



NUCLEAR RADIOLOGY
CONTINUING CERTIFICATION EXAM STUDY GUIDE

Diplomates sitting for the Continuous Certification Exam may choose one, two, or three nuclear radiology modules. The first module will contain more fundamental concepts, whereas the second and third modules test more advanced topics in greater depth and breadth. All FDA-approved, currently available radiopharmaceuticals and applicable nonradioactive pharmaceuticals are within scope. Imaging techniques and protocols include planar, SPECT and SPECT/CT, and PET and PET/CT. Image quality/artifacts and radioisotope safety are part of the practice of nuclear radiology. Here is the general topic outline (not all topics are tested in each module).

Central Nervous System

- Brain viability (Brain death, Viable brain)
- Dementias & behavioral disorders (Alzheimer, Lewy body, Frontotemporal, Multi-infarct)
- Movement disorders (Parkinsonism, Essential tremor)
- Seizure focus (Ictal, Interictal)
- Cerebrovascular disease (Stroke, Vascular reserve/challenge tests, Diaschisis)
- Cerebrospinal fluid - Hydrocephalus (Normal pressure hydrocephalus, V-P shunt patency)
- Cerebrospinal fluid - Leak (Nose/ear, Idiopathic intracranial hypotension)

Cardiovascular & Lymphatic Systems

- Myocardial perfusion imaging - Coronary artery disease (Ischemia, Infarction/scar, Cardiomyopathy - ischemic, Stunned myocardium, Hibernating myocardium, Risk stratification)
- Myocardial perfusion imaging - Noncoronary artery disease (Cardiomyopathy - non-ischemic, Pulmonary hypertension)
- Myocardial metabolism & viability (Hibernating myocardium, Infarction/scar)
- Multigated acquisition/Gated cardiac blood pool imaging (Baseline function, Cardiotoxicity)
- Lymphatic patency - Lymphedema (Lower extremity, Upper extremity/breast-related)

Pulmonary System

- Ventilation & perfusion - Thromboembolism (Acute pulmonary embolism (PE), Chronic pulmonary emboli, Pulmonary hypertension due to PE)
- Ventilation & perfusion - Nonthromboembolism (Fat emboli, Hilar masses, Vasculitis, Pre-operative differential ("split lung"), Lung transplant, Pulmonary hypertension not due to PE, Pulmonary artery atresia, Right-to-left shunt, Pleural effusion)

- COPD/airways (COPD/emphysema, Asthma, Cystic fibrosis, Mucus plug, Swyer-James syndrome, Pneumothorax)

Gastrointestinal System

- Liver & spleen (Cirrhosis, Hepatic masses/cavernous hemangioma/focal nodular hyperplasia, Hepatic arterial perfusion/systemic shunting pre-radioembolization/implanted pump, Accessory spleen/splenosis/ splenomegaly/splenic masses, Ascites shunt patency)
- Biliary (Cholecystitis - acute/chronic, Gallbladder ejection fraction (GBEF), Biliary dyskinesia, Common bile duct obstruction, Biliary atresia, Neonatal hepatitis; Postoperative complications: Liver transplant, Bile leak/biloma, Afferent loop syndrome)
- Bowel - GI bleed (Active GI bleeding localization, Meckel diverticulum)
- Bowel - GI motility (Gastroparesis, Rapid gastric emptying/dumping, Gastroesophageal reflux)

Genitourinary System (including Breast)

- Renal perfusion & function - native kidneys (Dysfunction/failure/anuria, Renal artery occlusion/thrombosis, Renal vein thrombosis, Acute tubular necrosis, GFR calculation)
- Renal diuretic challenge - native kidneys (Hydronephrosis - obstructive, Hydronephrosis - nonobstructive, Stent function, Hydroureter)
- Renal cortex - native kidneys (Differential function/Pre-nephrectomy assessment, Pyelonephritis - acute/chronic, scarring, Column of Bertin; Congenital anomalies: Horseshoe, Multicystic dysplastic, Cross-fused ectopia, Duplex)
- Urinary leak - native kidneys (Urinoma, Post-surgical/instrumentation, Trauma)
- Renal transplant (Acute tubular necrosis, Rejection, Drug toxicity - cyclosporine; Complications: obstruction, infection, infarction, lymphocele, leak/urinoma)
- Bladder/Nuclear cystogram (Vesico-ureteral reflux)

Musculoskeletal System (including Integument)

- Tumor-like or associated conditions (Fibrous dysplasia, Paget disease, Heterotopic ossification, Hypertrophic osteoarthropathy)
- Metabolic & vascular conditions (Hyperparathyroidism, Renal osteodystrophy, Myelofibrosis, "Superscan", Sickle cell disease, Avascular necrosis, Complex regional pain syndrome, Mandibular condylar hyperplasia)
- Trauma (Fracture: Traumatic/stress/insufficiency/occult/nonaccidental; Neuropathic joint, Rhabdomyolysis)
- Extra-skeletal processes on bone scan - Benign (Metastatic calcification, Myocardial infarction/myocarditis/pericarditis/amyloidosis, Vascular calcification, Renal anomalies, Splenic abnormality/sickle cell disease)
- Extra-skeletal processes on bone scan - Malignant (Breast cancer, Lung cancer, Pleural effusion, Liver metastases, Renal cancer, Peritoneal ovarian carcinoma)
- Bone mineral density/Dual-energy absorptiometry (Osteoporosis, Osteopenia, Fracture risk)

Endocrine System (thyroid, parathyroid)

- Thyroid gland (Goiter *in situ*/substernal, Benign thyroid nodules, Multinodular gland - non-toxic, Ectopic/absent thyroid tissue, Thyroglossal duct/pyramidal lobe; Congenital: agenesis/lingual/ dyshormonogenesis, Struma ovarii)
- Thyroid gland - Hyperthyroidism (Graves, Thyroiditis, Toxic nodules, Multinodular goiter - toxic)
- Parathyroid gland (Adenoma, Hyperplasia, Ectopia)

Infection & Inflammation

- Central Nervous System (Abscess, Encephalitis, Toxoplasmosis, Malignant otitis externa, Sinusitis)
- Cardiovascular & Lymphatic Systems (Abscess, Pericarditis, Myocarditis, Sarcoidosis, Amyloidosis, Vascular graft/vascular catheter/line/device infection, Vasculitis, Atherosclerosis)
- Pulmonary System (Lung inflammation, Abscess, Mycobacterium avium-intracellulare, Pneumocystis pneumonia, Tuberculosis, Sarcoidosis, Occupational lung disease, Talc pleurodesis)
- Gastrointestinal System (Sialadenitis, Sjögren syndrome, H. pylori, Abscess, Inflammatory bowel disease)
- Genitourinary System (including Breast) (Renal abscess, Pyelonephritis; Ovarian/endometrial abscess; Orchitis, Prostatitis; Breast: Abscess/inflammation/mastitis/fat necrosis, Chest wall infection)
- Musculoskeletal System (including Integument) (Prosthesis Loosening/Infection, Bone abscess, Osteomyelitis, Cellulitis, Synovitis, Arthritis, Septic joint, Diskitis, Myositis)

Neoplasms

- Central Nervous System (Benign: Meningioma; Malignant, primary: Glioblastoma/Astrocytoma, Lymphoma, Tumor viability vs. Radiation necrosis; Malignant, metastatic: Tumor viability vs. Radiation necrosis, staging/restaging disease, Treatment strategy/monitoring)
- Cardiovascular & Lymphatic Systems (Malignant, primary: Lymphoma/leukemia, Langerhans cell histiocytosis; Malignant, metastatic: Lymphatic mapping/sentinel nodes, Breast cancer/melanoma)
- Pulmonary System (Solitary nodule: Hamartoma/granuloma, Cancer; Malignant, primary: Lung cancer, Carcinoid, Thymoma/thymic hyperplasia/rebound, Pleural tumor, Lymphoma; Malignant, metastatic: Staging/restaging disease, Treatment strategy/monitoring)
- Gastrointestinal System (Benign: Warthin tumor; Malignant, primary: Head & neck, Esophageal, Gastric, Hepatocellular, Biliary, Pancreatic, Colorectal, GI stromal tumor, Peritoneal, Lymphoma; Malignant, metastatic: Staging/restaging disease, Treatment strategy/monitoring)
- Genitourinary System (including Breast) (Benign: Kidney, ureter & bladder - Angiolipoma, Complex cystic mass; Breast and female reproductive system - Breast seroma/hematoma; Male reproductive system; Malignant, primary: Kidney, ureter & bladder - Lymphoma, Renal cell cancer; Breast and female reproductive system; Male reproductive system; Malignant,

metastatic: Kidney, ureter & bladder, Breast and female reproductive system, Male reproductive system, Staging/restaging disease, Treatment strategy/monitoring)

- Musculoskeletal System (including Integument) (Benign: Osteoma/osteoid osteoma, Chondromatous lesions, Bone island, Fibrous cortical defect, Exostosis, Cyst; Malignant, primary: Osteosarcoma, Ewing sarcoma, Multiple myeloma, Lymphoma, Melanoma; Malignant, metastatic: Lung cancer, Renal cancer, Breast and female reproductive system, Male reproductive system, Staging/restaging disease, Treatment strategy/monitoring)
- Endocrine System (Thyroid cancer: Malignant thyroid nodules, Thyroid remnant, Staging/restaging metastases, Treatment strategy/monitoring; Adrenal & neuroendocrine neoplasms: Medullary thyroid cancer, Pheochromocytoma/paraganglioma, Adrenal cortical adenoma, Carcinoid tumor, Pancreatic islet cell tumor, Neuroblastoma)

Therapy & Theranostics

- Gastrointestinal System - parenteral ^{90}Y microspheres (Hepatic malignancies)
- Musculoskeletal System - parenteral ^{223}Ra dichloride (Painful bone metastases)
- Endocrine System - oral ^{131}I NaI (Thyroid Gland: Hyperthyroidism, Goiter; Thyroid Cancer: Remnant ablation, Adjuvant therapy, Metastases)
- Adrenal & neuroendocrine - parenteral ^{177}Lu dotatate

Technical & Quality

- Patient issues/preparation
- Radiopharmaceutical issues/contamination
- Imaging issues/protocols/processing/artifacts

Physics & Instrumentation

- Physics (Radiation dose, Radiation physics, Quality assurance/control, Instrument performance)
- Radiation measurement instruments - Principles, Operation, Calibration, Quality Control (Geiger-Mueller survey meter, Ionization survey meter, Dose calibrator, Well counter)
- Cameras - Principles, Operation, Quality Control (Planar gamma camera, SPECT camera & SPECT/CT hybrid system, PET/CT hybrid system, Specialized cameras)
- Probes - Principles, Operation, Calibration, Quality Control (Intraoperative gamma, Thyroid uptake)

Radioisotope Safety

- Radiation protection (ALARA program: Radiation protection program, Audit program, Operating & emergency procedures including interventions; Radiation areas: Restricted, Public, Caution signs, Engineering controls)
- Mathematics of radioactivity measurement (Radioactive decay, Radioactive equilibrium, Units of radioactivity)
- Radiation biology (Radiation dose: Absorbed dose, Dose equivalent, Effective dose; Tissue reactions (deterministic effects), Linear no-threshold effects (stochastic), Risks of radiation-induced cancer)

- Management of radioactive sources (Managing packages, Sealed sources, Exempt quantities, Use records, Area surveys, Waste management/disposal)
- Regulatory exposure limits (Occupational dose limits, Pregnant workers, Public, Embryo/fetus, Respiratory protection, Individual monitoring, Safe use of unsealed license material)
- Radiopharmaceutical administration (Confirming dosage, Patient identity, Record-keeping, Fetal dose, Breastfeeding/lactation, Administration of prescribed dosage)
- Administrative/practice controls and responsibilities (NRC Authority/Agreement states; Personnel: Technologists, Radiation safety officer (RSO), Authorized user (AU), Licenses, Written directive, Oral I-131 NaI therapy safety - Inpatient/Outpatient; Radiopharmacy ("hot lab"): Safe procedures, Generator systems – Elution/Quality control/Record keeping, Patient issues)
- Radiation accidents/incidents (Medical events/reportable events; Radiation spills: Major/Minor)

SAMPLE QUESTIONS:

QUESTION 1



What is the most likely diagnosis for the finding on the ^{123}I NaI scan?

- A. Multinodular goiter
- B. Thyroid carcinoma
- C. Thyroiditis
- D. Lymphoma
- E. S

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ANSW

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QUESTION 2

To decrease the risk associated with lung perfusion scans in patients with pulmonary hypertension, which of the following modifications should be employed?

- A. Decrease both the number of $^{99\text{m}}\text{Tc}$ -MAA particles and the activity administered.
- B. Decrease the number of $^{99\text{m}}\text{Tc}$ -MAA particles but do not change the activity administered.
- C. Inject the $^{99\text{m}}\text{Tc}$ MAA slowly over 5 minutes.

D. Inject the $^{99\text{m}}\text{Tc}$ MAA as a rapid bolus over 2 seconds.

ANSWER = B