to acquire knowledge about their patient, utilize that knowledge to analyze a study or perform a procedure and render an appropriate interpretation.
- Demonstrate an ability to acquire, investigate, and critically assess new information to be able to improve care of patients.
- Demonstrate and develop habits of life-long learning.
- Demonstrate the ability to utilize current technology to optimize learning and provide optimal care. Be aware of the strengths and weaknesses of their own abilities and knowledge.
- Be willing to implement changes in their practice which will enhance patient care and outcome.

5) Systems-Based Practice:

Residents Must:
- Learn to work within and appreciate the components of the healthcare system at all levels, local and national.
- Be able to work effectively in various healthcare delivery systems. Participate in peer review and system error identification process. Participate in committees within radiology and the hospital. Be aware of health care costs at all levels.
- Have knowledge of the allocation of healthcare resources at all levels.

6) Interpersonal and Communication Skills:

Resident Must:
- Demonstrate appropriate and effective interpersonal and professional relationship skills.
- Be able to communicate effectively and to work cooperatively with colleagues, patients, families, and imaging team personnel.
- Learn to act in a consultative role. Demonstrate listening skills. Be able to accept criticism.
NM APPENDIX C

NUCLEAR MEDICINE I-131 CHECKLIST

Resident Name: _____________________________________________________

Instructions: During each Nuclear Medicine rotation at Florida Hospital, the assigned resident must keep track of all nuclear therapies on the form below. Residents must complete:

3 of I-131>33 mCi  
3 of I-131<33 mCi

Treatments to be board eligible. Completed log sheets must be placed in the residents' portfolio. This can be used in lieu of an excel worksheet.

Administering dosages of radioactive drugs to patients or human research subjects

3 of I-131>33 mCi

Technologist/Attending ____________________________  Date ____________________________

Technologist/Attending ____________________________  Date ____________________________

Technologist/Attending ____________________________  Date ____________________________

3 of I-131<33 mCi

Technologist/Attending ____________________________  Date ____________________________

Technologist/Attending ____________________________  Date ____________________________

Technologist/Attending ____________________________  Date ____________________________
Nuclear Medicine Laboratories Experience Form

1. Know isotopes used for imaging and therapy:
   - Production
   - Half life
   - Decay
   - Bio distribution
   - Energy

2. Know principles of generator and elution of isotopes

3. Safe handling of radionuclides

4. Radiation protection from isotope exposure

5. Operations of a nuclear pharmacy

6. Proper disposal of unused, decayed radionuclides/radiopharmaceuticals

7. Techniques for detailing with radiation spills

8. Formation of various radiopharmaceuticals

9. Use of calibration of equipment:
   - Well counter
   - Geiger counters

10. Quality control
Nuclear Medicine Laboratories Experience Form

Resident Name: _____________________________________________________________

Documentation of your CLT – classroom & laboratory training in nuclear medicine – of 200 hours is required by the end of your third year. This receipt will be kept in your personal file.

Resident Name (please print)____________________________________________________

- Radiation physics and instrumentation: 100 hours
- Radiation protection: 30 hours
- Mathematics, statistics and computer sciences pertaining to the use and measurement of radioactivity: 20 hours
- Radiation biology: 20 hours
- Radiopharmaceutical chemistry: 30 hours

The hours listed for each of the subjects above are suggested values and should not be interpreted as specific requirements.

Resident Signature ___________________________________________________________
by signing this – you confirm that you have achieved your CLT requirement

Date__________________________

Preceptor Signature _________________________________________________________
by signing this – you are attesting this resident achieved his/her CLT requirement

Date__________________________
Training of General Radiology Resident for Nuclear Medicine

Routine Exams: Clinical indications, protocols, doses:
- Bone scan
  - WB
  - 3-phase
  - SPECT
- V/Q Scans
- Hepatobiliary with and without EF
- Thyroid uptake & scan
- MUGA
- Parathyroid
- Renal scans
- PET/CT
- Cardiac
- Gastric emptying
- Liver/spleen imaging
- White cell scans
- Lymphoscintigraphy

Exams generally performed as emergencies, between 5 pm to 7 am, on weekends:
- Lung scans
- Hepatobiliary scans
- GI bleeding scans
- Brain death studies, rarely

Exams performed infrequently:
- Octreoscans
- MIBG
- Prostascints

Radioactive therapy: I\(^{131}\) x 3: date, Dx, dose

Thyroid evaluations: Palpation, Rx, Etc.

Radiopharmacy skills:
- Calculate doses
- Elevation of generator – 99Mo/99Tc
  - Long ½ life
  - Decay-growth curve
  - Parent/daughter → 5 hour half life
- Volume concentration
- Decay factors, curves
- Quality control – camera
- Probes
- Calibrators
- Kit preparation
- Draw up doses
- Lymphoscintigraphy infections
- Wipe test
Molecular Imaging: fundamentals
   NM physics:
   Radioactivity
   Decay
   Attenuation

Instrumentation:
   • ν carnerus
   • Geiger counters
   • PET scanners
   • Well counters
   • SPECT camera
   • Others

Quality Control:
   Radiopharms
   Instruments

Computers:

Radiation Safety:
   Brodistribution
   Quality control
   Compo minding of radipharm
   Prodition
   Physical property of
   Generator elution & quality control

Government Regulations:

ACGME Competency:

AC R appropriateness criteria:

ACR practice guidelines:

ACR/APDR initiative for Residents
By signing this document you are confirming that you have received and reviewed, with your preceptor, the abdominal imaging goals and objectives for this academic year.

This receipt will be kept in your personal file.

Resident Name (please print) ______________________________________________________

Resident Signature ________________________________________________________________

by signing this – you confirm that you have reviewed the G&O with your preceptor

Date __________________________________________________________

Preceptor Signature ______________________________________________________________

by signing this – you confirm that you have reviewed the G&O with the resident

Date __________________________________________________________